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-- End of Project Table of Contents --

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

The work to be performed under this project consists of providing the labor, equipment, and materials to construct a new Fuel Cell Testing Laboratory and related site work.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01300, "Submittals," in sufficient detail to show full compliance with the specification:

SD-18 Records

Submit the following items to the Contracting Officer:

Utility Outages
Connection Request
Request for Hot Work Authorization

1.4 CONTRACT DRAWINGS

The following drawings accompany this specification and are a part thereof.

Drawing No.:	Title:
ARCHITECTURA :	
CF -192200	Title Sheet
CF -192201	Arch. Floor & Ceiling Plans
CF -192202	Roof Plan & Details
CF -192203	North & East Elevations
CF -192204	South & West Elevations
CF -192205	Door & Room Finish Schedules
CF -192206	Interior Elevations & Schedules
CF -192207	Building Sections
CF -192208	Wall Sections & Details
CF -192209	Miscellaneous Details
CIVI :	
CF -192211	Site Plan
CF -192212	Utility Plan
CF -192213	Utility Details

CF -192214	Site Details

STRUCTURA :

CF -192215	Foundation Plan & Slab on Grade Plan
CF -192216	Roof Framing Plan
CF -192217	Foundation & Slab Sections & Details
CF -192218	Miscellaneous Details

MECHANICA :

CF -192219	HVAC Legend & Abbreviations
CF -192220	HVAC Floor Plan
CF -192221	HVAC Flow Diagrams Temperature Control
CF -192222	HVAC Flow Diagrams Temperature Control
CF -192224	HVAC Schedules
CF -192225	HVAC Schedules
CF -192248	Plumbing Floor Plan
CF -192249	Typical Details & Plumbing Notes
CF -192250	Fire Protection Plan

ELECTRICA :

CF -192227	Electrical Symbol Legend, Schedules & General Notes
CF -192228	Electrical Site Plan
CF -192229	Electrical Cable Tray Layout & Lighting Plan
CF -192230	Electrical Area Classification, Power, Grounding & Auxiliary Plans
CF -192231	Electrical One-Line
CF -192232	Electrical Riser Diagrams
CF -192233	Electrical Schematics, Details & Elevations
CF -192234	Electrical Panel Schedules, Sheet 1 of 2
CF -192235	Electrical Panel Schedules, Sheet 2 of 2
CF -192236	Electrical Equipment Schedules
CF -192237	Electrical Wiring Diagrams
CF -192238	Electrical Site Details & Bill of Materials
CF -192239	Grounding Details
CF -192240	First Floor Plan Bldg. 333
SK -181880	Low Voltage Distribution System Electrical One Line

Drawings and specifications shall be purchased by the Contractor from the source identified in the Bid Soliciation. Reference publications will not be furnished.

The Contractor shall immediately check furnished drawings and notify the Government of any discrepancies.

1.5 WORK SCHEDULING

Normal duty hours for work shall be from 7:30 a.m. to 5:00 p.m., Monday through Friday. Requests for additional work shall require written approval from the Contracting Officer 3 days in advance of the proposed work period.

The Contractor shall telephone the Contracting Officer's Technical Representative each morning between 8 a.m. and 8:30 a.m. and report the following:

Themselves
Company name and contact
Work Area
Number of personnel on the job

The Contractor shall require each subcontractor to comply with the above requirements in the Contractors absense.

1.6 GOVERNMENT-FURNISHED PROPERTY

The Government will furnish to the Contractor the following property to be incorporated or installed in the work, or used in its performance.

DESCRIPTIO	QUANTIT	AVAILABL
Paper Towel Dispensers	2	Upon request

Quantities indicated for the above-listed items marked with an asterisk are estimates. It is the intention of the Government to furnish all quantities of the asterisk items required to complete the work as specified and the various quantities will be adjusted when necessary.

Quantities stated for the above items not marked with an asterisk are all that will be furnished by the Government. The Contractor shall furnish any additional quantities required.

1.7 ON-SITE PERMITS

1.7.1 Utility Outages and Connections

Work shall be scheduled to hold outages to a minimum.

Utility outages and connections required during the prosecution of work that affect existing systems shall be arranged for at the convenience of the Government and shall be scheduled outside the regular working hours or on weekends.

The Contractor shall not be entitled to additional payment for utility outages and connections required to be performed outside the regular work hours.

Requests for utility outages and connections shall be made in writing to the Contracting Officer at least 15 working days in advance of the time required. Each request shall state the system involved, area involved, approximate duration of outage, and the nature of work involved.

1.7.2 Hot Work Authorization

ACTIVIT	SUBMISSION DAT	SUBMISSION FORM
Hot Work	7 days prior to work	NASA Form C-7A & NASA Form C-7B

Permits shall be posted at a conspicuous location in the construction area.

Burning of trash or rubbish is not permitted.

1.7.3 Confined Space Permits

ACTIVIT	SUBMISSION DAT	SUBMISSION FORM
Confined Space	7 days prior to work	NASA Form C-199

1.7.4 Safety Permits

Requests for Safety Permits shall be submitted 30 days prior to scheduled work.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01031

OPTION ITEMS

PART 1 GENERAL

1.1 SUMMARY

This section contains the optional work shown on the drawings and described in the specifications.

Additive item work is defined as additional work of major elements of the construction, which may, at the Government's option and under terms established by the Schedule, be added to the requirements of the contract.

1.2 SUBMITTALS (Not Applicable)

1.3 ADDITIVE ITEM REQUIREMENTS

The following is a listing of additive items in order of acceptance:

a. Option No. 1 - Site Paving

1.3.1 Option No. 1 - Site Paving

Amount to be added to the Base Bid for constructing driveway and pavement.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01104

SOIL REMOVAL PROCEDURES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR Part 1910	(1993) Occupational Safety and Health Standards
40 CFR Part 262	(1993) Standards Applicable to Generators of Hazardous Waste
49 CFR Part 171	(1993) General Information, Regulations and Definitions
49 CFR Part 172	(1993) Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR Part 178	(1993) Shipping Containers Specifications

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01, Data

Container Sizes and Suppliers

Provide sizes and suppliers of drums, roll-offs, dump trailers, dump trucks, tanker trucks and frac tanks prior to use for approval.

Provide name of licensed hazardous waste hauler 2 weeks prior to transporting waste.

SD-08, Statements

Hazardous Communication Program

For companies performing hazardous waste operations, a Written

Program which address the evaluation of the potential hazards of chemicals in the work place, communicating information concerning these hazards to employees and descriptions of appropriate protective measures. Three (3) copies of the Hazard Communication Program shall be submitted.

Site Specific Health and Safety Plan

For companies performing hazardous waste operations,a Detailed Description of the work to be performed shall be submitted. The plan shall include but not be limited to objectives, methods, resources and personnel required to complete the task. Three (3) copies shall be submitted.

Site Specific Work Plan

For companies performing hazardous waste operations, a Detailed Description of the work to be performed shall be submitted. The plan shall include but not be limited to objectives, methods, resources and personnel required to complete the task. Three (3) copies shall be submitted.

SD-09, Reports

A Detailed Description of the specific task, methods and procedures used in performing the work shall be submitted. Include dates, locations, maps and other pertinent data in report. Reports shall be submitted upon completion of task.

SD-13, Certificates

Training Certificates

Provide 40 hour hazardous waste operations and emergency response training certificates, annual 8 hour refresher training certificates, 8 hour supervisor training certificates, and proof of hazardous materials employee training.

SD-13, Certificates

Transportation Licenses

Licenses for Vehicles and Companies transporting hazardous waste shall be submitted.

Approvals

Letters, forms, or other written documents supplied to the Contractor from the facility designated for the disposal of hazardous or solid waste acknowledging the wastes are acceptable for disposal. All approvals shall be on company letterhead and bear the signature of an authorized representative of the disposal facility.

Profiles

Profile Waste Profile Sheets, Waste Product Questionnaires, or Waste Characterization Reports describing the type of solid or hazardous waste generated, volume, frequency, generator name and address, broker and certification statement.

SD-18, Records

Provide Disposal Tickets or other records supplied by the disposal facility documenting the volume of waste material disposed of at the disposal facility.

SD-18, Records

Manifests

Provide Hazardous Waste or Solid waste Manifests completed by the Contractor describing the waste being disposed in accordance with CFR 40 Part 261.

Land Disposal Restriction Notification forms shall be included if applicable.

1.3 QUALITY ASSURANCE

A complete waste profile form, analytical data, manifest, and disposal facility approval shall be submitted to the COTR 2 weeks prior to shipment.

No materials shall be removed from the site without written authorization from the Government.

Personnel performing hazardous waste work shall be trained pursuant to 29 CFR Part 1910, Hazardous Waste Operations and Emergency Response and 49 CFR Part 172, Transportation of Hazardous Materials.

Transportation of hazardous waste shall be performed by a licensed hazardous waste hauler with proper state permits. The name of the transporter shall be submitted to the COTR a minimum of 2 weeks prior to transporting.

The COTR will obtain the required NASA signature on all manifests (and Land Disposal Restriction Forms if applicable) for hazardous and solid waste soil shipments in compliance with 40 CFR Part 262.

PART 2 PRODUCTS

2.1 DRUMS

Metal and fiberglass drums shall comply with 49 CFR Part 178.

Drums shall be marked with the manufacturer's certification, specification, approval, or exemption mark.

Reconditioned drums shall be free of old labels and markings.

Containers shall be of a suitable size and constructed of material which is compatible with the waste being placed in them.

Drums shall be identified with number provided by COTR.

2.2 ROLL-OFFS

Containers shall be leak proof, sift proof and lined with 10 mil plastic liner to prevent materials from coming into contact with the inner surface of the container.

Containers shall be constructed of materials which are compatible with the waste being placed in them.

Containers shall be covered with leak proof tarpaulin and secured at all times except when being loaded so that no foreign materials, debris, or rainwater enters the container.

2.3 DUMP TRAILERS AND SUMP TRUCKS

Containers shall be leak proof, sift proof and lined with 10 mil plastic liner to prevent materials from coming into contact with the inner surface of the container.

Containers shall be covered with a tarpaulin and secured at all times except when being loaded so that no foreign materials, debris, or rainwater enters the container.

2.4 TANKER TRUCKS

Inner and outer valves shall be in working condition with visible means of secure closure to prevent leakage.

Containers shall be made of material which are compatible for use with waste liquids.

2.5 FRAC TANKS

Inner and outer valves shall be in working condition with visible means of secure closure to prevent leakage.

Holding tanks used for the temporary storage shall be made of material which are compatible with the liquid waste.

PART 3 EXECUTION

3.1 DISPOSAL

The soil excavated from the areas indicated on the contract drawings has been designated as an F002 RCRA listed hazardous waste due to the suspected presence of chlorinated solvents, primarily 1,1,1 trichloroethane, with concentrations less than 5 ppm. All soil designated as hazardous waste

shall be disposed of at a State EPA licensed hazardous waste facility. The name and location of the facility designated for disposal shall be submitted a minimum of 2 weeks prior to excavation activities. The Contractor shall comply with the requirements of the disposal facility.

Any potential hazardous waste soils that are reclassified to a solid waste after sampling is completed shall be disposed of at an Ohio EPA licensed solid waste facility. The name and location of the facility designated for disposal shall be submitted a minimum of 2 weeks prior to excavation activities. The Contractor shall comply with the requirements of the disposal facility.

Any excess, nonhazardous waste soils that will not be used as backfill on the jobsite shall be transported to a designated storage location on Government property.

3.2 STORAGE

The Contractor shall obtain approval from the COTR for the location of any temporary stored soils.

Excavated solid waste soil not immediately disposed of shall be placed in containers or stored on 10 mil polyethylene and covered with the polyethylene to prohibit infusion of rainwater or foreign debris.

Containers used for the storage of solid waste soil shall be labeled with non-hazardous or non-regulated labels and the date of generation, COTR's name and phone number, and the Contractor's name.

All containers used for the storage and transportation of hazardous waste soils shall meet the requirements of 49 CFR Part 178. These containers shall be labeled in accordance with 40 CFR Part 262 prior to shipping, and shall include the date of generation, the COTR's name & phone number, and the Contractor's name.

Containers used for the transportation of hazardous waste soil shall be labeled in accordance with 49 CFR Part 171 and 49 CFR Part 172.

Storage of any hazardous waste soil shall not exceed 90 days from the date of generation in accordance with 40 CFR Part 262.

3.3 TRANSPORATION

Vehicles transporting waste soils for disposal shall be weighed on NASA scales located at Building 119. Vehicles shall be weighed by the Government prior to, and after, loading of excavated materials.

Vehicles transporting waste soils for disposal shall be accompanied by a Property Pass, issued and signed by the COTR, listing the vehicle contents and the name of the disposal facility.

The Contractor shall obtain the signature of the COTR on all shipping papers related to solid waste.

A manifest document number shall be obtained by the Contractor from the COTR.

The Contractor shall, at least 2 weeks prior to shipping hazardous waste, supply a completed waste profile form, manifest, and disposal facility approval, to the COTR.

Containers used for the transportation of hazardous waste soils shall be labeled in accordance with 49 CFR Part 171 and 49 CFR Part 172.

The Contractor shall provide the COTR with evidence of training for employees handling hazardous materials in compliance with 49 CFR Part 172.

The COTR will obtain the required NASA signature on all manifests (and Land Disposal Restriction Forms if applicable) for hazardous waste shipments in compliance with 40 CFR Part 262.

3.4 HAZARDOUS WASTE OPERATIONS

To reduce the spread of hazardous waste soil from contaminated areas to clean areas, the contractor shall delineate zones on the site where different types of operations will occur. The flow of personnel among these zones shall be controlled.

The site shall be divided into at least 3 zones:

1. Exclusion Zone - This is the area where most of the work is accomplished and contamination is present. The outer boundary shall be identified as the Hotline. The Hotline shall be marked by hazard tape, signs, barricades and fences. Flow of personnel and equipment shall be controlled.

2. Contamination Reduction Zone - This is the transition area between the contamination area and the clean area. Decontamination of personnel and equipment shall take place in this area. The outer boundary shall be identified as Contamination Control Line.

3. Support Zone - This is the outermost area. No contamination of any kind shall exist in this area. Administrative and support functions shall be performed in this area.

Hazardous waste operations shall be performed by personnel trained pursuant to 29 CFR Part 1910 (Hazardous Waste Operations and Emergency Response).

The Contractor shall prevent storm water runoff from entering any open hazardous waste excavation. Any water which accumulates in such an excavation shall be considered a hazardous waste liquid and shall be containerized fro analysis. Subsequent transportation and disposal shall be coordinated with the COTR, and be in accordance with this Section if the analytical testing determines the liquid to classified as a hazardous waste by NASA.

-- End of Section --

SECTION 01315

PROJECT MEETINGS

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

A Project Submittal Schedule shall be submitted in accordance with paragraph entitled, "Project Meetings," of this section.

The Contractor shall submit a Monthly Progress Report at the first meeting of each month.

1.4 PRECONSTRUCTION CONFERENCE

The Contractor shall attend a preconstruction conference scheduled by the Contracting Officer. Work shall not commence prior to the conference. Subcontractor representatives shall attend.

Discussion shall address project orientation, personnel contact, safety issues, permits, deficiencies, and the location of the Contractor's office.

1.5 PROJECT MEETINGS

The Contractor shall attend weekly project meetings scheduled by the Government. Subcontractor representatives shall attend.

A Monthly Progress Report shall be submitted with address the progress schedule, potential factors of delay, deficiencies, material delivery schedules, submittals, and safety issues.

A Project Submittal Schedule shall be submitted showing full coordination with the project schedule. All products and tests under each submittal number shall be prioritized and linked to the progress schedule.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

A standard transmittal form provided by the Government shall be used to transmit each submittal.

Submittal Description (SD): Drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials to be furnished by the Contractor explaining in detail specific portions of the work required by the contract.

The following items, SD-01 through SD-11, are descriptions of data to be submitted for the project. The requirements to actually furnish the applicable items will be called out in each specification.

SD-01 Preconstruction Submittals

Submittals which are required prior to a notice to proceed on a new contract. Submittals required prior to the start of the next major phase of the construction on a multi-phase contract. Schedules or tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work, submitted prior to contract notice to proceed or next major phase of construction.

SD-02 Shop Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, detail of fabrications, layout of particular elements, connections, and other relational aspects of the work.

SD-03 Product Data

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents.

SD-04 Samples

Samples, including both fabricated and unfabricated physical examples of materials, products, and units of work as complete units or as portions of units of work.

SD-05 Design Data

Design calculations, mix design analyses, or other data, written in nature, and pertaining to a part of the work.

SD-06 Test Reports

Written reports of a manufacturer's findings of his product during field inspections, attesting that the products are installed in accordance with the manufacturer's installation instructions, shop drawings, or other manufacturer's requirements. Written reports by a general contractor or his subcontractors including daily logs reporting on the progress of daily activities or attesting that the work has been installed in accordance with the contract plans and specifications.

SD-07 Certificates

A document, required of the Contractor, or through the Contractor by way of a supplier, installer, manufacturer, or other Lower Tier Contractor, the purpose of which is to further the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications, or other verification of quality.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

1.4 PREPARATION

1.4.1 Marking

Permanent marking shall be provided on each submittal to identify it by contract number; transmittal date; Contractor's, Subcontractor's, and supplier's name, address(es) and telephone number(s); submittal name; specification or drawing reference; and similar information to distinguish it from other submittals. Submittal identification shall include space to receive the review action by the Contracting Officer.

1.4.2 Drawing Format

Drawing submittals shall be prepared on translucent, reproducible sheets, not less than 210 by 297 millimeter nor larger than 841 by 1189 millimeter in size, except for full size patterns or templates. Drawings shall be prepared to accurate size, with scale indicated, unless other form is required. Drawing reproducibles shall be suitable for microfilming and reproduction on the Diazo or Ozalid machines and shall be of a quality to produce clear, distinct lines and letters. Drawings shall have dark lines

on a white background.

Copies of each drawing shall have the following information clearly marked thereon:

a. Job name, which shall be the general title of the contract drawings.

b. Date of the drawings and revisions.

c. Name of Contractor.

d. Name of Subcontractor.

e. Name of the item, material, or equipment detailed thereon.

f. Number of the submittal (e.g., first submittal, etc.) in a uniform location adjacent to the title block.

g. Government contract number shall appear in the margin, immediately below the title block.

Drawings shall be numbered in logical sequence. Contractor may use his own number system. Each drawing shall bear the number of the submittal in a uniform location adjacent to the title block. Government contract number shall appear in the margin, immediately below the title block, for each drawing.

A blank space, no smaller than 51 millimeter shall be reserved on the right hand side of each sheet for the Government disposition stamp.

1.4.3 Data Format

Required data submittals for each specific material, product, unit of work, or system shall be collected into a single submittal and marked for choices, options, and portions applicable to the submittal. Marking of each copy of product data submitted shall be identical. Partial submittals will not be accepted for expedition of construction effort.

1.4.4 Samples

Samples shall be physically identical with the proposed material or product to be incorporated in the work, fully fabricated and finished in the specified manner, and full scale. Where variations in color, finish, pattern, or texture are inherent in the material or product represented by the sample, multiple units of the sample, showing the near-limits of the variations and the "average" of the whole range (not less than 3 units), shall be submitted. Each unit shall be marked to describe its relation to the range of the variation. Where samples are specified for selection of color, finish, pattern, or texture, the full set of available choices shall be submitted for the material or product specified. Sizes and quantities of samples shall represent their respective standard unit.

1.5 SUBMISSION REQUIREMENTS

1.5.1 Schedules

Within 30 days of notice to proceed, the Contractor shall provide, for approval by the Contracting Officer, the following schedule of submittals:

a. A schedule of shop drawings and technical submittals required by the specifications and drawings. Schedule shall indicate the specification or drawing reference requiring the submittal; the material, item, or process for which the submittal is required; the "SD" number and identifying title of the submittal; the Contractor's anticipated submission date and the approval need date.

b. A separate schedule of other submittals required under the contract but not listed in the specifications or drawings. Schedule will indicate the contract requirement reference; the type or title of the submittal; the Contractor's anticipated submission date and the approved need date (if approval is required).

c. Submittals called for by the contract documents will be listed on one of the above schedules. If a submittal is called for but does not pertain to the contract work, the Contractor shall include it in the applicable schedule and annotate it "N/A" with a brief explanation. Approval of the schedules by the Contracting Officer does not relieve the Contractor of supplying submittals required by the contract documents but which have been omitted from the schedules or marked "N/A".

d. Copies of both schedules shall be re-submitted monthly annotated by the Contractor with actual submission and approval dates. When all items on a schedule have been fully approved, no further re-submittal of the schedule is required.

1.5.2 Drawings Submittals

One translucent reproducible copy(s) and five blackline or blueline opaque print(s) of each drawing shall be submitted. Three prints, marked with review notations by the Contracting Officer, will be returned to the Contractor.

1.5.3 Data Submittals

Six complete sets of indexed and bound product data shall be submitted. Three sets, marked with review notations by the Contracting Officer, will be returned to the Contractor.

1.5.4 Samples

One set of identified samples shall be submitted. A copy of the transmittal form, marked with review notations including selections by the Contracting Officer, will be returned to the Contractor.

Samples that are intended or permitted to be returned and actually incorporated in the work are so indicated in the individual technical sections. These samples will be returned to the Contractor, at his expense, to be clearly labeled, with installation location recorded. Samples shall be in undamaged condition at the time of installation.

Where mockups and similar large samples are required by individual technical sections, it is recognized that these are a special type of sample which cannot be readily "transmitted" as specified for submittal of samples. Otherwise, and except as indicated in the individual technical sections, the requirements for samples shall be complied with and a transmittal form shall be processed for each mockup, to provide a record of the activity.

1.6 GOVERNMENT'S REVIEW

1.6.1 Review Notations

Contracting Officer will review submittals and provide pertinent notation within 15 calendar days after date of submission. Submittals will be returned to the Contractor with the following notations:

a. Submittals marked "approved" authorize the Contractor to proceed with the work covered.

b. Submittals marked "approved as noted" authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections. Notes shall be incorporated prior to submission of the final submittal.

c. Submittals marked "return for correction" require the Contractor to make the necessary corrections and revisions and to re-submit them for approval in the same routine as before, prior to proceeding with any of the work depicted by the submittal.

d. Submittals marked "not approved" or "disapproved" indicate noncompliance with the contract requirements and shall be re-submitted with appropriate changes. No item of requiring a submittal shall be accomplished until the submittals are approved or approved as noted.

e. Contractor shall make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes" shall be given to the Contracting Officer. Approval of the submittals by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. Contractor shall be responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Government requiring rejection and removal of such work at the Contractor's expense.

f. If changes are necessary to approved submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change shall be accomplished until the changed submittals are approved.

1.6.2 Sample Approval

Contractor shall furnish, for the approval of the Contracting Officer, samples required by the specifications or by the Contracting Officer. Shipping charges shall be paid by the Contractor. Materials or equipment requiring sample approval shall not be delivered to the site or used in the work until approved in writing by the Contracting Officer.

Each sample shall have a label indicating:

a. Name of project

b. Name of Contractor

c. Material or equipment

d. Place of origin

e. Name of producer and brand

f. Specification section to which samples applies

g. Samples of furnished material shall have additional markings that will identify them under the finished schedules.

Contractor shall submit to the Contracting Officer two samples of materials where samples are requested. Contractor shall transmit with each sample a letter, original and two copies, containing the above information.

Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify any contract requirements. Before submitting samples, the Contractor shall assure that the materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Materials and equipment incorporated in the work shall match the approved samples. If requested, approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of the contract. Samples not approved will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make of that material. Government reserves the right to disapproved any material or equipment which previously has proved unsatisfactory in service.

Variations from contract requirements shall be specifically pointed out in transmittal letters. Failure to point out deviations may result in the Government requiring rejection and removal of such work at no additional cost to the Government.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer for testing. Samples failing to meet contract requirements will automatically void previous approvals. Contractor shall replace such materials or equipment to meet contract requirements.

Approval of the Contractor's samples by the Contracting Officer shall not relieve the Contractor of his responsibilities under the contract.

1.7 PROGRESS SCHEDULE

1.7.1 Bar Chart

Contractor shall:

a. Submit the progress chart, for approval by the Contracting Officer, at the Preconstruction Conference in one reproducible and 4 copies.

b. Prepare the progress chart in the form of a bar chart utilizing form "Construction Progress Chart" or comparable format acceptable to the Contracting Officer.

c. Include no less than the following information on the progress chart:

(1) Break out by major headings for primary work activity.

(2) A line item break out under each major heading sufficient to track the progress of the work.

(3) A line item showing contract finalization task which includes punch list, clean-up and demolition, and final construction drawings.

(4) A materials bar and a separate labor bar for each line item. Both bars will show the scheduled percentage complete for any given date within the contract performance period. Labor bar will also show the number of men (man-load) expected to be working on any given date within the contract performance period.

(5) The estimated cost and percentage weight of total contract cost for each materials and labor bar on the chart.

(6) Separate line items for mobilization and drawing submittal and approval. (These items are to show no associated costs.)

d. Update the progress schedule in one reproduction and 4 copies every 30 days throughout the contract performance period.

1.8 STATUS REPORT ON MATERIALS ORDERS

Within 15 days after notice to proceed, the Contractor shall submit, for approval by the Contracting Officer, an initial status report on materials orders. This report will be updated and re-submitted every 30 days as the status on material orders changes.

Report shall list, in chronological order by need date, materials orders necessary for completion of the contract. The following information will be required for each material order listed:

a. Material name, supplier, and invoice number.

b. Bar chart line item or CPM activity number affected by the order.

c. Delivery date needed to allow directly and indirectly related work to be completed within the contract performance period.

d. Current delivery date agreed on by supplier.

e. When item d exceeds item c, the effect that delayed delivery date will have on contract completion date.

f. When item d exceeds item c, a summary of efforts made by the Contractor to expedite the delayed delivery date to bring it in line with the needed delivery date, including efforts made to place the order (or subcontract) with other suppliers.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01411

GENERAL SAFETY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES

The publications listed below form a part of this section to the extent referenced:

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	(1996) Occupational Safety and Health Standards
29 CFR 1926	(1996) Safety and Health Regulations for Construction

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA NHB 1700.1	(1993) (V1-B) NASA Safety Policy and Requirements Documents

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-08 Statements

Statements shall be submitted for the following items in accordance with paragraphs entitled, "Safety Plan" and "Protection Plan," of this section.

Safety Plan
Protection Plan

SD-13 Certificates

License Certificates for Radiation Materials and Equipmentshall be submitted by the Contractor for all specialized material and equipment that could cause fatal harm to construction personnel or to the construction project.

SD-18 Records

Records shall be submitted in accordance with paragraph entitled, "Gas Protection," of this section.

1.3.1 Safety Plan

Contractor shall submit a site specific safety plan to the Contracting Officer for approval within 15 calendar days after notice to proceed. Compliance to the safety plan will be met. Copy of the approved document shall be made available at the Contractor's field office upon request from personnel working at the site. This document shall also be available to the Contracting Officer's Technical Representative and representatives of the Safety Assurance Office.

Safety plan shall include, as a minimum, the following:

a. Safety program objectives.

b. Methods to attain safety objectives.

c. Responsibility of key personnel for the Contractor.

d. Safety meetings, surveys, inspections, and reports.

e. Disaster and emergency programs.

f. Lists of key personnel to be contacted in times of emergency.

g. Program to show compliance with Federal OSHA Safety and Health Standards 29 CFR 1910 and 29 CFR 1926 and various safety requirements of NASA NHB 1700.1.

h. Methods to comply with the requirement for immediate reporting of accidents to the Contracting Officer.

i. Statement that the Contractor will not invalidate the integrity of safety systems without proper authorization.

j. Procedures for emergency actions to be taken to secure dangerous conditions, to protect personnel, and secure work areas in the event of accident or an act of nature.

l. Procedures for securing the accident site so that the area remains secure until arrival of a safety investigator. Accident site will remain secured until released by the Contracting Officer.

m. Provide MSDS sheets for all hazardous materials which will be used. Methods for handling and storage shall be identified.

1.3.2 Protection Plan

Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage.

1.4 GENERAL SAFETY PROVISIONS

Contractor shall take safety and health measures in performing work under this Contract. Contractor shall meet with the Contracting Officer to develop a mutual understanding relative to administration of the safety plan. Contractor is subject to applicable federal, state, and local laws, regulations, ordinances, codes, and orders relating to safety and health in effect on the date of this Contract.

During the performance of work under this Contract, the Contractor shall comply with procedures prescribed for control and safety of persons visiting the project site. Contractor is responsible for his personnel and for familiarizing each of his subcontractors with safety requirements. Contractor shall advise the Contracting Officer of any special safety restriction he has established so that Government personnel can be notified of these restrictions.

1.5 SAFETY LOCKOUT/TAGOUT PROCEDURES

Contractor shall ensure that each employee is familiar with and complies with these procedures and 29 CFR 1910.147.

Contracting Officer will, at the Contractor's request, apply lockout/tagout tags and take other actions that, because of experience and knowledge, are known to be necessary to make the particular equipment safe to work on.

No person, regardless of position or authority, shall operate any switch, valve, or equipment that has an official lockout/tagout tag attached to it, nor shall such tag be removed except as provided in this section.

No person shall work on any equipment that requires a lockout/tagout tag unless he, his immediate supervisor, project leader, or a subordinate has in his possession the stubs of the required lockout/tagout tags.

When work is to be performed on electrical circuits, the work shall be performed only by personnel qualified observing the required safety clearance.

A supervisor who is required to enter an area protected by a lockout/tagout tag will be considered a member of the protected group provided he notifies the holder of the tag stub each time he enters and departs from the protected area.

Identification markings on building light and power distribution circuits shall not be relied on for established safe work conditions.

Before clearance will be given on any equipment other than electrical (generally referred to as mechanical apparatus), the apparatus, valves, or systems shall be secured in a passive condition with the appropriate vents, pins, and locks.

Pressurized or vacuum systems shall be vented to relieve differential pressure completely.

Vent valves shall be tagged open during the course of the work.

Where dangerous gas or fluid systems are involved, or in areas where the environment may be oxygen deficient, system or areas shall be purged, ventilated, or otherwise made safe prior to entry.

1.5.1 Tag Placement

Lockout/tagout tags shall be completed in accordance with the regulations printed on the back thereof and attached to any device which, if operated, could cause an unsafe condition to exist.

If more than one group is to work on any circuit or equipment, the employee in charge of each group shall have a separate set of lockout/tagout tags completed and properly attached.

When it is required that certain equipment be tagged, the Government will review the characteristics of the various systems involved that affect the safety of the operations and the work to be done; take the necessary actions, including voltage and pressure checks, grounding, and venting, to make the system and equipment safe to work on; and apply such holdofflockout/tagout tags to those switches, valves, vents, or other mechanical devices needed to preserve the safety provided. This operation is referred to as "Providing Safety Clearance."

1.5.2 Tag Removal

When any individual or group has completed its part of the work and is clear of the circuits or equipment, the supervisor, project leader, or individual for whom the equipment was tagged shall turn in his signed lockout/tagout tag stub to the Contracting Officer. That group's or individual's lockout/tagout tags on equipment may then be removed on authorization by the Contracting Officer.

1.6 ACCIDENT TREATMENT AND RECORDS

Contractor shall post emergency first aid and ambulance information at project site.

Contractor employees may utilize Government dispensary facilities located in Building 15 for injury and emergency medical treatment. Such treatment shall be recorded by the Contractor on form 1627, Mishap Report. Contact Office of Safety, Environmental and Mission Assurance. (Telephone (216) 433-3057

1.7 FIRE PREVENTION AND PROTECTION

Open-flame heating devices will not be permitted except by approval in writing from the Contracting Officer. Approval for the use of open fires and open-flame heating devices will not relieve the Contractor from the responsibility for any damage incurred because of fires.

Burning trash, brush, or wood on the project site shall not be permitted.

1.8 USE OF EXPLOSIVES

Explosives shall not be used or brought to the project site without prior written approval from the Contracting Officer. Such approval shall not relieve the Contractor of responsibility for injury to persons or for damage to property due to blasting operations.

Storage of explosives, when permitted on Government property, shall be only where directed and in approved storage facilities. These facilities shall be kept locked at all times except for inspection, delivery, and withdrawal of explosives.

1.9 ELECTRICAL

Contractor shall appoint an individual responsible for the electrical safety of each work team to restrict entry to dangerous locations to those authorized by him jointly with the Government.

1.10 UNDERGROUND UTILITIES

Safety clearance from the Contracting Officer is required before any Contractor personnel enters a manhole. Contractor shall contact the Contracting Officer for support services by calling (216) 433-3057 at least 24 hours in advance.

Contractor shall be responsible for removing water and debris before commencement and during execution of work in manholes.

1.11 FACILITY OCCUPANCY CLOSURE

Streets, walks, and other facilities occupied and used by the Government shall not be closed or obstructed without written permission from the Contracting Officer.

1.12 PROTECTION OF WORK

Prior to performing any excavation work or any surface penetrations 150 millimeter or deeper (such as driving stakes more than 150 millimeter in the ground) on any ground surface, the Contractor shall obtain from the inspection office the current subsurface utility drawing of the particular area to be worked on. Contractor shall stake out subsurface high voltage cables, communication cables, and pipe lines indicated within the scope of the work contemplated. After exposure, the Contractor shall obtain agreement from the Contracting Officer on how much closer to cable or pipe the excavations can be permitted.

Contractor shall notify the Contracting Officer, 48 hours prior to the start of excavation work or surface penetration, to enable the Contracting Officer to review measures being taken to prevent hazard to employees and possible damage to subsurface utilities. Where emergency conditions preclude the 48 hours advance notification, the Contractor shall immediately inform the Contracting Officer of his intention to initiate work prior to actual start of activity.

After obtaining clearance from the Contracting Officer, the Contractor shall proceed with excavating work, or other surface penetration work. Contractor, however, shall temporarily halt any machine excavation work or other surface penetration when approaching within 3 meter of the staked-out cable or pipe line until the Contractor has exposed the cable or pipe by hand excavation to fix its location.

1.13 GAS PROTECTION

Contractor shall have one or more employees properly trained in operation of gas testing equipment and formally qualified as gas inspectors who shall be on duty during times workmen are in confined spaces. Their primary functions shall be to test for gas and operate testing equipment. Unless equipment of constant supervisory type with automatic alarm is employed, gas tests shall be made at least every 2 hours or more often when character of ground or experience indicates gas may be encountered. A gas test shall be made before workmen are permitted to enter the excavation after an idle period exceeding one-half hour.

Readings shall be permanently recorded daily, indicating the concentration of gas, number and location of drilled piers, point of test, date, and time of test.

Special requirements, coordination, and precautions will apply to areas that contain a hazardous atmosphere or, by virtue of their use or physical character, may be oxygen deficient. A check by Government is required prior to entering confined space. Surveillance and monitoring shall be required in these types of work spaces by both Contractor and Government personnel.

1.14 ROOFING AND COATING

At the beginning of each work day the Contractor shall check with the Contracting Officer before proceeding to work on the roof to ensure safe work conditions.

1.15 WELDING, FLAME CUTTING, AND MELTING

Contractor shall clear welding and cutting operations with the Contracting Officer before operations begin.

Contractor shall discontinue burning, welding, or cutting operations 1 hour prior to the end of the normal work day. A workman shall remain at the site for 1 hour after discontinuing these operations to make thorough inspection of the area for possible sources of latent combustion. He shall be equipped with two full 6.8 kilogram carbon dioxide fire extinguishers. Any unsafe conditions shall be reported to the Safety Assurance Office. (Telephone: (216) 433-3057)

During operations involving possible fire hazard, the Contractor shall notify the Contracting Officer and not proceed until clearance is obtained in writing. Contracting Officer may request a standby from the Fire Station. This requirement does not relieve the Contractor of his responsibility for welding and cutting safety.

1.16 HIGH NOISE LEVEL PROTECTION

Operations performed by the Contractor that involve the use of equipment with output of high noise levels (jackhammers, air compressors, and explosive device activated tools) shall be approved in writing by the Contracting Officer prior to commencement of work.

The Contractor shall comply with 29 CFR 1910.95, the OSHA standard on Occupational Noise Exposure. In addition, employees of the Contractor and its subcontractors shall wear personal hearing protection when exposed to noise that exceeds 85 dB(A), regardless of the intended or actual duration of exposure. The Contractor shall provide all employees and subcontractors assigned to this project with personal hearing protection, which shall have a Noise Reduction Rating (NRR) sufficient to reduce noise to a maximum of 85 dB(A), determined per OSHA methods. This requirement shall apply to continuous, intermittent, and impact noise that is generated by any NASA or Contractor-owned equipment or facility. The Contractor shall be responsible for enforcing the compliance of all employees and subcontractors.

If the Contractor cannot or does not provide personal hearing protection sufficient to reduce noise to a maximum of 85 dB(A), then administrative controls shall be implemented to limit employee noise exposure to a maximum time-weighted-average (TWA) level of 85 dB(A) (TWA), determined using a 5 dB exchange rate.

It is the Contractor's responsibility to monitor noise levels of its own operations for the purpose of determining personal hearing protection requirements. NASA will provide LeRC facility noise level information on request. Personal hearing protection requirements shall be determined on the basis of the highest noise level to which employees can reasonably be expected to be exposed.

Contractors working outdoors or in buildings known to have high noise operations shall have personal hearing protection equipment on their person at all times.

Contractor health and safety plans shall indicate personal hearing protection selections, including NRR, and any administrative controls that will be implemented to meet the default 85 dB(A) (TWA) noise exposure limit.

1.17 SEVERE STORM PLAN

In the event of a severe storm warning, the Contractor shall:

a. Secure outside equipment and materials and place materials possible to damage in protected locations.

b. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.

c. Ensure that temporary erosion controls are adequate.

1.18 HAZARDOUS WASTE

Contractor shall identify all wastes produced and dispose of them in the following approved manners:

Identify all wastes and waste producing processes including chemicals, paints, POL products and solvents, and their containers. Unknown wastes will be chemically identified by the Government.

Obtain a determination of whether the waste is hazardous from the Contracting Officer.

Notify the Contracting Officer prior to taking disposal action for any hazardous waste.

For disposal, provide either laboratory analysis data documenting the chemical content of the waste or certification by appropriate organization authority as to the chemical constituents of the waste. Technical assistance on disposal analysis requirements will be provided on request by contacting the Contracting Officer.

Document the waste type, quantity, location, and personnel/contractor/ agency responsible so the material can be tracked from generation through ultimate disposal as required by Environmental Protection Agency under Resource Conservation and Recovery Act.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01420

SOURCES FOR REFERENCE PUBLICATIONS

PART 1 GENERAL

1.1 REFERENCES

Reference publications are cited in other sections of the specifications along with identification of their sponsoring organizations. The addresses of the sponsoring organizations are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided.

AMERICAN CONCRETE INSTITUTE (ACI)

P.O. Box 9094
Farmington Hills, MI 48333-9094
Ph: 248-848-3700
Fax: 248-848-3701
Internet: http://www.aci-int.inter.net

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

4301 North Fairfax Dr., Suite 425
ATTN: Pubs Dept.
Arlington, VA 22203
Ph: 703-524-8800
Fax: 703-528-3816
E-mail: ari@dgsys.com
Internet: www.ari.org

AIR DIFFUSION COUNCIL (ADC)

104 So. Michigan Ave., No. 1500
Chicago, IL 60603
Ph: 312-201-0101
Fax: 312-201-0214

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

30 W. University Dr.
Arlington Heights, IL 60004-1893
Ph: 847-394-0150
Fax: 847-253-0088

ALUMINUM ASSOCIATION (AA)

900 19th Street N.W.
Washington, DC 20006
Ph: 202-862-5700
Fax: 202-862-5164
Internet: www.aluminum.org

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

1827 Walden Ofc. Sq.
Suite 104
Schaumburg, IL 60173-4268
Ph: 847-303-5664
Fax: 847-303-5774
Internet: www.aamanet.org

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

444 N. Capital St., NW, Suite 249
Washington, DC 20001
Ph: 800-231-3475 or 202-624-5800
Fax: 800-525-5562 or 202-624-5806
Internet: www.aashto.org

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

222 West Las Colinas Blvd., Suite 641
Irving, TX 75039-5423
Ph: 972-506-7616
Fax: 972-506-7682
Internet: http://www.concrete-pipe.org
e-mail: info@concrete-pipe.org

AMERICAN GAS ASSOCIATION (AGA)

Order from: AGA Distribution Center
400 N. Capitol St. N.W.
Washington, D.C. 20001
Ph: 202-824-7000
Fax: 202-824-7115

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

One East Wacker Dr., Suite 3100
Chicago, IL 60601-2001
Ph: 312-670-2400
Publications: 800-644-2400
Fax: 312-670-2400
Internet: http://www.aiscweb.com

AMERICAN IRON AND STEEL INSTITUTE (AISI)

ATTN: Publication Orders
P.O. Box 4321
Chestertown, MD 21690
Ph: 800-277-3850
Fax: 410-810-0910

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

11 West 42nd St
New York, NY 10036
Ph: 212-642-4900
Fax: 212-302-1286
Internet: http://www.ansi.org/

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
Ph: 610-832-9500
Fax: 610-832-9555
Internet: www.astm.org

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

1791 Tullie Cir., NE
Atlanta, GA 30329-2305
Ph: 800-527-4723 or 404-636-8400
Fax: 404-321-5478
Internet: http://www.ashrae.org

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Three Park Avenue
New York, NY 10016-5990
Ph: 212-591-7722
Fax: 212-591-7674
Internet: www.asme.org

AMERICAN WATER WORKS ASSOCIATION (AWWA)

6666 West Quincy
Denver, CO 80235
Ph: 800-926-7337
Fax: 303-795-2114
Internet: www.awwa.org

AMERICAN WELDING SOCIETY (AWS)

550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353
Fax: 305-443-7559
Internet: www.amweld.org

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

3246 Fall Creek Highway, Suite 1900
Grandbury, TX 76049-7979
Ph: 817-326-6300
Fax: 817-326-6306

AMERICAN WOOD PRESERVERS BUREAU (AWPB)

P.O. Box 5283
Springfield, VA 22150
Ph: 703-339-6660
Fax: 703-339-6711

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)

1101 Connecticut Ave., NW, Suite 300
Washington, DC 20036-2422
Ph: 202-429-5155
Fax: 202-828-6042

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

1952 Isaac, Newton Square West
Centreville, VA 20190
Ph: 703-733-0600
Fax: 703-733-0584
Internet: www.awinet.org

ASSOCIATED AIR BALANCE COUNCIL (AABC)

1518 K St., NW, Suite 503
Washington, DC 20005
Ph: 202-737-0202
Fax: 202-638-4833

BRICK INSTITUTE OF AMERICA (BIA)

11490 Commerce Park Dr., Suite 308
Reston, VA 22091
Ph: 703-620-0010
Fax: 703-620-3928

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

355 Lexington Ave.
New York, NY 10017-6603
Ph: 212-297-2100
Fax: 212-370-9047
Internet: www.buildershardware.com

BUILDING OFFICIALS & CODE ADMINISTRATORS (BOCA)

4051 W. Flossmoor Rd.
Country Club Hills, IL 60478
Ph: 708-799-2300
Fax: 708-799-4981
E-mail: boca@aecnet.com

CARPET AND RUG INSTITUTE (CRI)

310 Holiday Ave.
P.O. Box 2048
Dalton, GA 30722-2048
Ph: 706-278-0232
Fax: 706-278-8835
Internet: carpet-rug.com

CODE OF FEDERAL REGULATIONS (CFR)

Order from:
Government Printing Office
Washington, DC 20402
Ph: 202-512-1800
Fax: 202-275-7703
Internet: http://www.pls.com:8001/his/cfr.html

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

933 No. Plum Grove Rd.
Schaumburg, IL 60173-4758
Ph: 847-517-1200
Fax: 847-517-1206
Internet: http://www.crsi.org

CORPS OF ENGINEERS (COE)

Order from:
U.S. Army Engineer Waterways Experiment Station
ATTN: Technical Report Distribution Section
Services Branch, TIC
3909 Halls Ferry Rd.
Vicksburg, MS 39180-6199
Ph: 601-634-2571
Fax: 601-634-2506

COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)

5203 Leesburg Pike, Suite 708
Falls Church, VA 22041
Ph: 703-931-4533
Fax: 703-379-1546

DOOR AND HARDWARE INSTITUTE (DHI)

14170 Newbrook Dr.
Chantily, VA 20151-2232
Ph: 703-222-2010
Fax: 703-222-2410
Internet: www.dhi.org
E-mail: techdept@dhi.org

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

2500 Wilson Blvd.
Arlington, VA 22201-3834
Ph: 703-907-7500
Fax: 703-907-7501
Internet: www.eia.org

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

1151 Boston-Providence Turnpike
P.O. Box 9102
Norwood, MA 02062-9102
Ph: 617-255-4681
Fax: 617-255-4359
Internet: http://www.factorymutual.com

FEDERAL COMMUNICATIONS COMMISSION (FCC)

DOT, M-443.2
Utilization and Storage Section
Washington, DC 20590
Ph: 202-366-0039
Fax: 202-366-3911

FEDERAL SPECIFICATIONS (FS)

Order from:
General Services Administration
Federal Supply Service Bureau
470 L'Enfant Plaza, S.W.
Washington, DC 20407
Ph: 202-619-8925
Fax: 202-619-8978
Internet: http://pub.fss.gsa.gov/h1-pub.html

FEDERAL STANDARDS (FED-STD)

Order from:
General Services Administration
Federal Supply Service Bureau
470 E L'Enfant Plaza, S.W.
Washington, DC 20407
Ph: 202-619-8925
Fax: 202-619-8978
Internet: http://pub.fss.gsa.gov/hi-pub.html

FLAT GLASS MARKETING ASSOCIATION (FGMA)

White Lakes Professional Bldg.
3310 Harrison St.
Topeka, KS 66611-2279
Ph: 913-266-7013
Fax: 913-266-0272

FLUID SEALING ASSOCIATION (FSA)

2017 Walnut St
Philadelphia, PA 19103
Ph: 215-569-3650

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCHR)

USC
KAP-200 University Park MC-2531
Los Angeles, CA 90089-2531
Ph: 213-740-2032
Fax: 213-740-8399

INDUSTRIAL FASTENER INSTITUTE (IFI)

1717 East 9th St., Suite 1105
Cleveland, OH 44114-2879
Ph: 216-241-1482
Fax: 216-241-5901
Internet: http://www.industrial-fasteners.org
E-mail: indfast@aol.com

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

445 Hoes Ln, P. O. Box 1331
Piscataway, NJ 08855-1331
Ph: 732-981-0060 OR 800-701-4333
Fax: 732-981-9667
Internet: http//www.standards.ieee.org
E-mail: customer.service@ieee.org

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

20001 Walnut Dr., So.
Walnut, CA 91789-2825
Ph: 409-595-8449
Fax: 909-594-3690
Fax for Stds: 909-594-5265
Internet: www.iapmo.org

INTERNATIONAL STANDARDS ORGANIZATION (ISO)

1, rue de Varembe'
Case Postale 56
CH-1211 Geneve 20
Switzerland
Internet: www.iso.ch

INSTRUMENT SOCIETY OF AMERICA (ISA)

67 Alexander Drive
P.O. Box 12277

Research Triangle Park, NC 27709
Ph: 919-549-8411
Fax: 919-549-8288
e-mail: ISA@isa.org
Internet: http://www.isa.org

JOINT INDUSTRIAL COUNCIL (JIC)

Association for Manufacturing Technology
7901 Westpark Dr.
McLean, VA 22102
Ph: 703-893-2900
Fax: 703-893-1151

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

127 Park St., NE
Vienna, VA 22180-4602
Ph: 703-281-6613
Fax: 703-281-6671
Internet: //cssinfo.com/info/mss/html

MILITARY SPECIFICATIONS (MS)

Order from:
Standardization Documents Order Desk
Building 4, Section D
700 Robbins Ave.
Philadelphia, PA 19111-5094
Ph: 215-697-5147
Fax: 215-697-5148
Internet: www.dodssp.daps.mil

MILITARY STANDARDS (MIL-STD)

Order from:
Standardization Documents Order Desk
Building 4, Section D
700 Robbins Ave.
Philadelphia, PA 19111-5094
Ph: 215-697-2179
Fax: 215-697-2978
Internet: www.dodssp.daps.mil

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

Publication(s) Available From
Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402
Ph: 202-783-3238

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

8 So. Michigan Ave, Suite 100
Chicago, IL 60603
Ph: 312-782-4951
Fax: 312-332-0706
Internet: www.naamm.org

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBPVI)

1055 Crupper Ave.
Columbus, OH 43229-1183
Ph: 614-888-2463
Fax: 614-847-1147
e-mail: orders @ nationalboard.org

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

1300 N. 17th St., Suite 1847
Rosslyn, VA 22209
Ph: 703-841-3200
Fax: 202-841-3300
Internet: http//www.nema.org/

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

8575 Grovemont Circle
Gaithersburg, MD 20877-4121
Ph: 301-977-3698
Fax: 301-977-9589

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

One Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Ph: 800-344-3555
Fax: 800-593-6372
Internet: http://www.nfpa.org

NATIONAL INSTITUTE FOR STANDARDS AND TECHNOLOGY (NIST)

Department of Commerce
Gaithersburg, MD 20899-0001
Ph: 301-975-4025
Fax: 301-926-1630
Order From:
Superintendent of Documents
U.S. Government Printing Office (GPO)
Washington, DC 20402
Ph: 202-512-1800
Fax: 202-512-2250
or
National Technical Information Services (NTIS)
5285 Port Royal Rd.

Springfield, VA 22161
Ph: 800-553-6847
Fax: 703-321-8547
Internet: http://ww.gov/ntis.gov

NATIONAL SANITATION FOUNDATION (NSF)

ATTN: Publications
789 Dixboro Rd.
Ann Arbor, MI 48113-0140
Ph: 734-769-8010
Fax: 734-769-0109
Toll Free: 800-NSF-MARK
Internet: www.nsf.org

PIPE FABRICATION INSTITUTE (PFI)

3211 Jermantown Rd
Suite 100
Fairfax, VA 22030
Ph: 514-634-3434
Fax: 514-634-9736

PLUMBING AND DRAINAGE INSTITUTE (PDI)

45 Bristol Dr., Suite 101.
South Easton, MA 02375
Ph: 508-230-3516
Fax: 508-230-3529
E-Mail: pdhw@tiac.net

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

4201 Lafayette Center Drive
Chantilly, VA 20151-1209
Ph: 703-803-2980
Fax: 703-803-3732
Internet: http://www.smacna.org

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

400 Commonwealth Dr.
Warrendale, PA 15096-0001
Ph: 412-776-4841
Fax: 412-776-5760
Internet: http://www.sae.org
e-mail: publications @sae.org

SOUTHERN BUILDING CODE CONGRESS INTERNATIONAL (SBCCI)

900 Montclair Road
Birmingham, AL 35213-1206
Ph: 205-591-1853

Fax: 205-591-0775

SOUTHERN PINE INSPECTION BUREAU (SPIB)

4709 Scenic Highway
Pensacola, FL 32504-9094
Ph: 850-434-2611
Fax: 850-433-5594
e-mail: spib@spib.org

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

40 24th Street, 6th Floor
Pittsburgh, PA 15222-4656
Ph: 412-281-2331
Fax: 412-281-9992
Internet: www.sspc.org

STEEL DOOR INSTITUTE (SDOI)

30200 Detroit Rd.
Cleveland, OH 44145-1967
Ph: 216-899-0010
Fax: 216-892-1404

STEEL JOIST INSTITUTE (SJI)

3127 Tenth Ave., North Ext.
Myrtle Beach, SC 29577-6760
Ph: 803-626-1995
Fax: 803-626-5565

UNDERWRITERS LABORATORIES (UL)

333 Pfingsten Rd.
Northbrook, IL 60062-2096
Ph: 847-272-8800
Fax: 847-272-8129
Internet: http://www.ul.com/
Order from:
Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5776
Ph: 800-569-7128
Fax: 303-397-7945
Internet: http://global.ihs.com
E-mail: global@ihs.com

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

P.O. Box 23145
Portland, OR 97281
Ph: 503-639-0651
Fax: 503-684-8928

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

Yeon Bldg.
522 SW 5th Ave.
Portland, OR 97204-2122
Ph: 503-224-3930
Fax: 503-224-3934

-- End of Section --

SECTION 01450

QUALITY CONTROL

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-06 Test Reports

Contractor shall submit the following items in accordance with the paragraph entitled, "Records," of this section.

Quality Control Data
Quality Control Coordinating Actions
Quality Control Training
Inspection Records
Letters of Authority or Delegation
Field Tests

SD-07 Certificates

Contractor shall submit a detailed written statement describing procedures that will be implemented to achieve quality on the project according to the paragraph entitled, "Quality Assurance (QA) Plan," of this section.

Contractor shall submit the following in accordance with the paragraph entitled, "Qualifications," of this section.

Contractor's Quality Representative Qualifications
Special Certifications

1.3.1 Quality Assurance (QA) Plan

QA plan shall address the following:

Description of the authority, responsibilities and coordinating procedures, of on-site/off-site quality assurance personnel, including those QA personnel not under direct control of the Contractor.

QA plan shall list personnel designated by the Contractor to accomplish the work required by the contract.

QA plan shall also contain an appendix with a copy of each form, report format, or similar record to be used in the QA program.

Contractor's organization that handles construction contract activities.

Contractor's operational plan for accomplishing and reviewing work controls, fabrication controls, certifications, and documentation of quality control operations, inspections, and test records, including those for subcontractors.

These provisions shall include the methods to be used during the procurement cycle (order to delivery) for those materials or equipment that require source inspections, shop fabrications, or similar operations located separately from the work site.

Description of on-site personnel training.

Certification(s) of personnel, procedures, processes, and equipment.

Nondestructive testing requirements.

Identification of independent certifying and testing laboratories.

1.3.2 Records

Records shall include all quality control data; factory tests or manufacturer's certifications, quality control coordinating actions; records of quality control training/certifications as well as routine hydrostatic, electrical continuity, grounding, welding, line cleaning, field tests and similar tests. Quality records shall be available for examination by the Contracting Officer.

Legible copies of the test and inspection records shall be furnished to the Contracting Officer. Records shall cover work placement traceable to the contract schedule, specifications and drawings, and shall be verified by the Contractor.

Contractor shall submit for approval, the narrative description of an inspection system which provides for compliance with the quality requirements and technical criteria of the contract within 7 days after notice to proceed.

Contractor shall submit a monthly performance report that summarizes the quality operations. This report shall identify inspections made, tests performed, nonconformances, corrective actions taken, status of plans/procedures being developed, and status of open items/problems in work.

Contractor shall submit Letters of Authority or Delegation outlining the authority and responsibilities of quality control personnel along with a copy of the letter of delegation to the Contracting Officer that defines delegated duties and responsibilities.

In-process inspection records and control away from the job site may be used as evidence of quality of materials/work and may reduce further inspection or testing after delivery to the job site.

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

[Contractor's Quality Representative Qualifications shall be submitted to the Contracting Officer for approval. Quality Representative may be assigned to more than one contract provided that the assigned contracts are located at the same site.]

When approval or certification of special processes, operating personnel, and special equipment or procedures is required by the specifications, the Contractor shall obtain necessary approvals or special certifications prior to starting the work.

1.4.2 Quality Control Requirements

Contractor shall provide a quality control program encompassing: selection of construction materials and sources; suppliers; subcontractors; on-site and off-site fabrication of Contractor-furnished assemblies; on-site and off-site assembly; erection; work procedures; workmanship; inspection; and testing.

Contractor's program shall provide document systems ensuring that quality provisions of contract schedule, specifications, and drawings have been performed.

1.4.2.1 Management and Organization

Contractor shall designate an individual within the on-site organization whose sole responsibility shall be the day-to-day on-site management and direction of the Quality Program.

The Quality Program Manager shall report to the Contractor's management and shall have the necessary authority to discharge contractual responsibilities.

1.4.2.2 Identification and Data Retrieval

Contractor shall have an identification and data retrieval system.

Records, drawings, submittals, and equipment shall be identified by referencing the Contract Number; Contract Specification Number; Contract Drawing Number; Submittal Document Number; Contract Change Number; and the Contractor's Drawing Number System.

1.4.2.3 Procurement

Contractor shall be responsible for controlling procurement sources and those of his subcontractors to ensure that each purchase meets quality

requirements.

1.4.2.4 Receiving Inspection System

Contractor shall maintain a site receiving inspection system that ensures procured materials and equipment are inspected and tested.

Receiving inspection records shall accompany each procurement delivery to the construction site. Records of site receiving inspections shall be maintained by the Contractor.

Records shall show defects, discrepancies, dispositions, and waivers, including evidence of Government source inspection.

1.4.2.5 Nonconforming Articles and Material Control

The Contractor shall control nonconformances discovered by the Contractor, subcontractors, suppliers or Government quality representatives to prevent their use and to correct deficient operations.

a. Contractor shall prepare a "nonconformance" report for each instance comprising:

(1) A unique and traceable number.

(2) Identification of the nonconforming article or material.

(3) A description of the nonconformance and the applicable requirement.

(4) Cause or reason for the nonconformance.

(5) Remedial actions taken or recommended.

(6) Disposition of the nonconforming article or material.

b. The Contractor shall identify and mark each nonconforming article for removal from the work area.

c. The Contractor shall monitor and correct deficient operations.

1.4.2.6 Fabrication, Process, and Work Control

Contractor's procedures and controls shall ensure compliance with requirements in contract specifications and drawings.

Contractor shall establish in-process inspections, to ensure compliance with quality requirements.

Special processes may include, but are not limited to, plating, anodizing, nondestructive testing, welding, and soldering.

1.4.2.7 Quality Control Records

Quality control records shall be maintained at a central on-site location.

Maintenance of quality control records shall not relieve the Contractor from submitting samples, test data, detail drawings, material certificates, or other information required by each section in the specification.

Contractor shall ensure each record is identified and traceable to specific requirements in the specifications and drawings.

1.4.2.8 Drawings and Change Control

Drawing-control system shall be maintained to provide revised drawings and ensure continuous removal of obsolete drawings from work areas. Changes involving interface with other work areas, or affecting materials controlled by others shall be controlled by the Contractor. This system shall be integrated with the document requirements of the contract.

Drawing changes shall be clearly annotated. Implemented changes shall be clearly identified and associated drawings shall be revised accordingly. Drawings that have been approved, or approved as noted, by the Contracting Officer shall be used for fabrication and inspection.

1.4.3 Quality Inspections

1.4.3.1 Government Inspections

Work performed under this contract will be subject to inspection by the Contracting Officer. Changes to the specifications or drawings will not be allowed without written authorization of the Contracting Officer.

When the Contracting Officer determines that inspected work needs to be corrected, the Contracting Officer will be allowed 24 hours to complete reinspection of the corrected work.

Contracting Officer shall also be notified in writing before backfilling or encasing any [underground] utility so that work may be inspected. Failure to notify the Contracting Officer before backfill or encasement occurs shall require the work be uncovered at no additional cost to the Government.

Contractor's program is subject to continuous evaluation, review, and verification by the Contracting Officer. Contractor will be notified in writing of any noncompliance and will be given 7 days to correct identified deficiencies.

1.4.3.2 Contractor's Quality Inspections

Contractor shall implement an inspection system. Documentation shall indicate quality control through records of inspections, tests, and procedures.

Contractor's quality assurance system shall include the following:

a. Single Contractor's representative responsible for on-site communication and operation of the inspection program.

b. Purchasing control system documenting project procurement to drawings, specifications, and approved submittals.

c. Receiving inspection system documenting inspections for each procurement.

d. Documentation for handling and disposing of nonconforming components and materials.

e. Inspection records for each specific section of the specification and drawings.

f. Identification of test(s) to be performed, test procedures, records, and independent organizations used.

g. Documenting and maintaining certification or re-certification of procedures.

h. Management of government-furnished equipment, components, and materials.

i. Calibration of gages, tools, measuring instruments, and independent laboratories used.

Contractor shall establish a system of scheduled or random audits to ensure task completion.

1.4.4 Field Services

1.4.4.1 Responsibility for Inspection and Testing

Contractor shall be responsible for all inspections and tests, and the accompanying documentation for each inspection and test. Contractor may utilize independent inspection and testing laboratories or services as approved by the Contracting Officer.

Contractor shall also be responsible for tests of construction materials utilizing the services of an approved independent testing laboratory.

1.4.4.2 Inspection and Test Records

Contractor shall provide on-site records of each inspection and test performed throughout the life of the contract. Records shall include, but not be limited to, factual evidence that the required inspections or tests have been performed, including type and number of inspections or tests involved, identification of operators and inspectors, result of inspections or tests, nature of defects, causes for rejection, proposed remedial action, and corrective actions taken.

Inspection records, test procedures, test results, and associated forms will be verified by the Contracting Officer.

1.5 HANDLING AND STORAGE

Contractor shall provide controls, procedures and documentation with each shipment, that meet requirements of each section of the specifications.

The Contractor shall include documentation with each shipment. The data shall consist of documentation required by the contract along with specifications required to identify, store, preserve, operate, and maintain the items shipped.

1.6 SEQUENCING AND SCHEDULING

Contractor shall notify the Government at least 7 days prior to scheduled inspections and tests.

Contractor shall provide 7 days notice to the Government of the date when the contract work will begin at the site.

When Contractor suspends work for 1 day or longer prior to completion, the Contracting Officer shall be notified. Work shall not resume without notification of the Contracting Officer.

Contracting Officer shall be notified at least 24 hours in advance of backfilling or encasing any underground utility.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component of, each section of the specifications.

1.2 REFERENCES

The publications listed below form a part of this section to the extent referenced:

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 241	(1996) Standard for Safeguarding Construction, Alteration, and Demolition Operations (National Fire Codes, vol.6)

1.3 SUBMITTALS (Not Applicable)

PART 2 PRODUCTS

2.1 CONSTRUCTION SIGN

The Contractor shall provide a construction identification sign.

The sign shall comprise a face sheet of 4- by 8-foot exterior grade plywood, 1/2-inch thick, mounted on a substantial frame of treated lumber. Frame and sign shall be given one coat of lead-free alkyd primer paint and two coats of an exterior type white enamel.

2.2 CONSTRUCTION DETAILS

Lettering and further details of construction shall be in accordance with the drawings.

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES

The Contractor shall provide temporary utilities required for construction. Materials may be new or used, shall be adequate for the required usage, shall not create unsafe conditions, and shall not violate applicable codes and standards.

3.1.1 Electricity

Contractor shall provide connections, sized to provide service required for

power and lighting. Feeder and branch wiring with area distribution boxes shall be located so that power is available throughout the project site by use of power cords. 120/240 and 480 electrical volt feeder service is available. Lighting shall be provided by the Contractor. Electricity used will [not] be furnished by the Government.

3.1.2 Water

Contractor shall make connections to existing facilities to provide water for construction purposes. Water used will be furnished by the Government.

3.1.3 Telephone Service

Contractor shall provide telephone service. The Contractor shall pay costs of service.

3.1.4 Sanitary Facilities

Contractor shall provide temporary sanitary facilities and shall service, clean, and maintain these facilities and enclosures. Temporary facilities shall be removed from the site at the completion of the work.

3.1.5 Fire Protection

The Contractor shall provide temporary fire protection equipment for the protection of personnel and property during construction. Debris and flammable materials shall be removed daily to minimize potential hazards.

3.2 SIGNS

3.2.1 Construction Sign

Within 30 days after notice to proceed, the Contractor shall install the construction identification sign at the location designated by the Contracting Officer.

3.2.2 Other Signs and Advertisements

Only signs necessary to expedite deliveries, maintain traffic flow, promote safety (e.g. caution, danger, blasting, hardhat area), and prevent interference with Government operations shall be erected.

3.3 TRAFFIC PROVISIONS

3.3.1 Maintenance of Traffic

The Contractor shall conduct his operations in a manner that will not close any thoroughfare or interfere in any way with traffic on railways or highways except with written permission of the Contracting Officer. The Contractor may move oversized and slow-moving vehicles to the worksite provided requirements of the highway authority have been met.

Work shall be conducted so as to minimize obstruction of traffic, and traffic shall be maintained on at least half of the roadway width at all

times. Approval shall be obtained from the Contracting Officer prior to starting any activity that will obstruct traffic.

The Contractor shall provide, erect, and maintain, at his own expense, lights, barriers, signals, passageways, detours, etc., that may be required.

3.3.2 Rush Hour Restrictions

The Contractor shall not interfere with the peak traffic flows preceding and during normal operations from 7:00 a.m. to 5:00 p.m. without notification to and approval by the Contracting Officer.

3.3.3 Dust Control

The Contractor's dust control methods and procedures shall be approved by the Contracting Officer. Dust abatement on access roads shall be treated with applications of calcium chloride, water sprinklers, or similar methods or treatment.

3.4 TEMPORARY STRUCTURES

Contractor owned or leased trailers shall be identified with the name and phone number of the contractor. Size and location of the signage shall be approved by the Contracting Officer.

Temporary offices and sheds shall comply with NFPA 241.

3.5 PROTECTION OF EXISTING SYSTEMS

3.5.1 Utility

Connection to existing utilities, identified on the drawings to the Contractor, shall be protected from damage during construction activity.

3.5.2 Safety

The Contractor shall protect the integrity of any installed safety systems or personnel safety devices.

If entrance into systems serving safety devices is required, the Contractor shall obtain prior approval from the Contracting Officer. If it is temporarily necessary to remove or disable personnel safety devices in order to accomplish contract requirements, the Contractor shall provide alternative means of protection prior to removing or disabling any permanently installed safety devices or equipment and shall obtain prior approval from the Contracting Officer.

-- End of Section --

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS (Not Applicable)

1.4 SHIPMENT AND PROTECTION OF MATERIAL AND EQUIPMENT

Shipments shall be addressed to the Contractor who shall be responsible for their receipt, unloading, handling, and storage at the site. Government will not accept deliveries on behalf of the Contractor or his subcontractors or assume responsibility for security of materials, equipment, or supplies delivered to the site.

Contractor shall protect and preserve materials, supplies, and equipment of every description (including property which may be Government-furnished or -owned) and work performed.

1.5 STORAGE AND PROTECTION OF MATERIAL

1.5.1 New Material and Construction Equipment

Only material and construction equipment designated for performance of contract work may be stored at the construction site or located in Government-controlled warehouses or shop facilities.

PART 2 PRODUCTS

2.1 MECHANICAL MATERIALS AND EQUIPMENT

Materials and equipment to be provided under this contract shall be standard catalogue products of manufacturers regularly engaged in the manufacture of the products.

Material and equipment shall be installed in accordance with the requirements of the contract drawings and approved recommendations of the manufacturers.

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01750

STARTING AND ADJUSTING

PART 1 GENERAL

1.1 SUMMARY

Requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-06 Test Reports

Test reports shall be submitted in accordance with the paragraphs entitled, "Functional Test" and "Final Acceptance Test," of this section.

Test procedures and the recording forms shall be submitted according to paragraph entitled, "Test Procedures."

1.3.1 Tests Required

Tests shall be performed to verify proper functioning of fire protection, fire suppression, HVAC, compressed air, and other assemblies and components that need to be tested as an interrelated whole.

1.3.2 Functional Test

Contractor shall perform an "in-house" test to verify that the system and components have been properly installed and are functioning properly. Test shall be performed in the presence of the Contracting Officer. Test shall be completed and found acceptable when one full test has been performed without component or system malfunction.

1.3.3 Final Acceptance Test

Contractor shall perform a formal test with full documentation using the approved recording form. Contracting Officer will witness this test and issue a written final acceptance.

1.3.4 Test Procedures

Test procedure and recording form that document the test steps shall be submitted for approval to the Contracting Officer 21 calender days prior to

the proposed test date. Procedure shall consist of step by step instruction to verify system parameters, components, and functions.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

SECTION 01780

CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.1 SUMMARY

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 REFERENCES (Not Applicable)

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

The following shall be submitted in accordance with paragraph entitled, "General," of this section.

Reproducible Drawings
CAD System Drawings

SD-02 Shop Drawings

As-Built Drawings shall be submitted in accordance with paragraph entitled, "General," of this section.

SD-03 Product Data

Spare Parts Data shall be in accordance with paragraph entitled, "General," of this section.

SD-07 Certificates

A Work Plan shall be submitted in accordance with paragraph entitled, "General," of this section.

SD-08 Manufacturer's Instructions

The following shall be submitted in accordance with paragraph entitled, "General," of this section.

Preventative Maintenance and Inspection
Posted Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section.

1.4 GENERAL

Reproducible Drawings and CAD System Drawings shall be submitted as follows:

Three reproducible copy(s) of each drawing, product data record, or log 5.25 CAD system floppy disk showing each drawing, product data record, or log shall be submitted for historical record.

Final drawings shall incorporate contract changes and plan deviations. Lines, letters, and details will be sharp, clear, and legible. Additions or corrections to the drawings will be drawn to the scale of the original drawing. One copy, marked with review notations by the Contracting Officer, will be returned to the Contractor. Drawings are to be resubmitted within 30 calendar days after the completion of the representative work effort.

Documents shall be current. Contractor shall not conceal record information until as-built drawings have been made. Record drawings shall be submitted with a transmittal letter containing date, project title, Contractor's name and address, document list, and Contractor's signature.

As-Built Drawings shall be submitted under the following criteria:

In order to minimize the time for final payment at the completion of the project, the Contractor shall update the as-built drawings every month with the Contracting Officer's authorized representative. This update will be a part of "the monthly request for payment meeting," and payment--or a portion of the payment, including final payment--may be withheld until the as-built drawings have been updated, and accepted by the Contracting Officer.

After completion of all construction and before final payment is made under this contract, the Contractor shall provide the Contracting Officer with two complete sets of full size blue line contract drawings with alterations shown in red pencil, or a complete set of CAD system drawings produced in AutoCAD version 2002 with all changes clearly identified.

Preventative Maintenance and Inspection schedules shall be submitted by the Contractor with instructions that state when systems should be retested.

Schedule shall define the anticipated length of each test, test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements. Each test feature; e.g., liter per second, rpm, kilopascal, shall have a signoff blank for the Contractor and Contracting Officer. A remarks column of the testing validation procedure shall include references to operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system

notes. Procedures for preventative maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair shall be delineated.

Repair requirements shall inform operators how to check out, troubleshoot, repair, and replace components of the system. Instructions shall include electrical and mechanical schematics and diagrams and diagnostic techniques necessary to enable operation and troubleshooting of the system after acceptance.

A Work Plan shall be submitted to the Contracting Officer for project closeout. Plan shall include all scheduled inspections, instruction classes, items, closeout dates for all functions, and shall list the required Government and Contractor personnel that will be taking part in these functions.

Posted Instructions shall be submitted by the Contractor with labels, signs, and templates of operating instructions that are required to be mounted or installed on or near the product for normal, safe operation.

Contractor shall submit 6 copies of the project operation and maintenance manuals 30 days prior to testing the system involved. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

Spare Parts Data shall indicate manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair. List those items that may be standard to the normal maintenance of the system.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

3.1 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with the manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Information shall be bound in manual format and grouped by technical sections. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals shall have 10 millimeter holes and be bound in 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose-leaf binder. Binder shall lie flat with printed sheets that are easy to read. Caution and warning indications shall be clearly labeled.

Contractor shall submit classroom and field instructions in the operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor, using the manufacturer's factory-trained personnel or qualified representatives. Contracting Officer shall be given 7 days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor, such as lists, static exhibits, and visual aids,

shall be made available to the Contracting Officer.

-- End of Section --

SECTION 02220

DEMOLITION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(1993) Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-In. (457 mm) Drop

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-08 Statements

Contractor shall prepare and submit a detailed Demolition Plan of the work procedures and safety precautions to be used in the identification, demolition, handling, removal, transportation, and reclamation or disposal of removed materials. Contractor shall meet with the Contracting Officer, prior to beginning work, to discuss in detail the demolition plan.

SD-18 Records

Existing Conditions shall be recorded in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal. Such record shall contain the elevation of the top of foundation walls, the location and extent of cracks and other damage and description of surface conditions that exist prior to the start of work. Copies of the record shall be submitted and the stated conditions before starting work shall be verified.

SD-18 Records

Written approval by the Contracting Officer for Interruption of the following shall be submitted at least 48 hours prior to work:

Utility Outages
Traffic Interruptions

PART 2 PRODUCTS

2.1 FILL MATERIAL

Fill material shall be as per contract drawings.

PART 3 EXECUTION

3.1 DISCONNECTING EXISTING UTILITIES

Prior to the start of work, utilities serving each area of alteration or removal, the Contractor shall install temporary utility service.

3.2 TEMPORARY UTILITY SERVICES

The Contractor shall install temporary utility services before disconnecting existing utilities. The Contractor shall maintain the temporary services during the period of construction and remove only after permanent services have been installed, tested, and are placed in-service.

3.3 PRECAUTION AGAINST MOVEMENT

Contractor shall provide shoring and bracing or other supports to prevent movement, settlement, or collapse of facilities adjacent to areas of alteration and removal that are to remain.

3.4 DEMOLITION AND REMOVAL WORK

3.4.1 Demolition

3.4.1.1 Concurrent Earth-Moving Operations

Excavation, filling, and other earth-moving operations that are sequential to demolition work shall not be started in areas occupied by structures to be demolished until all demolition in the area has been completed and debris has been removed.

3.4.1.2 Buildings

Buildings shall be demolished or may be removed, subject to the approval of the Government and of the highway authorities having jurisdiction.

Demolition shall proceed in a systematic manner from the top of the structure to the ground. Demolition works above each tier or floor shall be completed before the supporting members on the lower levels are disturbed. Concrete and masonry wall shall be demolished in small sections. Structural framing members shall be removed and lowered by means of derricks, platform hoists, or other approved method.

Buildings, or the remaining portions thereof, not exceeding 25 meter in height may be demolished by the mechanical method of demolition.

Concrete slabs shall be broken up and removed.

3.4.1.3 Below-Grade Construction

Foundation walls shall be demolished to a depth of not less than 305 millimeter below the existing ground surface. In addition, below-grade wood and metal construction and floor construction, except basement concrete slabs on ground, shall be demolished and removed.

Foundations, basement concrete slabs on ground footings, and other below-grade construction shall be demolished and removed.

3.4.1.4 Filling Basements and Voids

Basements and voids resulting from the demolition of structures shall be completely filled as per contract drawings, and graded.

Prior to filling, basements and voids shall be free of standing water, frost, frozen material, trash, and debris.

Fill material shall be placed in horizontal layers not to exceed 200 millimeter in loose depth. Each layer shall be compacted to a minimum of 90 percent of the maximum density as determined by AASHTO T 180, Method D, at optimum moisture content.

After fill has been placed, the surface of the fill shall be graded to meet adjacent contours and to provide surface water drainage.

3.4.2 Protective Measures

Existing construction shall not be disturbed beyond that indicated or necessary for installation of new work. Temporary shoring and bracing shall be provided for support of building components to prevent settlement or other movement.

Protective measures shall be provided to control accumulation and migration of dust and dirt in all areas of work. Dust, dirt, and debris shall be removed from the areas of work daily.

3.4.3 Salvageable Materials and Equipment

Government will designate materials and equipment to be salvaged.

Salvageable materials and equipment shall be removed in a manner that will cause the least possible damage thereto. Contractor personnel shall handle, store, and protect removed items that are to be reused in the work or are to be retained by the Government.

Identification tags shall be provided on items boxed or placed in containers, indicating the type, size, and quantity of materials.

3.4.4 Scrap Metal

Scrap metal shall become the Contractor's property and shall be removed from the site as it accumulates.

3.4.5 Site Work

Chain-link fencing, gates, and other salvaged items shall be removed and stored. Gates shall be removed as whole units. Chain link fabric shall be cut to lengths of 7 meters and stored in rolls off the ground.

3.4.6 Buildings and Structures

Specified removal operations shall be performed in existing buildings as required to complete the work.

Concrete:

Existing concrete shall be demolished, removed, and disposed of. Square, straight edges shall be provided where existing concrete adjoins new work and other locations. Existing steel reinforcement shall be protected where indicated; otherwise, it shall be cut off flush with face of concrete.

Masonry:

All masonry construction shall be demolished and removed.

Masonry units for reuse shall be removed, cleaned, and stacked off the ground on wood pallets. Salvaged masonry units not reused in the work shall remain the property of the Government. Damaged units unsuitable for reuse shall be considered as debris and shall be disposed.

Structural steel:

Structural steel components shall be dismantled at field connections and in a manner that will prevent bending or damage.

Flame-cutting torches shall not be used.

Trusses and joists shall be transported as whole units and not dismantled.

Structural steel shall be transported to designated storage area, stacked according to size, type of member and length, and stored off the ground and protected from the weather.

Miscellaneous metals:

Shop-fabricated items such as access doors and frames, steel gratings, metal ladders, wire mesh partitions, metal railings, and similar items shall be salvaged as whole units.

Light-gage metal items, such as metal gutters, roofing and siding, and similar items, shall be salvaged unless designated as scrap metal.

Carpentry:

Lumber, millwork items, and finished boards, except those that are unfit for reuse, shall be salvaged.

Windows, doors and frames, and similar items shall be removed as units, complete with trim and accessories. Hardware shall be left intact and attached to units, except that door closers shall be removed. Open end of door frames shall be braced to prevent damage thereto.

Gypsum board, fiberboard, and other composition sheathing boards shall be classified as debris to be removed and disposed of.

Demountable partitions, built-in furniture, toilet partitions, lockers, and other prefabricated units shall be removed in sections and salvaged.

Bolts, nuts, washers, timber connectors, and other rough hardware shall be classified as debris and disposed of.

Miscellaneous items:

Chalkboards, tackboards, toilet-room accessories, and similar surface-mounted items shall be removed and salvaged as whole units, complete with all accessories.

Venetian blinds, complete with hardware items which shall be packaged and attached thereto, shall be removed and salvaged.

3.4.7 Mechanical Equipment and Fixtures

Mechanical hardware shall be disconnected at the nearest convenient connection to existing services that are to remain.

Each item of equipment and fixtures shall be salvaged as a unit; listed, indexed, tagged, and stored. Each unit shall be salvaged with its normal operating auxiliary equipment.

Equipment shall not be removed until approved.

Disconnection from utilities:

Mechanical equipment and fixtures shall be disconnected at fittings. Service valves shall be removed and attached to the unit.

Preparation for storage:

Water, dirt, dust, and foreign matter shall be removed from units; tanks, piping and fixtures shall be drained; and interiors, if previously used to store flammable, explosive, or other dangerous liquids, shall be steam cleaned. Openings shall be sealed with caps, plates, or plugs.

Motors attached by flexible connections shall be secured to the unit.

Lubricating systems shall be charged with the proper oil or grease.

Piping:

Piping shall be disconnected at unions, flanges and valves, and fittings as required to reduce the pipe into straight lengths for practical storage. Salvaged piping shall be stored according to size and type. If the piping that remains can become pressurized due to upstream valve failure, end caps, blind flanges, or other types of plugs or fittings with a pressure gage and bleed valve shall be attached to the open end of the pipe to ensure positive leak control.

Piping that previously contained gas, gasoline, oil, or other dangerous fluids shall be carefully dismantled, with precautions taken to prevent injury to persons and property. Such piping shall be stored outdoors until all fumes and residues are removed.

Prefabricated supports, hangers, plates, valves, and specialty items shall be boxed according to size and type. Sprinkler heads shall be individually wrapped in plastic bags before boxing.

Piping not designated for salvage, or not reusable, shall be considered as scrap metal.

Ducts:

Removed duct work shall be classified as scrap metal.

Fixtures:

Fixtures associated with plumbing, heating, air conditioning, refrigeration, and other mechanical system installations shall be removed and salvaged. Fixture units shall be tagged for identification, storage, and protection from damage.

Broken, damaged, or otherwise unserviceable units shall be classified as debris and disposed of by the Contractor.

Motor and machines:

Motors and machinery items associated with the plumbing, heating, air conditioning, refrigeration, and other mechanical system installations shall be removed and salvaged. Auxiliary units and accessories shall be salvaged and boxed and stored with the main unit.

Such items shall be tagged for identification, stored, and protected from damage.

3.4.8 Electrical Equipment and Fixtures

Motors, motor controllers, and operating and control equipment shall be salvaged and attached to the driven equipment.

Wiring systems and components shall be salvaged. Loose items shall be boxed and tagged for identification.

Primary, secondary, control, communication, and signal circuits shall be disconnected at the point of attachment to their distribution system.

Fixtures:

Electrical fixtures shall be removed and salvaged. Unprotected glassware shall be removed from the fixture and salvaged separately.

Incandescent lamps, mercury-vapor lamps, and fluorescent lamps shall be salvaged, boxed and tagged for identification, and protected from breakage.

Electrical devices:

Switches, receptacles, switchgear, transformers, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items shall be removed and salvaged. These items shall be boxed and tagged for identification according to type and size.

Conductors:

Conductors, including insulated wire and nonmetallic sheathed and flexible armored cable, shall be removed and salvaged.

Conduit:

Conduit, except where embedded in concrete or masonry, shall be salvaged. Corroded, bent, or damaged conduit shall be considered as scrap metal. Straight, undamaged lengths shall be sorted and stockpiled according to size and type.

Wiring ducts or troughs:

Wiring ducts or troughs shall be removed and salvaged. Plug-in ducts and wiring troughs shall be disassembled into unit lengths. Plug-in or disconnecting devices shall be removed from the busway and stored separately.

Miscellaneous items:

Supports, knobs, tubes, cleats, and straps shall be classified as debris to be removed and disposed.

3.4.9 Elevators and Hoists

Elevators, hoists, and similar conveying equipment shall be removed and salvaged as whole units, to the most practical extent. Items shall be removed and prepared for salvage without damage to any of the various parts.

Rails for structural steel shall be salvaged and stored with the equipment as an integral part of the unit.

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 General

Debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations shall be disposed of in accordance with all applicable federal, state and local regulations as contractually specified off the Lewis Center. Removed materials shall not be stored on the project site.

3.5.2 Burning on Government Property

Burning of materials removed from demolished structures will not be permitted on Government property.

3.5.3 Removal from Government Property

Waste materials removed from demolished structures, except waste soil, shall be transported from Government property and legally disposed. Waste soil shall be disposed of as directed.

-- End of Section --

SECTION 02225

EXCAVATION, BACKFILLING AND COMPACTING FOR UTILITIES

PART 1 GENERAL

1.1 SUMMARY

The work under this section consists of all labor, services, materials, equipment, tools and testing services necessary to excavate and backfill for the underground utility work detailed on the Contract drawings. The work includes removal of concrete pavement and base, removal of asphalt pavement and base, removal and stockpiling of topsoil, pit excavation, trench excavation, disposal of excavated soil, disposal of contaminated soil, stockpiling of excavated soil for re-use as fill, placement of granular bedding material, backfill and compaction of stockpiled soil, backfill and compaction with granular material, backfill with low strength mortar backfill, protection of existing utility lines, and temporary excavation shoring.

1.2 REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 145	(1987I) The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T 180	(1986) Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-In. (457 mm) Drop
AASHTO T 2	(1991) Standard Methods of Sampling of Aggregates
AASHTO T 87	(1986) Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1984; Rev A) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1556	(1990) Density of Soil in Place by the Sand-Cone Method
ASTM D 2922	(1990) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(1994) Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used In

Engineering Design and Construction

ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 4318	(1995) Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C1	(1991) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C3	(1991) Piles - Preservative Treatment by Pressure Processes

CODE OF FEDERAL REGULATIONS (CFR)

CFR 29 Part 1926, SUBPART P	Excavation, Trenching, and Shoring

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 203	(1997) Roadway Excavation and Embankment; and Subparts as Specified
ODOT 603	(1997) Pipe Culverts, Sewers and Drains; and Subparts as Specifie

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01300, "Submittals," in sufficient detail to show full compliance with the specification:

SD-04, Drawings

As-Built Drawings shall be submitted in accordance with Section 01700, "Contract Closeout".

SD-07, Schedules

Construction Equipment List of all major equipment to be used shall be submitted by the Contractor prior to commencing construction.

SD-08, Statements

Demolition Plan shall be approved by the COTR at least 48 hours in advance of the work. The plan will include all special environmental considerations and safety precautions along with the coordination procedures for the protection plan and work plan of this phase of the work.

SD-08, Statements

Work Plan shall be submitted including proposed methods of excavation, shoring of excavation sides, coordination with utility construction, backfilling, compaction and testing at least 48 hours in advance of the work for approval by the COTR. The plan shall be coordinated with the demolition and protection plans of this section.

SD-08, Statements

The Contractor shall provide a Protection Plan of the existing utilities, facilities and any other structures to remain undisturbed during construction to the COTR at least 48 hours in advance of the work.

SD-09, Reports

Test Reports shall be submitted in writing by the Contractor for Daily Inspection and Field and Laboratory Soil Test results within 3 working days. Reports shall be as specified in the paragraph entitled "Quality Control Testing During Construction" of this section.

SD-13, Certificates

Certificates of Compliance for Soil Materials shall be submitted in accordance with the paragraph entitled "Tests for Proposed Soil Materials" of this section.

SD-18, Records

Record of Existing Conditions shall be submitted by the Contractor prior to the start of this work. The COTR will provide any Underground Record information upon request. The Contractor shall verify that the conditions indicated on the Contract drawings are consistent with the available Underground Record information. Any discrepancies found shall be noted immediately, and notification given to the COTR so that instructions for proceeding can be given.

The records shall include the following:

Location and elevations of Underground Utilities
Location and elevations of Approved Utilities
Locations and elevations of all field soil tests

SD-18, Records

The Contractor shall be aware that the Record location of any underground utility or structure may be approximate. The actual locations of all utilities and structures encountered during excavation shall be noted in sketch form and the information conveyed to the COTR immediately. The locations of all soil tests and inspections shall also be noted and included with the results.

1.4 GENERAL REQUIREMENTS

The Contractor shall be held absolutely responsible for the safety of his workers as well as the protection of other Glenn employees and the Government property while engaging in earthwork operations - as well as all other aspects of the project. All applicable OSHA regulations must be adhered to and strictly enforced by the Contractor.

The requirements contained in ODOT 203 shall be adhered to; except as modified by these specifications.

1.5 LIMITS OF CONSTRUCTION

Work under this section includes excavation and backfill up to subgrade elevation and/or bottom of topsoil and in the area shown on the Contract drawings and approved by the COTR.

1.6 COMPACTION EQUIPMENT

The Contractor shall consult with a Geotechnical Engineer about the types of equipment to use to achieve the specified soil compaction. Compaction equipment shall be of suitable type and size, and shall consist of vibrating tampers, back hoe mounted hydraulic compactors, sheeps-foot rollers or other compaction equipment capable of obtaining the required density throughout the entire lift being compacted.

Generally, clay-type soils will require high energy tampers, rammers or sheeps-foot rollers. Sand, gravel or other granular soils require vibrating equipment with smooth plates or wheels.

The COTR, based on recommendations by the Geotechnical Engineer, or a demonstrated lack of performance on the job, reserves the right to reject the equipment types chosen by the Contractor. All costs associated with replacing the compaction equipment shall be paid by the Contractor.

1.7 LABORATORY AND FIELD SAMPLING AND TESTING

1.7.1 Environmental Soil Testing

The Government will supply an environmental site assessment report containing the information needed to characterize the excavated soil for disposal, as well as the level of personal protective equipment needed for workers in contact with that soil.

1.7.2 Geotechnical Construction Soil Testing

The Contractor shall retain a Geotechnical engineering and testing service, approved by the COTR, to provide sampling, laboratory tests on proposed backfill materials, field tests on in-place backfill soil for quality control, and to make daily verbal and written progress reports to the COTR. Testing agency shall conform to the requirements of ASTM D 3740.

1.7.3 Geotechnical Soil Tests for Proposed Backfill Materials

Soil materials proposed for backfill on this project shall be as specified on the Contract drawings. The materials shall be tested by the Contractor and approved by the COTR prior to the start of work. Each separate backfill type shall be tested as follows:

Requiremen	Test Method
Sampling	AASHTO T 2
Preparation of Samples	AASHTO T 87
Sieve Analysis of Aggregates	ASTM C 136
Mechanical Analysis of Soils	ASTM D 422
Liquid Limits, Plastic Limits and Plasticity Index	ASTM D 4318
Moisture-Density Relationship (Standard Proctor Test)	AASHTO T 180 method B or D

1.7.4 Quality Control During Construction

The field representative (inspector) from the soil testing agency shall be present during al backfilling and compaction operations.

Backfill materials shall be inspected and tested after placement and compaction during construction for in-place density, moisture content and compliance with design requirements as follows:

MATERIA	REQUIREMEN	TEST METHOD AND NO. TESTS
All	Lift thickness: Material type; Compaction method	Measurement and visual inspection of every lift; Continuous
Granular: Bank run sand; Gravel	In-place density; Judgement of moisture content	Visual inspection of every lift using a hand probe or other method approved by the COTR
Site soil; Clay borrow; Silt/clay mix	In-place dry density and moisture content	ASTM D 1556 Sand Cone Method or ASTM D 2922 Nuclear Method or as directed by the COTR to ensure that the specified compaction is achieved

The intent of the inspection procedure is to aid the Contractor in accomplishing the specified work while that work is being done. The

Contractor is encouraged to utilize the soil testing agency to the fullest in order to minimize disputes over the degree of compaction achieved.

The COTR, at his discretion, may request additional compaction tests.

1.7.5 Reports

Backfilling operations shall not proceed until written laboratory test results on the soil proposed for use are available, reviewed and approved by the COTR.

The field inspector retained by the Contractor shall verbally report to the COTR on a daily basis to review progress on the project. Results of all field tests will be reported.

The field inspector retained by the Contractor shall submit a written daily report within three working days following completion of the field tests, detailing the progress of the backfilling operation, visual inspection results and field test results. All deviations from this specification and the corrective action taken shall be described. A duplicate copy of all written material shall be retained by the Contractor.

1.7.6 Evaluation of Test Results and Subsequent Requirements

The Contractor will be informed of all test results immediately after they are concluded.

Granular soil materials delivered to the backfill location will be rejected if the moisture content, in the judgement of the construction inspector and the COTR, is so high that proper compaction can not be achieved.

A lift of clay-type soil will be considered satisfactory if the result of the in-place dry density test is no more than 1 percentage point below that specified for that material.

Results of in-place dry density tests will be considered satisfactory if the average of any group of four consecutive tests demonstrates a dry density equal to or greater than the specified value for that material and if no single test reveals a dry density value more than 2 percentage points below the specified value.

If the field inspector retained by the Contractor determines that the reason the soil is failing to achieve specified compaction is that the moisture content is too high, then the soil must be removed and replaced; or disced, dried and recompacted.

If the COTR determines that the reason soil tests or visual inspections of granular material are not meeting the specified compaction is due to inadequate compaction equipment or procedure, then the COTR will require the Contractor to replace such equipment and procedures until compaction can be consistently achieved at no additional charge to the Government.

If, in the judgement of the COTR, a significant material change has occurred between the material that was laboratory tested and that which is

being placed, then the COTR will request that an additional laboratory dry-density test be run on the new material, at the Contractors expense, to establish what the maximum dry density and optimum moisture content are for the soil being placed.

PART 2 PRODUCTS

2.1 BACKFILL MATERIAL

Backfill material shall consist of low strength mortar backfill, bank run sand, washed pea gravel, crushed stone aggregate base or approved stockpiled or borrowed clay soil or silt/clay mixtures as per contract drawings.

Under no circumstances shall slag be used for any purpose on Government property. This requirement supercedes all other referenced specifications.

2.1.1 Satisfactory Materials

Satisfactory soil materials shall consist of AASHTO M 145 Soil Classification Groups A-1, A-2-4, A-2-5 and A-3; and as approved by the COTR. Aggregate base and crushed stone shall consist of limestone or dolomite only.

2.1.2 Unsatisfactory Materials

Unsatisfactory materials shall consist of AASHTO M 145 Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, highly organic soils, and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

Any soil determined to be a solid waste shall not be reused as fill unless specifically instructed to do so in writing by the COTR. Any soil determined to be a hazardous waste shall be properly handled and disposed of per all applicable federal, state and local regulations.

2.2 STRUCTURAL MATERIALS

Materials used for shoring and bracing, such as sheet piling, uprights, stringers, and crossbraces, shall be in good serviceable condition. Any timber used shall be sound and free from large or loose knots.

Pressure-treated timber shall be used where wood sheeting or piling is specified or indicated to be cut and left in place. Timber and treatment shall conform to AWPA C1. Pressure treatment for piles shall conform to AWPA C3. Chromate Copper Arsenate (CCA) retention shall be not less than 0.8 pounds per cubic foot.

PART 3 EXECUTION

3.1 GENERAL

Before starting earthwork, the location of all utilities shall be verified to the fullest extent possible. Utilities to remain shall be protected from damage.

Excavation, backfilling and grading shall be to subgrade elevations calculated from the finished grades shown on the Contract drawings and the detailed cross-sections.

Excavated materials to be re-used for backfill shall be stockpiled in an orderly manner sufficiently distant from the excavation to prevent overloading the sides and causing a failure.

3.1.1 Excavation

The Contractor shall cut all excavations so that the sides are vertical in order to minimize the generation of soil for disposal. Trench box and/or shoring is required.

The Contractor shall maintain at the project site the capability to rapidly de-water the excavations if required.

The Contractor shall assign a competent person(s) to be present at open excavations as appropriate for the situation; shall maintain means of egress, and provide emergency rescue equipment.

3.2 SHORING, BRACING AND SHEETING

Excavation, trenching and shoring requirements for the protection of employees found in OSHA Regulations, CFR 29 Part 1926, SUBPART P shall be enforced.

The Contractor shall retain the services of a professional engineer registered by the State of Ohio qualified to design the excavation shoring and protective systems required by the project. This design shall be submitted to the COTR for approval at least 2 weeks prior to commencing excavation operation. The Contractor is encouraged to enlist the services of the Geotechnical Engineer to aid in the preparation of these plans.

Shoring and bracing shall be maintained regardless of the amount of time the excavations shall remain open. Shoring and bracing shall be carried down with the excavation.

Materials used for shoring and bracing shall be in good serviceable condition subject to the approval of the COTR. Timber shall be sound and free of large or loose knots.

Red oak or ash timber shall be used where wood sheeting or piling is specified or indicated to be cut and left in place.

At the discretion of the COTR, portions of the sheeting or shoring may be left in place and the Contract adjusted accordingly.

Trench boxes shall be used wherever possible in trench excavating.

3.3 TRENCH EXCAVATION

Trenches shall be executed according to the details shown on the Contract drawings or as approved by the COTR. Trench sides shall be as nearly vertical as possible. Bottoms of the trenches shall be accurately graded to provide uniform support to the bedding material and shall be free of all loose material and in a compact state. The bottom of all excavations shall not be considered finished until approval has been received from the construction inspector and/or the COTR. Over-excavation down below the detailed bottom elevation to remove soft or unstable material shall only be permitted at the expressed direction of the COTR with the trench bottom subsequently refilled to the designed bottom elevation with compacted granular material. Trenches are to be considered confined spaces. All appropriate precautions shall be taken until proven otherwise via testing or use of adequate controls.

3.4 WATER REMOVAL

Water shall not be permitted to accumulate in excavations. Dewatering systems shall be provided by the Contractor to convey water away from excavations so that softening of foundation bottoms, footing undercutting, and soil changes detrimental to subgrade stability and foundation will not occur. Dewatering systems and methods of disposal shall be approved by the Contracting Officer.

Dewatering shall be continued until backfill is completed.

Water removal from excavations shall be conveyed to approved collecting or runoff areas. Temporary drainage ditches and other diversions shall be provided by the Contractor and maintained outside of excavation limits.

Trench excavations for utilities shall not be used for temporary drainage ditches.

3.5 SANITARY AND STORM SEWERS

The requirements of ODOT 603 shall be adhered. Conduit type (pipe) and bedding Class shall be as specified and/or detailed on the Contract drawings.

3.6 APPURTENANCES

Excavations for manholes, vaults and other similar structures shall be kept to minimum dimensions practical to execute the work.

3.7 BACKFILLING

3.7.1 Bedding

Class B bedding under the new utility, except where noted on the contract drawings, shall consist of a minimum of 153 mm of No. 57 limestone, compacted, and approved by the COTR prior to placing that utility. Where noted on the contract drawings, bedding shall consist of ODOT 604 Class A bedding, ODOT 499 Class C concrete.

Bedding on the sides and top of the new utility shall be as detailed on the Contract drawings, consolidated as much as possible without damaging the utility.

3.7.2 Between Bedding and Subgrade

Under pavements, ground slabs and structures the remainder of the fill shall be low strength mortar backfill; see Section 02238, "Low Strength Mortar Backfill or compacted bank run sand a minimum of 1.5 m beyond the edge of pavement.

Lift thickness shall be no more than 203 mm throughout. Lift thickness not applicable to low strength mortar backfill.

Compaction requirements are as follows:

Materia	Requirement
Fill under pavements, walks, etc.	95% Maximum Dry Density
Fill under grassed areas	90% Maximum Dry Density

Every lift shall be inspected, tested and approved prior to the placement of the subsequent lift. Lift thickness not applicable to low strength mortar.

3.8 DISPOSAL OF EXCESS AND WASTE MATERIALS

Soil shall be disposed of in accordance with Section 01104.

All demolished items such as utilities, pavements, structures, etc. shall be removed from Government property and disposed of as construction debris.

3.9 RESTORATION OF SURFACES

Areas within the limits of earthwork under this section, including adjacent transition areas, shall be uniformly graded. The finished surface shall be smooth within the specified tolerances, compacted, and with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

Grassed areas:

The finished surface of areas to receive topsoil shall be not more than 30.5 mm above or below the specified finish elevations.

Walks:

The surface of areas under walks shall be shaped to line, grade, and cross section, and the finished surface shall be not more then 15.3 mm above or 15.3 mm below the specified finish elevations.

Pavements:

The surface of areas under pavements shall be shaped to line, grade, and cross section, and the finished surface shall be not more than 12.2 mm above or below the specified finish elevations.

-- End of Section --

SECTION 02238

LOW STRENGTH MORTAR BACKFILL

PART 1 GENERAL

1.1 REFERENCES

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1989) Portland Cement

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 499	(1997) Concrete General; and Subparts as Specified
ODOT 701	(1997) Hydraulic Cement; and Subparts as Specifie

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-13, Certificates

Certificates of Compliance shall be submitted demonstrating compliance with the mix design specified herein. Certificates must contain project name and Contract number, date, name of Contractor, name of supplier and the mix design data.

PART 2 PRODUCTS

2.1 GENERAL

All materials shall conform to the applicable requirements of ODOT 499.

2.2 MATERIALS

2.2.1 Cement

Cement shall conform to ODOT 701.01 or ODOT 701.04, (ASTM C 150 Type I or Type II).

2.2.2 Fine Aggregate

Fine aggregate shall be natural sand consisting of mineral aggregate particles.

The gradation of the sand shall be:

Sieve Siz	Percent Passing
No. 4	90-100
No. 50	7-40
No. 200	0-10

It is intended that the sand be fine enough to stay in suspension in the mixture during all placement activities, without segregation. The COTR reserves the right to reject the sand gradation if a flowable mixture is not produced at the project site.

2.2.3 Performance Enhancing Admixture

A performance enhancing admixture shall be incorporated in the mix that shall have the effect of lowering the wet density to a maximum of 1600 kg per cubic meter, a cured compressive strength of 700 to 1,400 kilopascals; entrained air content 30% minimum and shall eliminate bleed water and segregation This admixture product shall be specifically manufactured for this purpose and shall be used at the recommended design rate.

2.3 MORTAR DESIGN MIX

The initial trial mix shall be proportioned as follows:

Quantities of Dry Materials Per Cubic Meter

Cement	60 kg
Sand (SSD)*	1,335 kg
Water	163 kg

*saturated surface dry

These quantities of materials are expected to produce 1 cubic yard of mortar of the proper consistency. The COTR reserves the right to make adjustments to the mix design if it is determined that a properly flowable material is not being produced. Adjustments will be made such that the total volume remains constant.

Trial Batch: To expedite consolidation of the mortar, it will be necessary for bleed water to appear on the surface immediately after it is struck off. A delay in bleeding indicates there are too many fines in the mixture; therefore, the fly ash quantity shall be reduced in increments of 29.7 kilogram per cubic meter until mixture is bleeding freely. 35.6 Kilograms per cubic meter of sand shall be added to replace each 22.7 kilograms of fly ash removed/cubic yard to maintain the original volume.

2.4 ON-SITE MIXING EQUIPMENT

Mortar shall be mixed on site by mixers of sufficient capacity to permit

the mortar to be placed in a minimum quantity of 4.59 cubic meters at a time, or as approved by the COTR.

2.5 READY-MIX MORTAR

Low strength mortar backfill shall be supplied by a ready-mix supplier approved by the COTR and delivered to the project site in standard concrete delivery trucks.

PART 3 EXECUTION

3.1 PLACING MORTAR

Mortar shall be discharged from the mixer or truck as close to the fill location as possible in a manner that will minimize spillage. The mortar shall be brought up uniformly to the fill line shown on the Contract drawings or as directed by the COTR.

-- End of Section --

SECTION 02311

EXCAVATING, BACKFILLING, AND COMPACTING FOR STRUCTURES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 145	(1991) Recommended Practice for the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T 103	(1991) Soundness of Aggregates by Freezing and Thawing
AASHTO T 180	(1993) Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-In. (457 mm) Drop
AASHTO T 2	(1991) Standard Methods of Sampling of Aggregates
AASHTO T 87	(1986; Rev 1993) Standard Method for the Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Standard Test Method for Materials Finer than 75-microns (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 131	(1989) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1995; Rev A) Standard Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 32	(1993) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 33	(1993) Standard Specification for Concrete Aggregates

ASTM C 387	(1987) Standard Specification for Packaged, Dry Combined Materials for Mortar and Concrete
ASTM C 700	(1991) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 88	(1990) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D 1556	(1990) Standard Test Method for Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Test Method for Laboratory Compaction of Soil Using Modified Effort (56,000 ft-lbf/ft (2700 kN-m/m))
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
ASTM D 226	(1994) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 227	(1994) Standard Specification for Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 2922	(1991) Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3282	(1993) Standard Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D 3740	(1994) Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used In Engineering Design and Construction
ASTM D 422	(1963; R 1990) Standard Test Method for Particle-Size Analysis of Soils
ASTM D 4318	(1995) Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1926	(1996) Safety and Health Regulations for

Construction

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-07 Schedules

Construction Equipment List of all major equipment to be used shall be submitted.

SD-09 Reports

Test Reports shall be submitted for soil test results within 3 working days. Test reports shall be submitted according to paragraph entitled, "Quality Control Testing During Construction," of this section.

SD-13 Certificates

Certificates of Compliance for Proposed Soil Materialsshall be submitted according to paragraph entitled, "Tests for Proposed Soil Materials," of this section.

Certificates of Compliance for Compost shall be submitted indicating grade and compliance with state and local regulations.

SD-18 Records

A Record of Existing Conditions shall be recorded, in the presence of the Contracting Officer, and shall include all structures and other facilities adjacent to areas of work. Such records shall contain the location of existing utilities, the elevation of the top of foundation walls, the location and extent of cracks and other damage, and a description of surface conditions that exist prior to the start of work. Copies of the record shall be submitted and the conditions prior to starting work shall be verified.

1.3 LIMITS OF CONSTRUCTION

Work in this section relates to excavation, fill, and backfill to a point 1500 millimeter beyond the building or structure line.

1.4 SAMPLING AND TESTING

1.4.1 Soil Testing and Inspection Service

Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil-testing service approved by the Contracting Officer shall be provided by the Contractor. Testing shall include soil survey for satisfactory soil materials; sampling

and testing soil materials proposed for use in the work, and field-testing facilities for quality control during construction period.

Testing agencies shall conform to the requirements of ASTM D 3740.

1.4.2 Tests For Proposed Soil Materials

Materials shall be approved by the Contracting Officer prior to start of work.

Soil materials proposed for use in the work shall be tested as follows.

MATERIA	REQUIREMEN	TEST METHO	NUMBER OF TESTS
Satis-factory soil materials	Sampling	AASHTO T 2	One from each source of materials to determine con-formance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis is of fine and coarse aggre-gates	ASTM C 136	
	Amount of material pass-ing 75 micrometer sieve	ASTM C 117	
	Liquid limit	ASTM D 4318	
	Plastic limit and plasticity index	ASTM D 4318	
	Mechanical analysis	ASTM D 422	
	Moisture-density relations	ASTM D 1557, Method D	As required to determine moist-ure-density re-quirement of materials from each source
	Los Angeles abrasion of coarse aggre-gates	ASTM C 131	One for each soil material from each source if called for in reference

MATERIA	REQUIREMEN	TEST METHO	NUMBER OF TESTS
			specification
	Freezing and thawing sound-ness of aggre-gates	AASHTO T 103	
	Magnesium Sul-fate Soundness Test	ASTM C 88	

1.4.3 Quality Control Testing During Construction

Soil materials shall be tested during construction as follows:

MATERIA	REQUIREMEN	TEST METHO	NUMBER OF TESTS
Soil materials specified	Sieve analysis of fine and coarse aggre-gates	ASTM C 136	One daily for each soil material from each source; additional test whenever there is any apparent change
	Amount of material pass-ing 75 micrometer sieve	ASTM C 117	
	Moisture con-tent of subbase material	ASTM D 2216	
Soil materials prior to compaction	Moisture-den-sity relations of soil	ASTM D 1557, Method D	One of each type of sub-grade soil material except under backfill for structures; one for each backfill and fill material from each source
Soil material-in-place after com-paction	Density of soil-in-place	ASTM D 1556, Sand Cone Method or ASTM D 2922, Nuclear	At least three daily for each subgrade soil material except under backfill

MATERIA	REQUIREMEN	TEST METHO	NUMBER OF TESTS
		Method (when approved by Contracting Officer)	for structures, and for each layer and back-fill and fill material; ad-ditional test whenever there is any change in moisture conditions

1.4.4 Test Reports

No soil material shall be used until test reports have been reviewed and approved.

1.4.5 Evaluation of Test Results

Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if not more than one density test in five has a value more than 2 percentage points below the specified density.

PART 2 PRODUCTS

2.1 BACKFILL AND FILL MATERIALS

Materials for backfill and fill shall be free of clay clods, rock or gravel larger than 50 millimeter in any dimension, debris, waste, frozen materials, and other deleterious matter and shall be satisfactory soil materials as follows:

AREA CLASSIFICATIO	BACKFILL OR FILL MATERIALS
In excavations, unless otherwise specified	Excavated or borrow mate-rial that has been sampled, tested, and approved as "Satisfactory Soil Material"
Against face of structures where footing drains from top of porous fill for footing drains to indicated elevation, and from face of structure a distance equal to three footing drain diameters	Filtering material
Against surfaces having applied waterproofing for a distance of at least 150 millimeter	Sand

AREA CLASSIFICATIO from surface	BACKFILL OR FILL MATERIALS
In foundation subdrain trenches over porous fill drain pipe	Filtering material
Under grassed areas	Excavated or borrow material that has been sampled, tested, and approved as "Satisfactory Soil Material"
Under walks, steps, and paved areas	Subbase material or excavated or borrow material that has been sampled, tested, and approved as "Satisfactory Soil Material"
Under building slabs	Drainage fill

2.1.1 Satisfactory Materials

Satisfactory materials shall mean AASHTO M 145, (ASTM D 3282) Soil Classification Groups A-1, A-2-4, A-2-5, and A-3.

2.1.2 Unsatisfactory Materials

Unsatisfactory soil materials shall mean AASHTO M 145, Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, peat and other highly organic soil, and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

2.2 TOPSOIL

Topsoil shall be any soil removed from the project site which consists of clay or sandy loam.

The topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, roots, and other objectionable materials larger than 50 millimeter in any dimension.

2.3 COMPOST

Compost shall be yard trimmings or yard waste compost processed and graded according to state and local regulations.

2.4 TOPSOIL BLEND

Where insufficient topsoil is removed from the project site the topsoil removed shall be stockpiled and blended with compost at the site to achieve the required volume.

2.5 COHESIONLESS MATERIALS

Cohesionless soil materials include gravels, gravel-sand mixtures, sands, and gravelly-sands. Moisture-density relations of compacted cohesionless soils, when plotted on graphs, will show straight lines or reverse-shaped moisture density curves.

2.6 COHESIVE MATERIALS

Cohesive soil materials include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture-density relations of compacted cohesive soils, when plotted on graphs, will show normal moisture-density curves.

2.7 SUBBASE MATERIAL

Subbase material shall be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, or sand.

2.8 DRAINAGE FILL

Drainage fill shall be a washed, uniformly graded mixture of crushed stone or crushed or uncrushed gravel, with 100 percent passing 37.5 millimeter sieve and not more than 5 percent passing 4.75 millimeter sieve.

2.9 FILTERING MATERIAL

Filtering material shall conform to ASTM C 33 and shall be a uniformly graded mixture of natural or crushed gravel, crushed stone, and natural sand, with 100 percent passing 9.5 millimeter sieve and 2 to 10 percent passing a 150 micrometer sieve.

2.10 SAND

Sand shall be natural sand.

2.11 DRAINAGE PIPE AND FITTINGS

Drainage pipe shall be extra-strength perforated clay pipe, ceramic glazed, of size indicated, with self-centering lugs in bell ends, and shall conform to ASTM C 700.

Fittings shall be of corresponding weight and quality as drainage pipe.

2.12 SEWER BRICK AND MORTAR MATERIALS

Sewer brick shall be standard brick size and shall conform to ASTM C 32, Grade MM.

Mortar materials shall be dry packaged, proportioned for Type M unit masonry mortar, and shall conform to ASTM C 387.

Mixing water for mortar shall be potable.

PART 3 EXECUTION

3.1 PREPARATION

Before earthwork is started, the location of underground utilities shall be carefully verified by hand methods. Utilities to be left in place shall be protected from damage.

3.2 UNAUTHORIZED EXCAVATION

Unauthorized excavation shall consist of removal of materials beyond indicated subgrade elevations or side dimensions specified without specific direction and shall be replaced as specified at no additional cost to the Government.

Unauthorized excavation under foundations or retaining walls shall be filled by lowering the bottom elevation of the footing or base to the excavation bottom without altering the approved top elevation.

Elsewhere unauthorized excavations shall be backfilled and compacted as specified for authorized excavations of the same classification.

3.3 CLEARING AND GRUBBING

Prior to ditching operations, the Contractor shall strip and clear the area off all sod grasses and their associated root structures to a depth of 75 mm. This stripped organic material shall be handled as construction debris and hauled offsite at the Contractor's expense.

3.4 SHORING, BRACING AND SHEETING

Excavation, trenching and shoring requirements for the protection of employees found in OSHA Regulations CFR 29 Part 1926, SUBPART P shall be enforced.

The Contractor shall retain the services of a professional engineer registered by the State of Ohio qualified to design the excavation shoring and protective systems required by the project. This design shall be submitted to the COTR for approval at least 2 weeks prior to commencing excavation operation. The Contractor is encouraged to enlist the services of the Geotechnical Engineer to aid in the preparation of these plans.

Shoring and bracing shall be maintained regardless of the amount of time the excavations shall remain open. Shoring and bracing shall be carried down with the excavation.

Materials used for shoring and bracing shall be in good serviceable condition subject to the approval of the COTR. Timber shall be sound and free of large or loose knots.

Red oak or ash timber shall be used where wood sheeting or piling is specified or indicated to be cut and left in place.

At the discretion of the COTR, portions of the sheeting or shoring may be left in place and the Contract adjusted accordingly.

Trench boxes shall be used wherever possible in trench excavating.

3.5 WATER REMOVAL

Water shall not be permitted to accumulate in excavations, or flood the site and surrounding area. Dewatering systems shall be provided by the Contractor to convey water away from excavations so that softening of foundation bottoms, footing undercutting, and soil changes detrimental to subgrade stability and foundation will not occur. Dewatering systems and methods of disposal shall be approved by the Contracting Officer.

Dewatering shall be continued until construction subject to water pressure has obtained full specified strength and backfill is completed.

Water removal from excavations shall be conveyed to approved collecting or runoff areas. Temporary drainage ditches and other diversions as necessary shall be provided and maintained outside of excavation limits.

Trench excavations for utilities shall not be used for temporary drainage ditches.

3.6 MATERIAL STORAGE

Excavated materials classified as satisfactory soil material shall be stockpiled, where directed, until required for backfill or fill. Stockpiles shall be placed, graded, and shaped for proper drainage.

Materials required in the work shall be located and retained a sufficient distance from the edge of excavations to prevent such material falling or sliding back into the excavations and to prevent cave-ins.

3.7 EXCAVATION FOR STRUCTURES

Excavation for structures shall conform to the dimensions and elevations indicated within a tolerance of plus or minus 30 millimeter and shall extend a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services and other construction indicated, and for inspection.

In excavating for footings and foundations, care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall be done just before concrete is placed. Bottoms shall be trimmed to the required lines and grades to leave a solid bed to receive concrete.

For pile foundations, excavation shall stop at an elevation of from 150 to 300 millimeter above the bottom of the footing before piles are driven. After pile driving has been completed, loose and displaced material shall

be removed and excavation to final grade shall be done, leaving a solid bed to receive concrete.

3.8 EXCAVATION FOR FOUNDATION SUBDRAINAGE SYSTEM

Contractor shall adhere to and enforce precautions as outlined in OSHA Regulations, 29 CFR 1926.

Excavation for foundation subdrainage system, except for footing drains located in the excavations for footings and foundations, shall have vertical sides for a vertical dimension above the bottom of the trench not less than two times the outside dimension of the drain pipe, and shall have a clear horizontal distance between the drain pipe barrel and the trench wall, on both sides, of not less than 150 millimeter nor more than 225 millimeter. Bottom of the trench excavations shall be graded to obtain the required slope and shall be tamped to provide a firm bed for the drain pipe bedding material.

3.9 REMOVAL OF UNSATISFACTORY SOIL MATERIALS

Unsatisfactory soil materials encountered that extend below the required elevations shall be excavated to the depth directed by the COTR.

3.10 REMOVAL OF EXISTING UNDERGROUND UTILITIES

Existing underground utilities indicated to be removed shall be demolished and completely removed from the excavation.

3.11 CLOSING ENDS OF ABANDONED UNDERGROUND UTILITIES

Open ends of abandoned underground utilities to remain shall be closed with hydraulic cement to prevent water that may accumulate in such utilities from flowing into excavated areas. Closures shall withstand any hydrostatic or earth pressure that may result after ends of the abandoned utilities have been closed.

Open ends of abandoned underground utilities to remain shall have brick masonry bulkheads constructed to completely close the openings and sealed with 26 mm of hydraulic cement.

Mortar shall be mixed with water for workability by methods that can be controlled and accurately maintained during work progress. Retempering of mortar will not be permitted. Mortar mixing and conveying equipment shall be kept clean. Mortar shall not be deposited or permitted to contact the ground.

Brick shall be wet when laid. Brick shall be laid in mortar so as to form full bed with ends and side joints in one operation and with joints not more than 10 millimeter wide. Fresh masonry work shall be protected from freezing and from too rapid drying from effects of sun and wind. Protection shall be maintained until mortar has set.

Open ends of metallic conduit and pipe shall be closed with threaded galvanized metal caps or plastic plugs or other approved method suitable

for the type of material and size of pipe. Wood plugs will not be permitted.

3.12 FOUNDATION SUBDRAINAGE SYSTEM

Foundation subdrainage system outlets shall drain by gravity to free outfall to point of discharge.

3.12.1 Impervious Fill At Footings

After concrete footings have been cured as specified, impervious fill at least 150 millimeter in depth and 300 millimeter in width shall be placed on the subgrade adjacent to the bottom of footing and shall be compacted at optimum moisture content by means of hand tampers to not less than the density specified for cohesive material. Impervious fill shall be clayey soil material conforming to AASHTO M 145, Soil Classification Groups A-2-6 and A-2-7.

3.12.2 Laying Drain Pipe

Drain pipe shall be laid with the perforations down and firmly bedded in specified drainage fill material, with each pipe section having full bearing throughout its length to true grades and alignment and continuous fall in the direction of flow. One-eighth bends shall be used for changes in direction; Y-fittings shall be used at intersections. Drain pipe joints shall be closed.

Recesses in the excavation bottom shall be excavated to receive bells for drain pipe having bell and spigot ends. Such pipe shall be laid with bells facing up the slope and with spigot end entered fully into the adjacent bell.

3.12.3 Testing Drain Lines

Drain lines shall be tested with water before backfilling to ensure free flow. Any obstruction encountered shall be removed, damaged components replaced, and system retested until satisfactory.

3.12.4 Porous Fill Over Drain Pipe

After drain lines have been tested, drain pipe shall be backfilled to a width of at least 100 millimeter on sides and 300 millimeter above the top of pipe with specified drainage fill material. Fill material shall be placed in layers not exceeding 75 millimeter in loose depth and compacted with not less than two passes of a hand-operated plate type vibrating compactor. Fill material shall be overlaid with one layer of 0.7 newton per 10 square meter asphalt or tar-saturated felt conforming to ASTM D 226 or ASTM D 227, respectively.

3.13 FILLING AND BACKFILLING

3.13.1 Preparations Prior to Backfill Placement

Excavations shall be backfilled as promptly as the work permits but not

until completion of the following:

Approval of construction below finish grade

Inspection, testing, approval, and recording location of underground utilities

Removal of concrete formwork

Removal of shoring and bracing; backfilling of voids with satisfactory soil material; temporary sheet piling driven below bottom of structures; and cutting off and removing of utilities in a manner that prevents settlement of the structure or utilities

Removal of trash and debris

Completion of concrete waterproofing

3.13.2 Preparation of Ground Surface to Receive Fill

Vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials shall be removed from ground surface prior to the placement of fills. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stripped, or broken up in such manner that fill material will bond with the existing material.

When the ground surface has a density less than that specified for the particular area classification, the ground surface shall be broken up, pulverized, moisture-conditioned to near optimum moisture content of the soil material, and compacted to the required depth and percentage of maximum density.

3.13.3 Placement and Compaction

Backfill and fill materials shall be placed in layers not more than 150 millimeter in loose depth. Before compaction, each layer of backfill or fill material shall be moistened or aerated as necessary to provide the optimum moisture content of the soil material and shall then be compacted to the percentage of maximum density for each area classification as specified. Backfill or fill material shall not be placed on surfaces that are muddy, frozen, icy, or contain frost.

Backfill and fill materials adjacent to structures shall be brought up evenly around structures and shall be carried up to the indicated elevations.

Compaction adjacent to structures, within a horizontal distance from the face of the structure equal to the depth of backfill or fill material (measured from the bottom of footing or bottom of foundation or retaining wall) to final grade, shall be done with power-driven hand tampers.

3.14 COMPACTION

Degree of compaction required is expressed as a percentage of the maximum

density obtained by the test procedure in AASHTO T 180, Methods B or D.

3.14.1 Percentage of Maximum Density Requirements

Actual density of each layer of soil material-in-place shall be not less than the following percentages of the maximum density of the same soil material determined by the moisture-density test specified.

AREA CLASSIFICATIO	PERCENT MAXIMUM DENSITY COHESIONLESS SOIL MATERIA	COHESIVE SOIL MATERIAL
Structures		
Each layer of back-fill material	98	98
Building slabs and steps		
Top 300 millimeter of subgrade and each layer of backfill material	98	98

3.14.2 Moisture Control

Moisture content in soil material at time of compaction shall be within limits specified.

Where the moisture content of a layer of soil material is below optimum before compaction, the required amount of water shall be uniformly applied to the surface of the layer of soil material and the layer of soil disked or otherwise mixed until a uniform moisture content is reached.

Moisture of a layer of soil material that is above optimum shall be removed by drying.

3.15 GRADING

Areas within the limits of grading under this section, including adjacent transition areas, shall be uniformly graded. Finished surface shall be smooth within the specified tolerances, compacted, and with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

3.15.1 Grading Outside Building Lines

Areas outside the building lines for each structure shall be hand-graded to drain away from the structure and to prevent ponding of water after rains. Finished surface shall be within the tolerance specified below for each area classification, compacted as specified, and free from irregular surface changes.

Grassed or planted areas:

Finished surface of areas to receive topsoil blend shall be not more than 30 millimeter above or below the indicated finish elevations.

Walks:

Surface of areas under walks shall be shaped to line, grade, and cross section; finished surface shall be not more than 0.0 millimeter above or 30 millimeter below the indicated finish elevation.

Pavements:

Surface of areas under pavements shall be shaped to line, grade, and cross section; the finished surface shall be not more than 25 millimeter above or below the indicated finish elevation when tested with a 3000 millimeter straightedge applied both parallel with and at right angles to the centerline of the area. Finished surface shall vary no more than 25 millimeter.

3.15.2 Grading Surface of Fill Under Structures

Surface of fill under building slabs shall be smooth and even, free of voids, compacted as specified and to indicated grade within the specified tolerances. When tested with a 3000 millimeter straightedge, parallel with and at right angles to the building lines, the finished surface shall show no deviation in excess of 25 millimeter.

3.16 MAINTENANCE

3.16.1 Protection of Graded Areas

Newly graded areas shall be protected from traffic and erosion and shall be maintained free of trash and debris.

3.16.2 Reconditioning Compacted Areas

Where approved compacted areas are disturbed by subsequent construction operations or adverse weather, the surface shall be scarified, reshaped, and compacted as specified to the required density prior to further construction.

3.17 DISPOSAL OF EXCESS AND WASTE MATERIALS

Excess excavated satisfactory materials shall be transported to and disposed in designated storage areas on Government property.

Waste materials, including excavated material classified as unsatisfactory soil material, trash, and debris, shall be removed from Government property and legally disposed at no additional cost to the Government. Permits and fees for disposal shall be paid by the Contractor.

-- End of Section --

SECTION 02312

EXCAVATION, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 145	(1991) Recommended Practice for the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T 180	(1993) Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-In. (457 mm) Drop
AASHTO T 2	(1991) Standard Methods of Sampling of Aggregates
AASHTO T 87	(1986; Rev 1993) Standard Method for the Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1995; Rev A) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1556	(1990) Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 2922	(1991) Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(1994) Standard Practice for Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used In Engineering Design and Construction
ASTM D 422	(1963; R 1990) Standard Test Method for Particle-Size Analysis of Soils

ASTM D 4318	(1995) Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C1	(1995) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C3	(1991) Piles - Preservative Treatment by Pressure Processes

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Record of Existing Conditions shall be submitted in accordance with the paragraph entitled, "Records of Existing Conditions," of this section.

The records shall include the following:

Location of Underground Utilities
Location of Approved Utilities
Location of Test
Location of Inspection

SD-02 Shop Drawings

As-Built Drawings shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

SD-06 Test Reports

Test reports shall be submitted in writing by the Contractor for Soil Test results within 3 working days. Reports shall be according to the paragraph entitled, "Field Quality Control," of this section.

SD-07 Certificates

Certificates for the following shall be submitted by the Contracting Officer in accordance with the paragraph entitled, "Plans," of this section.

Demolition Plan
Work Plan
Protection Plan

Certificates for Proposed Soil Materials shall be submitted by the

Contracting Officer in accordance with paragraph entitled, "Proposed Soil Materials," of this section.

Certificates for Compost shall be submitted indicating grade and compliance to state and local regulations.

1.3 QUALITY ASSURANCE

Soil testing service will be provided by the Government. Testing service will include testing soil materials proposed for use in the work , subbase materials at the mixing plant, and field-testing facilities for quality control testing during construction period.

Testing agencies shall conform to the requirements of ASTM D 3740.

1.4 PLANS

The Demolition Plan shall be approved by the Contracting Officer at least 48 hours in advance of the work. The plan shall include all special environmental consideration and safety precautions along with the coordination procedures for the protection plan and work plan of this phase of work.

A Work Plan shall be submitted including proposed methods of excavation, earth support, utility construction, and backfilling at least 48 hours in advance of the work, for approval by the Contracting Officer. The plan shall be coordinated with the demolition and protection plans of this section.

The Contractor shall provide a Protection Plan of existing utilities place, and coordinate the plan with the demolition plan.

1.5 DRAWINGS

As-Built Drawings shall be submitted in accordance with Section 01780, "Closeout Submittals."

1.6 RECORDS OF EXISTING CONDITIONS

The Contractor shall verify the existing conditions are correct as shown on the plans and mentioned in the specification. Any discrepancies found shall be noted immediately, and notification given to the Contracting Officer.

The records shall include Location of Underground Utilities, Location of Approved Utilities, Location of Test and Location of Inspection.

PART 2 PRODUCTS

2.1 STRUCTURAL MATERIALS

Materials used for shoring and bracing, such as sheet piling, uprights, stringers, and crossbraces, shall be in good serviceable condition. Any timber used shall be sound and free from large or loose knots.

Pressure-treated timber shall be used where wood sheeting or piling is specified or indicated to be cut and left in place. Timber and treatment shall conform to AWPA C1. Pressure treatment for piles shall conform to AWPA C3. Chromate Copper Arsenate (CCA) retention shall be not less than 13 kilogram per cubic meter.

2.2 BACKFILL MATERIAL

Backfill material shall consist of sandy clay, sand, gravel, soft shale, or other satisfactory soil materials.

2.2.1 Proposed Soil Materials

Soil materials proposed for use in the work shall be tested. The materials shall be approved by the Contracting Officer prior to start of work, as follows:

MATERIA	REQUIREMEN	TEST METHO	NUMBER OF TESTS
Satisfactory soil materials	Sampling	AASHTO T 2	One for each source of material to determine conformance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregate	ASTM C 136	
	Mechanical analysis of soils	ASTM D 422	
	Liquid limit of soils	ASTM D 4318	
	Plastic limit and plasticity index of soils	ASTM D 4318	
	Moisture-density relations of soil	AASHTO T 180, Method B or D	

2.2.2 Satisfactory Materials

Satisfactory soil materials - AASHTO M 145 Soil Classification Groups A-1, A-2-4, A-2-5, and A-3.

2.2.3 Unsatisfactory Materials

Unsatisfactory soil materials - AASHTO M 145 Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, highly organic soils, and soil materials of any classification that have a moisture content at the time of

compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

2.3 TOPSOIL

Topsoil shall be any soil removed from the project site which consists of clay or sandy loam. The topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, roots, and other objectionable materials larger than 50 millimeter in any dimension.

2.4 COMPOST

Compost shall be yard trimmings or yard waste compost processed and graded according to state and local regulations.

2.5 TOPSOIL BLEND

Where insufficient topsoil is removed from the project site the topsoil removed shall be stockpiled and blended with compost at the site to achieve the required volume.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Before starting earthwork, the location of underground utilities shall be carefully verified by hand methods. Utilities to be left in place shall be protected from damage.

Excavation, filling, backfilling, and grading shall be to subgrade elevations specified.

Excavated materials suitable for backfill shall be piled in an orderly manner sufficiently distant from excavations to prevent overloading, slides, and cave-ins.

Excavations shall be done in ways that will prevent surface water and subsurface water from flowing into excavations and will also prevent flooding of the site and surrounding area.

3.2 PROTECTION OF PERSONS AND PROPERTY

Excavations shall be barricaded and posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness.

Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage including settlement, lateral movement, undermining, and washout.

Topsoil removal operations shall be conducted to ensure safety of persons and to prevent damage to existing structures and utilities, construction in

progress, trees and vegetation to remain standing, and other property.

3.3 SHORING, BRACING, AND SHEETING

Shoring and bracing in excavations shall be maintained for the entire length of time excavations will be open. Shoring and bracing shall be carried down with the excavation.

Sheeting used to prevent lateral movement of soil shall be removed in accordance with the requirements.

Untreated sheeting shall not be left in place beneath structures or pavements.

3.4 TRENCH EXCAVATION

Trenches shall be of adequate width and depth for the specified purpose. Side slopes of the trenches shall be as nearly vertical as practicable. Care shall be taken not to overexcavate. Bottoms of the trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on undisturbed soil at every point along its entire length except where it is necessary to excavate for bell holes and for proper sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded to ensure that the pipe rests on the prepared bottom for as much of its full length as practicable. Bell holes and depressions shall be only of such length, depth, and width as required to make the joint. Stones shall be removed, as necessary, to avoid point bearing. Where rock excavation is required in trenches for pipe, the rock shall be excavated to a minimum overdepth of 150 millimeter below the trench depth specified. Except as specified for wet or otherwise unstable material, overdepths shall be backfilled with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe, as determined by the Contracting Officer, is encountered in the bottom of the trench, it shall be removed and the trench shall be backfilled to the proper grade with coarse sand, fine gravel, or other suitable, approved material.

Trench excavations in surfaced areas shall be by open cut, unless otherwise shown. The pavement shall be cut by concrete saw or other approved method. Cuts shall be in straight lines parallel to the utility line location and shall be to a depth of at least one quarter of the pavement thickness. The remainder of the pavement shall be broken out. Pavement shall be removed a minimum of 300 millimeter on each side of the trench and 150 millimeter beyond where the base course is to be removed.

3.5 WATER REMOVAL

Water shall not be permitted to accumulate in excavations. Dewatering systems shall be provided by the Contractor to convey water away from excavations so that softening of foundation bottoms, footing undercutting, and soil changes detrimental to subgrade stability and foundation will not occur. Dewatering systems and methods of disposal shall be approved by the Contracting Officer.

Dewatering shall be continued until construction subject to water pressure has obtained full specified strength and backfill is completed.

Water removal from excavations shall be conveyed to approved collecting or runoff areas. Temporary drainage ditches and other diversions as necessary shall be provided and maintained outside of excavation limits.

Trench excavations for utilities shall not be used for temporary drainage ditches.

3.6 EXCAVATION FOR SANITARY SEWERS AND STORM SEWERS

The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall not exceed 200 millimeter or be less than 125 millimeter on either side of the pipe. The width of the trench above that level shall be as wide as necessary for sheeting and bracing and for the proper performance of the work.

For pipe indicated resting on the trench bottom, the bottom of the trench shall be rounded so that the pipe shall nest firmly on undisturbed soil for as nearly the full length of the barrel (as proper jointing operations will permit). This part of the excavation shall be done manually only a few meter in advance of the pipe being laid.

Depth of excavation for gravity sewer lines shall permit the installation of the pipe at the flow line elevations shown on the plans.

3.7 EXCAVATION FOR WATER DISTRIBUTION SYSTEM

Trenches shall be graded to avoid high points that necessitate placing vacuum and relief valves in the waterlines. If a profile of the pipes is not provided, trenches shall be of a depth to provide a minimum cover over the top of the pipe of 762 millimeter from the existing ground surface or the indicated finished grade (whichever is lower) and at additional depth if necessary to avoid interference of the waterlines with other utilities.

3.8 EXCAVATION FOR GAS DISTRIBUTION SYSTEM

Trenches for gas distribution lines shall be excavated to a depth that will provide not less than 600 millimeter of cover over the top of the pipe from the existing ground surface or from the indicated finished grade (whichever is lower).

3.9 EXCAVATION FOR ELECTRICAL UTILITIES

Excavation of trenches for electrical cables and duct lines shall provide vertical walls, unless otherwise approved by the Contracting Officer, and the trench shall be only as wide as necessary for workers to install the cables or ducts. Abrupt changes in grade of the trench bottom shall be avoided. Trenches shall be of a depth to provide a minimum cover over the top of the cables or ducts of 600 millimeter below finished grade, and at additional depth if necessary to avoid interference of the electrical

cables or ducts with other utilities.

3.10 EXCAVATION FOR APPURTENANCES

Excavation for manholes and similar structures shall be sufficient to leave at least 300 millimeter in the clear between the outer surfaces and the embankment or timber used to hold and protect the walls. Any overdepth excavation below such appurtenances that has not been directed will be considered unauthorized and shall be refilled with select bedding material or concrete, as directed by the Contracting Officer, at no additional cost to the Government.

3.11 BORING AND JACKING

Where utilities beneath concrete and asphaltic pavement shall be installed by boring and jacking, The boring and jacking installation shall be performed by workers experienced in such operations, with equipment designed and regularly used for this work. The bored opening shall be kept to the minimum size practical for the installation of the utility. When a void greater than 25 millimeter exists between the bored opening and outside edge of the utility installation, the void shall be filled with grout under pressure, as approved by the Contracting Officer.

3.12 BACKFILLING AND COMPACTION

Where trench sheeting is pulled, withdrawal shall be in increments of not more than 300 millimeter and backfilling and compaction operations shall be carried on simultaneously with trench sheeting pulling.

Trenches shall not be backfilled until required tests are performed and until the utilities systems, as installed, conform to the requirements for the installation of the various utilities. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified, or the condition shall be otherwise corrected as directed.

3.12.1 Bedding

Where the trench is excavated in rocks, a minimum of 150 millimeter of specified bedding material shall be placed on the rock surface before laying conduit or electrical cable.

3.12.2 Backfill Around Pipe

Backfill around pipe shall be applied to 150 millimeter above pipe with the specified bedding material.

3.12.3 Lower Portion of Trench

Backfill material shall be deposited in 200 millimeter uncompacted layers and compacted to the density of the adjacent soil until there is a cover of not less than 300 millimeter. The backfill material in this portion of the trench shall consist of sandy clay, sand, gravel, soft shale, or other approved materials, free from hard clods and stones larger than 25

millimeter in any dimension.

3.12.4 Remainder of Trench

The remainder of the trench shall be backfilled with material that is free of stones larger than 75 millimeter in any dimension. Backfill material shall be deposited in layers not exceeding the thickness specified, and each layer shall be compacted to the minimum density specified.

Under concrete slabs and paved parking areas:

150 millimeter layers, 95 percent of maximum density prescribed in AASHTO T 180, Method B or D

Under other areas:

200 millimeter layers, 90 percent of maximum density prescribed in AASHTO T 180, Method B or D

3.13 FIELD QUALITY CONTROL

The Contractor shall arrange his Soil Test work so that sampling and testing may be performed without interruption. Moisture-density relations shall be determined in accordance with AASHTO T 180, Method B or D. Field density tests shall be performed by methods in sufficient number to ensure that the specified density is obtained.

Soil materials shall be tested during construction as follows:

MATERIA	REQUIREMEN	TEST METHO	MATERIAL TESTED AND NUMBER OF TESTS
Soil material-in-place after compaction	Density of soil-in-place	ASTM D 1556, Sand Cone Method or ASTM D 2922, Nuclear Method (when approved by Contracting Officer)	At least three daily for each subgrade soil material, and for each layer of soil material; additional test whenever there is in moisture

3.14 RESTORATION OF SURFACES

Areas within the limits of earthwork under this section, including adjacent transition areas, shall be uniformly graded. The finished surface shall be smooth within the specified tolerances, compacted, and with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

Grassed areas:

The finished surface of areas to receive topsoil blend shall be not more than 30 millimeter above or below the specified finish elevations.

Walks:

The surface of areas under walks shall be shaped to line, grade, and cross section, and the finished surface shall be not more then 0.0 millimeter above or 30 millimeter below the specified finish elevations.

Pavements:

The surface of areas under pavements shall be shaped to line, grade, and cross section, and the finished surface shall be not more than 13 millimeter above or below the specified finish elevations.

3.15 DISPOSAL OF EXCESS AND WASTE MATERIALS

Excess excavated satisfactory materials shall be transported to, and disposed in, designated storage areas on Government property.

-- End of Section --

SECTION 02315

EXCAVATION AND FILL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(1993) Standard Method of Test for Moisture-Density Relations of Soils Using a 10-lb (4.54 kg) Rammer and an 18-In. (457 mm) Drop

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 117	(1995) Standard Test Method for Materials Finer than 75-micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 136	(1995; Rev A) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1556	(1990) Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Standard Test Method for Laboratory Compaction of Soil Using Modified Effort (56,000 ft-lbf/ft (2700 kN-m/m))
ASTM D 2216	(1992) Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2922	(1991) Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3282	(1993) Standard Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1926	(1996) Safety and Health Regulations for

Construction

1.2 DEFINITIONS

Satisfactory materials shall mean ASTM D 3282, Soil Classification Groups A-1, A-2-4, A-2-5, and A-3.

Unsatisfactory soil materials shall mean ASTM D 3282, Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, peat and other highly organic soil, and soil materials of any classification that have a moisture content at the time of compaction beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.

Subgrade shall mean the top surface of a backfill or fill or the uppermost surface of an excavation, graded to conform to the required subgrade elevation and compacted to support a structure.

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure in AASHTO T 180, Methods B or D.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Construction Equipment List shall be submitted.

Records of Underground Utilities shall be submitted for the following items:

Location of Inspections
Location of Testing
Location of Utility Approvals

SD-06 Test Reports

Contractor shall submit written Test Reports of Soil Test results within 3 working days. Submit test reports in accordance with paragraph entitled, "Quality Control Testing During Construction," of this section.

SD-07 Certificates

Certificates of Compliance for Compost shall be submitted indicating grade and compliance to state and local regulations.

1.4 QUALITY CONTROL TESTING DURING CONSTRUCTION

Soil materials shall be tested by the Contractor during construction as follows:

MATERIA	REQUIREMEN	TEST METHO	NUMBER OF TESTS
Soil materials specified	Sieve analysis of fine and coarse aggre-gates	ASTM C 136	One daily for each soil material from each source; additional test whenever there is any apparent change
	Amount of material pass-ing 75 micrometer sieve	ASTM C 117	
	Moisture con-tent of subbase material	ASTM D 2216	
Soil materials prior to compaction	Moisture-den-sity relations of soil	ASTM D 1557 Method D	One of each type of sub-grade soil material except under backfill for structures; one for each backfill and fill material from each source
Soil material-in-place after com-paction	Density of soil-in-place	ASTM D 1556 Sand Cone Method or ASTM D 2922 Nuclear Method	At least three daily for each subgrade soil material except under backfill for structures, and for each layer and back-fill and fill material; ad-ditional test whenever there is any change in moisture conditions

1.5 TEST REPORTS

No soil material shall be used until a written report of Soil Test results has been reviewed and approved by the Contracting Officer.

1.6 CONSTRUCTION EQUIPMENT LIST

Construction Equipment List for all major equipment to be used in this section shall be submitted by the Contracting Officer prior to start of work.

1.7 UNDERGROUND UTILITIES

Records of Underground Utilities Location of Inspections, Location of Testing and Location of Utility Approvals shall be submitted to the Contracting Officer prior to start of work.

PART 2 PRODUCTS

2.1 SUBBASE MATERIAL

Subbase material shall be a naturally or artificially graded mixture of natural or crushed gravel, crushed stone, or sand.

2.2 BACKFILL AND FILL MATERIALS

Materials for backfill and fill shall be satisfactory soil materials, free of clay clods, rock or gravel larger than 50 millimeter in any dimension, debris, waste, frozen materials, and other deleterious matter.

2.3 TOPSOIL

Topsoil shall be any soil removed from the project site which consists of clay or sandy loam. The topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, roots, and other objectionable material larger than 50 millimeter in any dimension.

2.4 COMPOST

Compost shall be yard trimmings or yard waste compost processed and graded according to state and local regulations.

2.5 TOPSOIL BLEND

Where insufficient topsoil is removed from the project site, the topsoil removed shall be stockpiled and blended with compost at the site to achieve the required volume.

2.6 COMPACTION EQUIPMENT

Compaction equipment shall consist of sheepsfoot rollers, pneumatic-tired rollers, tamper rollers, vibrating tampers, or other compaction equipment capable of obtaining the required density throughout the entire layer.

PART 3 EXECUTION

3.1 GENERAL

Before earthwork is started, the location of Underground Utilities shall be verified by hand methods. Utilities to be left in place shall be protected from damage.

Excavations shall be done in ways that will prevent surface water and subsurface water from flowing into excavations and will also prevent flooding of the site and surrounding area.

3.2 SURFACE PREPARATION

Heavy growths of grass and other vegetation, roots, debris, stones, objects larger than 50 millimeter in any dimension, and other materials undesirable to the subsurface construction shall be removed by mowing, grubbing, raking, or other methods from the surface of areas to be stripped.

3.2.1 Stripping

Topsoil shall be stripped from the surface of those areas to receive fills or embankments.

Excavated topsoil shall be transported to, and stockpiled in, designated topsoil storage areas.

3.2.2 Clearing Operations

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within the areas to be cleared. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be completely removed except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 40 millimeter or more in diameter and of live branches to the indicated height. Live limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts made shall be painted with tree-wound paint. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require.

3.2.3 Grubbing Operations

Contractor shall completely remove stumps, roots, and organic or other debris protruding through the ground surface. This material shall be excavated and removed to a depth of not less than 200 millimeter below the surface level of the original ground. Mechanical grubbing equipment shall not be used inside the drip lines of trees indicated to remain standing.

3.2.4 Filling Depressions

Depressions resulting from grubbing operations shall be completely filled with acceptable backfilling material, unless further excavation or earthwork is required.

Prior to filling, subgrade surfaces of depressions shall be free of standing water, frost, or frozen material. Unsatisfactory soil materials shall be removed.

Contractor shall place fill material in horizontal layers not to exceed 150 millimeter in loose depth. Each layer shall be compacted at the optimum moisture content to a density equal to the original adjacent ground. Surface of filled depressions shall be graded to meet adjacent contours and to provide surface water drainage.

3.3 EXCAVATION

3.3.1 Stability of Sides

Sides of excavations over 1500 millimeter in depth shall be sloped not steeper than 34 degrees from the horizontal (slope 1/1.5) of the material excavated or shall be shored and braced where sloping is not possible because of space restrictions, stability of material excavated, or where excavations are subjected to vibrations from vehicular traffic, the operation of machinery, or any other source.

Sides and slopes of excavations shall be maintained in a safe condition by scaling, benching, shelving, or bracing until completion of backfill placement.

3.3.2 Shoring and Bracing

Contractor shall adhere to and enforce precautions as outlined in OSHA Regulations, 29 CFR 1926, Subpart P.

3.3.3 Water Removal

Water shall not be permitted to accumulate in excavations. Dewatering systems shall be provided by the Contractor to convey water away from excavations so that softening of foundation bottoms, footing undercutting, and soil changes detrimental to subgrade stability and foundation will not occur. Dewatering systems and methods of disposal shall be approved by the Contracting Officer.

Dewatering shall be continued until construction subject to water pressure has obtained full specified strength and backfill is completed.

Water removal from excavations shall be conveyed to approved collecting or runoff areas. Temporary drainage ditches and other diversions shall be provided by the Contractor and maintained outside of excavation limits.

Trench excavations for utilities shall not be used for temporary drainage ditches.

3.3.4 Excavation For Structures

Excavation for structures shall conform to the dimensions and elevations indicated in the Construction Documents within a tolerance of plus or minus 30 millimeter and shall extend a sufficient distance from footings and

foundations to permit placing and removal of concrete formwork, installation of services and other construction indicated, and for inspection.

In excavating for footings and foundations, care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall be done just before concrete is placed. Bottoms shall be trimmed to the required lines and grades to leave a solid bed to receive concrete.

3.3.5 Excavation of Ditches, Gutters, and Channels

Excavation shall be accomplished by cutting accurately to the cross sections, grades, and elevations indicated. Excessive open-ditch or gutter excavation shall be backfilled with suitable materials to grade at no additional cost.

3.3.6 Excavation for Drainage Structures

Excavation shall be made accurately to the lines, grades, and elevations indicated. Dimensions and elevations of footings and foundation excavations are only approximate and may be changed if necessary to ensure adequate foundation support. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as indicated. Rock or other hard foundation materials shall be cleaned of loose debris and cut to a firm surface, either level, stepped, or serrated, as indicated. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before concrete or masonry is to be placed.

3.3.7 Trench Excavation

Trenches shall be of adequate width and depth for the specified purpose. Side slopes of the trenches shall be as nearly vertical as practicable. Bottoms of the trenches shall be accurately graded to provide uniform bearing and support for each section of pipe on undisturbed soil at every point along its entire length except where it is necessary to excavate for bell holes and for proper sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded to ensure that the pipe rests on the prepared bottom for as much of its full length as practicable. Bell holes and depressions shall be only of such length, depth, and width as required to make the joint. Stones shall be removed, as necessary, to avoid point bearing. Where rock excavation is required in trenches for pipe, the rock shall be excavated to a minimum overdepth of 150 millimeter below the trench depth specified. Except as specified for wet or otherwise unstable material, overdepths shall be backfilled with materials specified for backfilling the lower portion of trenches.

3.3.8 Removal of Unsatisfactory Soil Materials

Unsatisfactory soil materials encountered that extend below the required

elevations shall be excavated to the depth directed by the Contracting Officer.

3.4 FILLING AND BACKFILLING

3.4.1 Preparations Prior to Backfill Placement

Excavations shall be backfilled as promptly as the work permits but not until completion of the following:

Approval of construction below finish grade

Inspection, testing, approval, and recording location of underground utilities

Removal of concrete formwork

Removal of shoring and bracing; backfilling of voids with satisfactory soil material; temporary sheet piling driven below bottom of structures; and cutting off and removing of utilities in a manner that prevents settlement of the structure or utilities

Removal of trash and debris

Completion of concrete waterproofing

3.4.2 Preparation of Ground Surface to Receive Fill

Vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials shall be removed from ground surface prior to the placement of fill. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stripped, or broken up in such manner that fill material will bond with the existing material.

When the ground surface has a density less than that specified for the particular area classification, the ground surface shall be broken up, pulverized, moisture-conditioned to near optimum moisture content of the soil material, and compacted to the required depth and percentage of maximum density.

3.4.3 Placement and Compaction

Backfill and fill materials shall be placed in layers not more than 150 millimeter in loose depth. Before compaction, each layer of backfill or fill material shall be moistened or aerated as necessary to provide the optimum moisture content of the soil material and shall then be compacted to the percentage of maximum density for each area classification. Backfill or fill material shall not be placed on surfaces that are muddy, frozen, icy, or contain frost.

Backfill and fill materials adjacent to structures shall be brought up evenly around structures and shall be carried up to the indicated elevations.

Compaction adjacent to structures, within a horizontal distance from the face of the structure equal to the depth of backfill or fill material (measured from the bottom of footing or bottom of foundation or retaining wall) to final grade, shall be done with power-driven hand tampers.

3.5 COMPACTION

3.5.1 Percentage of Maximum Density Requirements

Actual density of each layer of soil material-in-place shall be not less than the following percentages of the maximum density of the same soil material determined by the moisture-density test.

AREA CLASSIFICATIO	PERCENT MAXIMUM DENSITY
Grassed areas	90
Walks	100
Structures	100
Building slabs and steps	100
Utility trenches	90

3.5.2 Moisture Control

Moisture content in soil material at time of compaction shall be within specified limits.

Where the moisture content of a layer of soil material is below optimum before compaction, the required amount of water shall be uniformly applied to the surface of the layer of soil material and the layer of soil disked or otherwise mixed until a uniform moisture content is reached.

Where the moisture of a layer of soil material is above optimum, it shall be dried.

3.6 GRADING

3.6.1 General

Areas within the limits of grading under this section, including adjacent transition areas, shall be uniformly graded. Finished surface shall be smooth within the specified tolerances, compacted, and with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

3.6.2 Grading Outside Building Lines

Areas outside the building lines for each structure shall be graded to drain away from the structure and to prevent ponding of water after rains. Finished surface shall be within the tolerance specified below for each area classification, compacted as specified, and free from irregular

surface changes.

3.6.2.1 Grassed or Planted Areas

Finished surface of areas to receive topsoil blend shall be not more than 30 millimeter above or below the indicated subgrade elevations.

3.6.2.2 Walks

Surface of areas under walks shall be shaped to line, grade, and cross section; finished surface shall be not more than 0.0 millimeter above or 30 millimeter below the indicated subgrade elevation.

3.7 MAINTENANCE

3.7.1 Protection of Graded Areas

Newly graded areas shall be protected from traffic and erosion and shall be maintained free of trash or debris.

3.7.2 Reconditioning Compacted Areas

Where approved compacted areas are disturbed by subsequent construction operations or adverse weather, the surface shall be scarified, reshaped, and compacted as specified to the required density prior to further construction.

-- End of Section --

SECTION 02511

CONCRETE FOR SITE WORK

PART 1 GENERAL

1.1 SUMMARY

The work under this specification consists of all labor, services, materials, equipment and tools necessary to install and test cast-in-place concrete for slab(s) on grade, equipment pad(s), equipment foundation pier(s), as shown and detailed on the Contract Drawing(s). The work includes portland cement concrete, formwork, admixtures, expansion joints, testing, finishing and curing.

1.2 REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 260	1984, Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 223	(1983) Standard Practice for the Use of Shrinkage-Compensating Concrete
ACI 305R	(1989) Hot Weather Concreting
ACI 306R	(1988) Cold Weather Concreting
ACI 316R	(1982) Construction of Concrete Pavements and Concrete Bases, Recommendations for
ACI 318	(1989; 318R-89) Building Code Requirements for Reinforced Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1988) Welded Steel Wire Fabric for Concrete Reinforcement
ASTM C 143	(1990) Slump of Portland Cement Concrete
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 231	(1989a) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1986) Air-Entraining Admixtures for Concrete

ASTM C 309	(1989) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31	(1990) Making and Curing Concrete Test Specimens in the Field
ASTM C 39	(1986) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 494	(1986) Chemical Admixtures for Concrete
ASTM C 94	(1990) Ready-Mixed Concrete
ASTM D 1621	1979 Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D 3575	1984 Test Method for Flexible Cellular Materials made from Olefin Polymers

CORPS OF ENGINEERS (COE)

COE 204	(1977; Notice 24) Concrete (For Building Construction)

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 499	(1997) Concrete General; and Subparts as Specified
ODOT 509	(1997) Reinforcing Steel; and Subparts as Specified
ODOT 511	(1997) Concrete for Structures; and Subparts as Specified
ODOT 701	(1997) Hydraulic Cement; and Subparts as Specified
ODOT 705	(1997) Concrete Pavement Incidentals; and Subparts as Specified
ODOT 709	(1997) Reinforcing Steel; and Subparts as Specifie

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01300, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01, Data

Mix Designs (Contractor and Job) shall be submitted for approval for each concrete class. The design for concrete properties shall equal or exceed the specified design properties.

SD-04 Drawings

Fabrication Drawings for the following items shall be submitted showing size and spacing:

Reinforcing Steel
Bar Lists

SD-04 Drawings

Erection/Installation Drawings shall be submitted including the size and spacing for the following items:

Reinforcing Steel
Bar Lists
Expansion and Construction Joint Details

SD-06, Instructions

Manufacturer's Instructions for all products used shall be submitted, including any special instructions for equipment installation, for approval prior to use.

SD-09 Reports

Test Reports for the following items shall be submitted in accordance with the paragraph entitled, "Concrete Testing During Construction:"

Slump
Air Content
Cylinder Test Specimens

SD-13, Certificates

Certificates of Compliance shall be submitted for the following items demonstrating conformance with the referenced specifications contained in this section. Certificates must contain project name and Contract number, date, name of Contractor, name of concrete testing service, source and mineralogy of aggregates, complete catalog information for all manufactured products proposed and test results.

Reinforcing steel
Form materials
Curing and sealing materials
Joint materials
Concrete materials
Concrete mix design

SD-14, Samples

Samples of each concrete mix shall be submitted in accordance with the paragraph entitled "Quality Control During Construction" of this section.

SD-18 Records

Daily Reports with the following items shall be submitted:

Delivery Tickets Copy

1.4 LABORATORY AND FIELD SAMPLING AND TESTING SERVICE

Sampling and testing services shall be provided by the Contractor at the direction of the Contracting Officers Technical Representative (COTR). The testing service agency shall be approved prior to commencing construction. The field testing shall be done to determine conformance with reference specifications and for quality control.

1.4.1 Laboratory Testing

Laboratory testing shall consist of running compressive strength tests on concrete cylinders prepared in the field according to ASTM C 39.

1.4.2 Field Testing and Quality Control During Construction

Concrete shall be sampled and tested at the direction of the COTR and as follows:

REQUIREMEN	TEST METHO	NUMBER OF TESTS
Sampling	ASTM C 172	As required for each test.
Slump	ASTM C 143	One for each concrete load; one each time water or an admixture is added to the mix.
Air Content	ASTM C 231	One at the point of delivery for each load and one for each set of compressive strength tests.
Compression test	ASTM C 31	One set of two (2) standard specimens cylinders for each compressive strength test for each load, 76.5 cubic meters.
Concrete temperature		Hourly when air temperature is 4.44 degrees Celsius and below or 26.67 degrees Celsius and above and each time a set of compressive test specimens is made.

PART 2 PRODUCTS

2.1 READY-MIX CONCRETE

Concrete shall be ready-mix and shall conform to ASTM C 94.

The provisions contained in ODOT 499 apply to this specification as modified herein:

Minimum 28 day compressive strength of 281.2 kilograms per square centimeter.

Maximum chloride ion content of 0.30% by weight of cement in mix per cubic yard according to AASHTO T 260.

Air entrainment of 5% to 7% at point of placement.

Maximum delivered slump shall be 51 mm.

Maximum water-cement ratio shall be 0.40.

Course aggregate shall be limestone or dolomite only.

Mix water shall be potable.

2.1.1 Admixtures

The COTR shall approve all proposed admixture products prior to their use. The COTR, at his discretion, may direct the Contractor as to which admixtures to use. The application of all admixtures shall be done in strict accordance with the manufacturers instructions.

The Contractor is encouraged to use some or all of the following admixtures to ease constructability while complying with this specification and to produce a more durable product:

Slump may be increased to a maximum of 203 mm by adding an approved superplastisizer at the job site to ease casting.

Slump may be increased to a maximum of 254 mm by adding an approved batch plant added high-range water reducer producing a rheoplastic concrete to ease casting.

Note: water shall not be added at the job site for the purpose of increasing slump and easing casting.

Accelerator shall be non-corrosive and shall not contribute more than 0.005% chloride ion content by weight of cement and will comply with ASTM C 494, Type C.

A corrosion inhibiting admixture shall be included where concrete will be exposed to deicing salts or any other corrosive environment at the maximum rate allowed by the manufacturer.

Set-retarding admixture shall comply with ASTM C 494, Type D.

Water-reducing admixture shall comply with ASTM C 494, Type A.

Air-entraining admixture shall comply with ASTM C 260.

2.1.2 Shrinkage Compensating Concrete

The above specifications apply to this section and shall include the following:

Shrinkage compensating concrete shall be Type constructed according to ACI 223 and ODOT 701.08.

Minimum cement content per cubic meter is 305.5 kilograms.

Maximum water-cement ratio can be increased to 0.50.

Maximum delivered slump can be increased to 101.6 mm.

2.2 REINFORCING MATERIALS

2.2.1 Reinforcing Steel

Reinforcing bars shall meet the requirements of ODOT 509.

2.2.1.1 Epoxy-Coated Reinforcing Steel

Epoxy-coated reinforcing bars shall meet the material requirements of ODOT 709.00.

2.2.1.2 Deformed and Plain Billet Steel Bars for Concrete Reinforcement

Reinforcing bars shall meet the material requirements of ODOT 709.01.

2.2.1.3 Welded Steel Wire Fabric for Concrete Reinforcement

Welded steel wire fabric shall meet the material requirements of ODOT 709 .10, ODOT 709.11, ODOT 709.12, or ODOT 709.14.

2.2.2 Welded Wire Fabric

Welded wire fabric (WWF) shall meet the requirements of ODOT 709 and ASTM A 185 and shall be delivered to the project site as flat sheets; any rolled (WWF) shall be rejected.

2.2.3 Fiber Reinforcing

Synthetic fiber reinforcing shall be polyester (P.E.T.) monofilament with a specific gravity of 1.34, fiber length of 38.1 mm and mixed at a rate of 0.89 kilograms per cubic meter of concrete. This type of reinforcing shall be used for temperature and shrinkage control only.

2.2.4 Dowels

Dowels located in expansion or construction joints in concrete pavements, slabs and/or as located on the Contract drawings shall be smooth round mild steel bar stock with end cap, 457 mm long and 25.4 mm in diameter.

2.3 EXPANSION JOINT MATERIAL

2.3.1 Shrinkage Compensating Concrete

All expansion joint material in contact with shrinkage compensating concrete shall be 12.7 mm thick, extend the full depth of the concrete section and have a maximum compression of 1.76 kilograms per square centimeter at 50% deformation and comply with ASTM D 1621 and/or ASTM D 3575.

2.3.2 Non-Shrinkage Compensating Concrete

Expansion joint material in contact with non-shrinkage compensating concrete shall be 12.7 mm thick, extend the full depth of the concrete section, located as shown on the Contract drawings and comply with ODOT 705 .03 Preformed Fillers.

2.4 FORM MATERIALS

Forms shall be of wood, steel or other material approved by the COTR, and shall conform to ACI 318.

Form release agent shall conform to Corps of Engineers COE 204.

2.5 CURING AND SEALING COMPOUND

Curing and sealing compound shall conform to ODOT 705.07 Type A and ASTM C 309.

PART 3 EXECUTION

3.1 GENERAL

Concrete shall be constructed in accordance with ACI 318 Building Code, ACI 305R, ACI 306R, ACI 316R, and ODOT 511.

3.2 FORM WORK

Forms shall be true to line and grade, mortar tight and sufficiently rigid to prevent any observable deformation under the load resulting from the wet concrete.

Form surfaces for permanently exposed faces shall be smooth, free from irregularities, dents, sags or holes. Exposed joints, corners and edges shall be chamfered 19.05mm. Depth of embedment of form ties shall be no less than that required for reinforcing per ACI 318.

Forms for exposed surfaces and surfaces exposed to freezing conditions shall have applied a non-staining release agent.

Forms shall be stripped carefully to avoid damaging the concrete and shall not be removed prior to 24 hours after casting, unless directed to by the COTR.

3.2.1 Shrinkage Compensating Concrete

The slab formwork must allow for the expansive action of this type of concrete. A formed edge must have the brace stakes or pins loosened immediately after the concrete has set to permit the concrete to expand. Edges that abut adjacent rigid construction shall have the proper expansion joint material applied prior to casting.

3.3 REINFORCING

3.3.1 Steel Reinforcing

The requirements of ODOT 509 shall be strictly adhered to.

Reinforcing bar and/or welded wire fabric (WWF) shall be free of loose, flaky rust and scale as well as any other deleterious materials such as oil, grease or paint that would reduce the bond with the concrete. WWF shall be delivered and installed as flat sheets only.

Epoxy coated bar shall be installed as shown on the Contract drawings and according to ODOT 509.10.

Reinforcement shall be secured in the formwork or on the subgrade surface by ties and chairs of sufficient number and strength to prevent movement during placement and casting operations.

3.3.2 Fiber Reinforcing

Fiber reinforcing shall be added to the concrete in the truck at a rate of 0.89 kilogram per cubic meter and according to the manufacturers instructions.

3.4 CONCRETE CASTING

A plasticizing agent should be added to ease casting; water shall not be added for this purpose.

Concrete shall be placed within 90 minutes of being mixed if no set-retarding admixture is used. Loads received after this time will be rejected.

Concrete shall be consolidated and worked uniformly into corners and around all reinforcing by rodding, vibrating, handspading and tamping in such a way as to prevent segregation.

3.5 FINISHING

3.6 CURING AND PROTECTION

Fresh concrete shall be cured in accordance with ODOT 511 Method (b) using

an approved liquid membrane curing compound. Traffic on new concrete will be restricted for a minimum of 14 days to allow proper curing to occur.

3.7 FIELD TESTING

Quality control and field testing during construction is the responsibility of the Contractor.

Specimens shall be tested for compressive strength at 7 days and at 28 days.

-- End of Section --

SECTION 02514

ASPHALT PAVEMENT

PART 1 GENERAL

1.1 SUMMARY

The work under this section shall include all labor, services, equipment, materials and tools necessary to install bituminous asphalt concrete pavement according to the Contract drawings and as specified herein. The work includes preparing the subgrade surface, installing an aggregate base course, a bituminous aggregate base course, a bituminous aggregate intermediate course, an asphalt concrete wearing course, and joints abutting other construction.

The bituminous asphalt pavement shall be installed in the full depth replacement areas and in the new pavement areas as shown on the Contract drawings.

1.2 REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 247	(1981; Rev 1986) Glass Beads Used in Traffic Paint
AASHTO M 248	(1986) Ready Mixed White and Yellow Traffic Paints

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 203	(1997) Roadway Excavation and Embankment; and Subparts as Specified
ODOT 301	(1997) Bituminous Aggregate Base; and Subparts as Specified
ODOT 304	(1997) Aggregate Base; and Subparts as Specified
ODOT 401	(1997) Plant Mix Pavement General; and Subparts as Specified
ODOT 402	(1997) Asphalt Concrete; and Subparts as Specified
ODOT 404	(1996) Asphalt Concrete; and Subparts as Specified
ODOT 407	(1997) Tack Coat; and Subparts as Specified

ODOT 408	(1997) Prime Coat; and Subparts as Specified
ODOT 411	(1997) Stabilized Crushed Aggregate; and Subparts as Specified
ODOT 641	(1997) Pavement Marking - General; and Subparts as Specified
ODOT 642	(1997) Traffic Paint; and Subparts as Specified
ODOT 705	(1997) Concrete Pavement Incidentals; and Subparts as Specifie

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01, Data

Mix Designs for each bituminous concrete mixture shall be submitted for approval for each type. Compliance with ODOT material specifications is mandatory.

SD-07, Schedules

Construction Equipment List for all major pieces of equipment to be used to execute this specification shall be submitted by the Contractor.

SD-13, Certificates

Certificates of Compliance for the following items shall be submitted in accordance with the applicable reference standards and specifications contained within this section:

Coarse Aggregate Mineralogy and Gradation
Fine Aggregate Mineralogy and Gradation
Asphalt Cement

PART 2 PRODUCTS

2.1 AGGREGATE BASE

The aggregate base shall consist of ODOT 304 aggregate base except that aggregate shall only consist of limestone or dolomite. Slag shall no be permitted for any purpose. All other requirements apply. Thickness shall be as shown on the Contract drawings.

2.2 BITUMINOUS AGGREGATE BASE

The bituminous aggregate base course shall consist of ODOT 301 bituminous aggregate base. All requirements found in ODOT 401 apply except that the aggregate shall consist only of limestone or dolomite. Slag shall not be permitted for any purpose. Thickness shall be as shown on the Contract drawings.

2.3 INTERMEDIATE COURSE

The intermediate course shall consist of ODOT 402 asphalt concrete. All requirements found in ODOT 401 apply except that the aggregate shall consist only of limestone or dolomite. Slag shall no be permitted for any purpose. Thickness shall be as shown on the Contract drawings.

2.4 WEARING COURSE

The wearing course shall consist of ODOT 404 asphalt concrete. All requirements found in ODOT 401 apply except that the aggregate shall consist only of limestone or dolomite. Slag shall not be permitted for any purpose. Thickness shall be as shown on the Contract drawings.

2.5 TACK COAT

The bituminous tack coat shall be rapid curing cut-back asphalt conforming to designation RC-70, as specified in ODOT 407.

2.6 JOINT SEALANT

The bituminous joint sealant shall be ODOT 705.04 hot-applied crack and joint sealer.

2.7 PRIME COAT

The bituminous prime coat shall comply with the requirements of ODOT 408, except that cover aggregate, where specified on the contract drawings, shall no be slag.

2.8 STABILIZED AGGREGATE SHOULDER

The stabilized aggregate shoulder, where specified on the Contract drawings, shall comply with ODOT 411, except that slag shall not be permitted. Limestone or dolomite are the only acceptable materials.

2.9 PAVEMENT MARKING

2.9.1 Paint

Paint shall conform to AASHTO M 248, Type S. Parking lanes, stop lines, crosswalks, and traffic lanes shall be white. Center lines shall be yellow.

2.9.2 Reflective Beads

Glass beads for reflectorized paint shall conform to AASHTO M 247, Type 1.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

All earthwork associated with establishing the pavement subgrade shall conform to ODOT 203 as modified by these specifications.

The trenches shall be backfilled and compacted to subgrade elevation (no less than 360 mm below finished grade) as specified elsewhere.

The subgrade surface shall be free of all loose materials prior to placing subbase stone as per subpart entitled, "AGGREGATE BASE."

All milled or planed surfaces shall be thoroughly cleaned of all loose material, dust and water by brooming and vacuuming.

3.1.1 Grading and Compaction

Final subgrade line grade and compaction shall be as shown on the Contract Drawings.

The compacted subgrade surface must be approved by the Contracting Officers Technical Representative (COTR) prior to placing any materials covered by these specifications.

3.1.2 Proof Rolling

The subgrade surface under pavement repair locations shall be compacted using powered compaction equipment approved by the COTR and, at the direction of the COTR, demonstrate that the subgrade surface is suitably compact. This must be done in the presence of the COTR in order to receive approval to place paving materials.

3.1.3 Replacement of Unsuitable Subgrade Material

Any subgrade material judged by the COTR to be soft, organically contaminated or unsuitable shall be removed to a maximum depth of 300 mm and replaced, at the direction of the COTR, with rolled and compacted granular fill material approved by the COTR. It will be paid for at the Contract unit price for that material unless the COTR determines that the unsuitable material was the result of Contract negligence, in which case the Contractor will pay for repair.

3.2 AGGREGATE BASE COURSE

Aggregate base course material shall be placed according to the requirements of ODOT 304 Aggregate Base. Maximum lift thickness will be 150 mm prior to compaction with vibratory equipment; 75 mm thickness if non-vibratory equipment is used.

3.3 BITUMINOUS AGGREGATE BASE COURSE

Bituminous aggregate base course material shall be placed according to the requirements of ODOT 301. Maximum lift thickness shall be 75 mm. Joints between adjacent and underlying lanes of placed asphalt material shall be

lapped a minimum of 610 mm. All other requirements of ODOT 401 shall be followed.

3.4 INTERMEDIATE COURSE

Intermediate course shall be placed according to the requirements of ODOT 402 Asphalt Concrete. Maximum compacted lift thickness shall be 75 mm. Joints between adjacent and underlying lanes of placed asphalt material shall be lapped a minimum of 610 mm. All other requirements of ODOT 401 shall be followed.

3.5 WEARING COURSE

Wearing course shall be placed according to the requirements of ODOT 404 Asphalt Concrete. Maximum compacted lift thickness shall be 75 mm. Joints between adjacent and underlying lanes of placed asphalt material shall be lapped a minimum of 610 mm. All other requirements of ODOT 401 shall be followed.

3.6 TACK COAT

ODOT 407 Tack Coat shall be applied between cold joints, as required by ODOT 401, at a rate of 1.2 liter per square meter.

3.7 BUTT JOINTS

All applicable requirements found in ODOT 401 shall be followed.

The Contractor shall line out the pavement repair areas in roughly rectangular zones using chalk lines followed by water-soluble spray paint. All lines shall be straight, neat, and true. Small, isolated "islands" of original pavement within zones of repaired pavement shall be removed. All pavement repair areas shall be specifically approved by the NASA field inspector and/or COTR prior to commencing work on that area. Modifications to the line work shall be made at their direction.

All butt joints with adjoining pavements shall be saw cut a minimum of 100 mm depth if not indicated on the contract drawings. All pavement, subbase stone and subgrade soil shall be removed to a depth of 360 mm.

Butt joints shall be executed at all locations where new asphalt pavement will abut existing asphalt or concrete pavements and as shown on the Contract drawings.

3.7.1 Saw Cutting

A line shall be marked on the existing pavement that will designate the limits of new asphalt pavement installation. This line shall be saw cut neat and true to a minimum depth of 100 mm if not indicated on the drawing, or if indicated as shown on the Contract Drawings with a pavement saw. Water shall be used as the cutting medium to prevent dust. All materials designated for demolition shall be removed and disposed of properly.

3.7.2 Tack Coat

ODOT 407 shall be applied to the exposed vertical surface of the existing pavement. The rate of application will be 1.2 liters per square meter of vertical surface area.

3.7.3 Joint Sealant

ODOT 705.04 shall be applied to the joint following placement of all pavement materials. Joint sealant shall not be placed on joints between cast or ductile iron products (e.g. manhole cover and rim).

3.7.4 Contact With Curbs, Manholes and Other Surface Fixtures

Contact surfaces abutting the asphalt pavement shall be coated with ODOT 407 Tack Coat no higher than the finished grade of the pavement prior to placing the pavement materials.

ODOT 705.04 Hot-Applied Joint Sealant shall be applied to the joint following placement of the pavement materials.

3.8 PRIME COAT

Bituminous prime coat shall be applied according to the requirements of ODOT 408 at a rate of 1.8 liters per square meter.

3.9 HAND PLACING ASPHALT PAVEMENT

In areas where the use of machine spreading is not practical, the asphaltic materials shall be spread and finished by the use of heated hand tools. Compaction will be done with a pavement roller where possible or a hand compactor where not possible.

All specified subgrade compaction requirements apply.

Aggregate base shall be compacted using pavement roller or powered hand tamper.

The asphalt mixtures shall be dumped on approved dump boards and distributed into place from the dump boards in a uniformly loose layer of a thickness that will, when compacted, conform to the required grade and thickness. The mixture will be dumped no faster than the shovelers and rakers can spread it properly. Any improperly placed pavement will, at the direction of the COTR, be removed and replaced at the Contractor's expense.

3.10 ACCEPTANCE PROVISIONS

At the discretion of the COTR composition, density, surface smoothness and thickness of the completed pavement section will be tested for compliance with specifications. Any substandard areas will be completely removed and replaced at the Contractor's expense.

Surface smoothness tolerance specifications found in ODOT 401 will be adhered to strictly. Any pavement found not to comply shall be removed,

replaced and regraded at the Contractor's expense.

3.11 PAVEMENT MARKING

Pavement marking shall comply with the requirements of ODOT 641 and ODOT 642 and shall be replaced where removed or worn by Contractor activity. Placement shall be in accordance with the Ohio Manual of Uniform Traffic Control Devices (OMUTCD).

-- End of Section --

SECTION 02524

CONCRETE WALKS, RAMPS, CURBS AND SLABS

PART 1 GENERAL

1.1 SUMMARY

The work under this section includes all labor, services, equipment, materials and tools necessary to install concrete walk(s), concrete curb(s), concrete handicap ramp(s), concrete pavement slab(s), at location(s) shown on the Contract drawings(s) and as specified herein. The work includes subgrade preparation, installation of a limestone aggregate base, formwork, casting and curing the specified concrete item(s).

1.2 REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1960; Rev 1974) Burlap Cloth made from Jute or Kenaf
AASHTO T 260	1984, Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 223	(1983) Standard Practice for the Use of Shrinkage-Compensating Concrete
ACI 305R	(1989) Hot Weather Concreting
ACI 306R	(1988) Cold Weather Concreting
ACI 318	(1989; 318R-89) Building Code Requirements for Reinforced Concrete
ACI SP-66	(1988) ACI Detailing Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1988) Welded Steel Wire Fabric for Concrete Reinforcement
ASTM C 143	(1990) Slump of Portland Cement Concrete
ASTM C 171	(1969; R 1986) Sheet Materials for Curing Concrete
ASTM C 172	(1990) Sampling Freshly Mixed Concrete

ASTM C 231	(1989a) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 309	(1989) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31	(1990) Making and Curing Concrete Test Specimens in the Field
ASTM C 39	(1986) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	(1990) Ready-Mixed Concrete
ASTM D 1621	1979 Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D 3575	1984 Test Method for Flexible Cellular Materials made from Olefin Polymers

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 203	(1997) Roadway Excavation and Embankment; and Subparts as Specified
ODOT 451	(1997) Reinforced Portland Cement Concrete Pavement; and Subparts as Specified
ODOT 499	(1997) Concrete General; and Subparts as Specified
ODOT 509	(1997) Reinforcing Steel; and Subparts as Specified
ODOT 511	(1997) Concrete for Structures; and Subparts as Specified
ODOT 608	(1997) Walks, Curb Ramps and Steps; and Subparts as Specified
ODOT 609	(1997) Curbing; and Subparts as Specified
ODOT 701	(1997) Hydraulic Cement; and Subparts as Specified
ODOT 705	(1997) Concrete Pavement Incidentals; and Subparts as Specified
ODOT 709	(1997) Reinforcing Steel; and Subparts as Specifie

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330,

"Submittals," in sufficient detail to show full compliance with the specification:

SD-01, Data

Mix Designs (Contractor and Job) shall be submitted for approval for each concrete class. The design for concrete properties shall equal or exceed the specified design properties. following items:

SD-06, Instruction

Manufacturers Instructions for all products used shall be submitted, including any special instructions for equipment installation, for approval prior to use. Special notices shall detail all pedestrian impedances, hazards and safety precautions.

SD-13, Certificates

Certificates of Compliance shall be submitted for the following items demonstrating conformance with the referenced specifications contained in this section. Certificates must contain project name and Contract number, date, name of Contractor, name of concrete testing service, source and mineralogy of aggregates, complete catalog information for all manufactured products proposed and test results. The items are:

Reinforcing steel
Form materials
Curing and sealing materials
Joint materials
Concrete materials
Concrete mix design

SD-14, Samples

Samples of each concrete mix shall be submitted in accordance with the paragraph entitled "Quality Control During Construction" of this section.

1.4 LABORATORY AND FIELD SAMPLING AND TESTING SERVICE

Sampling and testing services shall be provided by the Contractor at the direction of the Contracting Officers Technical Representative (COTR). The testing service agency shall be approved prior to commencing construction. The field testing shall be done to determine conformance with reference specifications and for quality control.

1.4.1 Laboratory Testing

Laboratory testing shall consist of running compressive strength tests on concrete cylinders, prepared in the field, according to ASTM C 39.

1.4.2 Field Testing and Quality Control During Construction

Concrete shall be sampled and tested at the direction of the COTR and as follows:

REQUIREMEN	TEST METHO	NUMBER OF TESTS
Sampling	ASTM C 172	As required for each test.
Slump one	ASTM C 143	One for each concrete load; each time water or an admixture is added to the mix.
Air content	ASTM C 231	One at the point of delivery for each load and one for each set for compressive strength test cylinders.
Compression test	ASTM C 31	One set of two (2) standard cylinders for each compressive strength test for each load.
Concrete temperature		Hourly when air temperature is 4.49 degrees C and below or 2.67 degrees C and above and each time a set of compres-sive-test specimens is made.

PART 2 PRODUCTS

2.1 CONCRETE

All Code requirements contained within ACI 318, ACI 305R, ACI 306R, and ACI SP-66 shall be strictly adhered.

The general provisions contained in ODOT 499 apply to this specification as modified herein:

Minimum 28 day compressive strength of 281.2 kilograms per square centimeter.

Maximum chloride ion content of 0.30% by weight of cement in mix per cubic yard according to AASHTO T 260.

Air entrainment 5% to 7% at point of placement.

Maximum delivered slump of 51 mm without plastisizers added; 208 mm after an approved superplastisizer is added; 254 mm with an approved batch plant added high-range water reducing admixture producing a rheoplastic concrete. Water shall no be added at the job site for the purpose of easing casting or finishing.

Maximum water-cement ratio of 0.40.

Course aggregate shall be limestone or dolomite only.

Mix water shall be potable.

Ready mix concrete shall conform to ASTM C 94.

2.1.1 Shrinkage Compensating

The above specifications apply to this item and shall include the following:

Shrinkage compensating concrete shall be Type , constructed according to ACI 223 and ODOT 701.08.

Minimum cement content per cubic meter is 305.5 kilograms.

Maximum water-cement ratio can be increased to 0.50.

Maximum delivered slump can be increased to 102 mm.

2.1.2 Reinforcing Bar

Reinforcing bars shall meet the requirements of ODOT 509.

2.1.3 Welded Wire Fabric

Welded wire fabric (WWF) shall meet the requirements of ODOT 709 and ASTM A 185 and shall be delivered to the project site as flat sheets; any rolled (WWF) will be rejected.

2.2 FORM MATERIALS

Forms shall be of ample strength to resist any deformation during concrete casting and to remain in vertical and horizontal alignment until concrete has hardened. Forms shall be straight (except where a curve is detailed on the Contract drawings, in which case a smooth, even radius shall be executed), free of distortion or defects and extend the full depth of the concrete. At the direction of the COTR, all unacceptable forms shall be removed and replaced at the Contractors expense.

Form releasing agent shall be used and will be a clear compound that will not discolor or damage the concrete surface.

2.3 CURING AND SEALING MATERIALS

2.3.1 Curing Mats

Mats shall consist of a filling material of cotton batts, covered with unsized cloth tufted or stitched to maintain the shape and stability, as approved.

Burlap cloth shall be made from jute or kenaf and shall be plain weave, weighing 10 ounces per square yard, conforming to AASHTO M 182, Class 3.

2.3.2 Moisture-Retaining Cover

The cover shall be fiber-reinforced, two-ply, nonstaining, white waterproof paper; 4-mil, white, opaque polyethylene film; or 4-mil burlap-polyethylene sheet, conforming to ASTM C 171.

2.3.3 Liquid Membrane-Forming Compounds

Compounds shall be spray applied, white pigmented, conforming to ASTM C 309, and ODOT 705.07.

2.4 JOINT MATERIALS

2.4.1 Preformed Filler

Preformed expansion join filler material shall conform to ODOT 705.03, except as noted below:

All expansion joint material in contact with shrinkage compensating concrete shall be 12.7 mm thick, extend the full depth of the concrete section and have a maximum compression of 1.76 kilograms per square centimeter at 50% deformation and comply with ASTM D 1621 and or ASTM D 3575.

2.4.2 Joint Sealer

Hot-applied joint sealer shall conform to ODOT 705.04.

2.5 AGGREGATE BASE

Aggregate base shall consist of #57 limestone. Slag shall not be permitted. Limestone is the only acceptable material.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

All earthwork associated with establishing the subgrade shall conform to ODOT 203 as modified by these specifications.

3.1.1 Grading and Compaction

Final subgrade line, grade and compaction shall be as shown on the Contract drawings.

The compacted subgrade surface must be approved by the COTR prior to placing any construction materials.

3.2 FORM WORK

Forms shall extend the full thickness of concrete walks as specified on the Contract drawings.

3.3 CONCRETE WALK

The applicable sections contained in ODOT 608 Walks, Curb Ramps and Steps

shall be adhered to except as modified herein.

3.3.1 Subgrade

The subgrade surface shall be proof rolled with a paving roller or smooth-wheel vibratory compactor of at least 1814 kg weight.

3.3.2 Aggregate Base

The aggregate base shall consist of a minimum of 75 mm of #57 limestone or dolomite, placed and spread uniformly and compacted with a paving roller or smooth-wheel vibratory compactor of at least 1814 kg weight.

3.3.3 Concrete

Cast in place concrete shall be placed in the location(s) shown on the Contract drawing(s).

Concrete shall be unreinforced and shall be a minimum 127 mm in depth.

Sidewalk width shall be 1.524 m.

Tooled construction joints shall be placed every 1.524 m of walk and as shown on the Contract drawings.

Expansion joints shall be located at sidewalk terminations, every 6.1 m of walk as shown on the Contract drawings and against adjacent structures.

Broom finish shall be applied after bleed water has disappeared.

Concrete curing and sealing compound shall be applied to all exposed concrete surfaces.

3.4 HANDICAP RAMPS

All specification covering sidewalk installation as per paragraph entitled "Concrete Walk" apply to this section. Location(s) of handicap ramps are as shown on the Contract drawing(s).

3.5 CONCRETE CURBS

Concrete curbs shall be constructed at the location(s) shown on the Contract drawing(s) and according to the requirements of ODOT 609 Curbing as modified herein.

Locations where new curbs abut existing curbs shall be saw cut neat and true and the full depth of the existing curb.

Curbs shall be constructed of cast-in-place concrete, and shall have an expansion joint every 6.1 m and at butt joints with other construction.

3.6 PAVEMENT SLABS

Pavement slab(s) shall be constructed according to the plan(s) and

profile(s) shown on the Contract drawing(s); and in accordance with the requirements of ODOT 451.

3.7 CURING

Concrete curing shall follow the requirements of ODOT 511.

3.8 INCIDENTALS

Items under this section include all other slabs on grade, surface fixture protection slabs, equipment mounting pads and any other non-structural concrete items.

Location and design of these items are as shown on the Contract drawing(s).

Concrete surface shall be broom finished.

-- End of Section --

SECTION 02536

SANITARY SEWERAGE SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1995) Standard Specification for Portland Cement
ASTM C 425	(1991) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1994) Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 443M	(1994) Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric)
ASTM C 564	(1995) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 700	(1991) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 76M	(1995) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM D 1869	(1994) Rubber Rings for Asbestos-Cement Pipe
ASTM D 3034	(1994) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM C 478M	(1990) Standard Specification for Precast Reinforced Concrete Manhole Sections Including: Base Sections, Riser Sections, and Appurtenances such as grade rings, tops, and special sections for use in the

sanitary sewerage systems.

STATE OF OHIO DEPARTMENT OF TRANSPORTATION

ODOT 703 (1997) Aggregate; and Subparts as Specified

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-04 Drawings

Installation Drawings for the following items shall be submitted showing complete detail, both plan and sideview details with proper layout dimension and elevations.

SD-04 Drawings

As-Built Drawings for the complete Sanitary Sewer System.

SD-08 Statements

A Sewer Bypass Plan shall be submitted when sewer flow is to be interrupted. The following items shall be noted in the plan:

Proposed Schedules
Methods
Materials
Equipment

SD-09 Reports

Test Reports for the following items shall be submitted. Compaction and density test shall be in accordance with Section 02225, "Excavation, Backfilling, and Compacting for Utilities."

SD-09 Reports

Inspection Reports for Daily Activities during the installation of the sanitary system shall be submitted. Information in the report shall be detailed enough to describe location of work and amount (footage) laid.

SD-13 Certificates

Certificates of Compliance for the following items shall be submitted in accordance with the applicable reference standards and description of this section:

Precast Reinforced Concrete Grade Rings Manholes
Precast Reinforced Concrete Manhole Sections

Concrete Aggregates
Portland Cement
Concrete Grout Mix Design
Rubber Gaskets
Pipe
Pipe Connection Device
Frames and Covers
Manhole Steps

SD-18 Records

Record of Existing Conditions shall be submitted after a thorough inspection of the area by the Contractor in the presence of the Contracting Officer.

PART 2 PRODUCTS

2.1 PRECAST REINFORCED CONCRETE GRADE RINGS FOR MANHOLES

Precast Reinforced Concrete Grade Rings shall conform to ASTM C 478M, Grade SW.

2.2 CEMENT MORTAR

Mortar shall consist of 1 part portland cement and 2 parts fine sand with enough water to produce mortar of the proper consistency for the type of joint.

2.3 CONCRETE AGGREGATES

Aggregates shall conform to ODOT 703 except that granulated slag (ODOT 703.8) shall not be permitted.

2.4 RUBBER GASKETS

Rubber gaskets shall conform to ASTM C 443M, ASTM C 564, ASTM D 1869, and ASTM C 443M.

2.5 PIPE

Pipe shall be as follows:

Vitrified clay pipe and fittings shall conform to ASTM C 700, extra strength, bell-and-spigot type. Joints shall be in accordance with ASTM C 425.

Concrete pipe and fittings shall conform to ASTM C 76M and shall be the bell-and-spigot type. Joint gaskets shall conform to ASTM C 443M.

Polyvinyl chloride (PVC) pipe and fittings shall conform to ASTM D 3034, Cell Classification 12454-B.

2.6 PORTLAND CEMENT

Cement shall conform to ASTM C 150, Type 1.

2.7 HYDRAULIC CEMENT

Hydraulic cement shall be Sono Plug or Water Plug.

2.8 FRAMES AND COVERS

Ductile iron frames and solid covers shall be in accordance with ODOT 711.13.

Deviations in standard castings shall be acceptable only when prior approval has been granted. Frames and covers shall conform to ASTM A 536.

"SANITARY" at least 50 millimeter high shall be cast into covers so as to be conspicuously visible.

2.9 JOINTING

Cement mortar shall not be used as a pipe-jointing material. Hydraulic cement shall be used at manhole joints and pipe joints approved by the COTR.

Pipe joints shall be sealed with:

A rubber gasket configuration conforming to ASTM C 478, as recommended by the pipe manufacturer for the particular type of pipe joint. Gaskets shall be installed to provide a tight fit. Rubber gaskets may be used with clay pipe, concrete pipe, and PVC pipe.

2.10 MANHOLES

2.10.1 Construction

Manholes shall be constructed of reinforced precast-concrete rings conforming to ASTM C 478 with cast iron frames and covers. Frames and covers shall be bolted down and as necessary. Frames and covers shall be set so that the top of the cover is 100 millimeter higher than finished grade, where no pavement exists. Where pavement does exist, frames shall be flush with surface. Invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly.

2.10.1.1 Invert Channels

Invert channels shall be formed directly in the concrete of the manhole base. Flooring of the manhole outside the channels shall be smooth and shall slope toward the channels, no less than 25 millimeter per 300 millimeter nor more than 50 millimeter per 300 millimeter. The free drop inside the manholes shall not exceed 760 millimeter measured from the invert of the inlet pipe to the top of the floor of the manhole outside the channels. Drop manholes shall be constructed whenever the free drop would be greater than 760 millimeter.

2.10.1.2 Concrete

Concrete used in manholes shall have a compressive strength of not less than 21 Megapascal after 28 days and shall be composed of not less than 7-1/2 bags of portland cement per cubic meter. Coarse aggregate shall be used in the greatest amount consistent with required workability. The foregoing requirements apply to concrete in precast rings, segmental blocks, and concrete poured in place. Concrete rings shall conform to ASTM C 76M, except that the length of sections may be shorter as conditions require. Wall thicknesses shall be not less than 127 millimeter nor less than 1/12 the diameter of the manhole for either vertical walls or cone sections and shall be reinforced with not less than 3 square millimeter of steel per 300 millimeter of height. Joints between precast rings shall be have resilient gaskets conforming to ASTM C 443.

2.10.1.3 Steps

Steps shall be as detailed on the contract drawings and shall conform to ODOT 711.31, Reinforced Propylene Plastic Manhole Steps.

2.10.1.4 Jointing and Plastering

Mortar for jointing and plastering shall consist of 1 part portland cement and 2 parts fine sand. For brickwork, lime may be added to the mortar in the amount of not more than 25 percent of the volume of cement. Joints shall be completely filled, smooth, and free from surplus mortar on the inside of the manhole.

2.11 CONNECTIONS TO STRUCTURES

New manholes shall have predesigned factory installed rubber boots with Stainless Steel (S.S.) band pipe connectors. The pipe inserted in the opening around the pipe shall be neatly and permanently closed (water tight) with non-shrinking and non-corrosive grout.

Pipes connecting to an existing manhole without a stub, shall be with a water tight connection. Sewers shall be designed to enter an existing manhole at an elevation so that core bore is not any closer than 150 millimeters to any manhole joint.

PART 3 EXECUTION

3.1 LOCATION

Where the location of the sewer is not clearly defined by dimensions, the sewer shall be laid not closer than 3050 millimeter horizontally to a water supply main or service line except that where the bottom of the water pipe will be at least 300 millimeter above the top of the sewer pipe, the horizontal spacing shall be a minimum of 1830 millimeter. Water lines shall be above sewage force mains.

Where gravity-flow sewers cross above waterlines, the sewer pipe for a distance of at least 3000 millimeter each side of the crossing shall be ductile iron, pipe and without joints closer horizontally than 900

millimeter to the crossing, or the sewer pipe shall be fully encased in concrete. Thickness of the concrete, including that at the pipe joints, shall be not less than 100 millimeter.

3.2 PIPE LAYING

Bottom of trench shall be shaped to give uniform circumferential support to the lower fourth of each pipe. Pipe laying shall proceed upgrade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid true to line and grade in a manner to form a close concentric joint with the adjoining pipe and prevent sudden offsets of the flow line. Interior of the sewer shall be cleared of superfluous materials at all times. Where cleaning after laying is difficult, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after jointing has been completed. When the maximum width of the trench at the top of the pipe is exceeded for any reason other than by direction, the Contractor shall install, at no additional cost to the Government, such bedding as may be required to satisfactorily support the added load of the backfill. Trenches shall be kept free from water until the pipe-joining material has set. Pipe shall not be laid when the condition of the trench or the weather is unsuitable for such work. When work is not in progress, open ends of pipe and fittings shall be closed to prevent intrusion of foreign materials.

3.3 INFILTRATION AND EXFILTRATION

Leakage shall not exceed a rate of 18.5 liter per millimeter of pipe diameter per kilometer per day of sewer for any section between successive manholes. When infiltration appears excessive, the amount of leakage shall be measured by a suitable weir or other device. When the determination of infiltration is not practicable because of dry trench conditions, exfiltration tests shall be made by filling the sewer between successive manholes with water to the top of the outlet of the upper manholes. Amount of water required to maintain the pipe full for the required test period shall be measured and the rate of leakage determined. When leakage exceeds the maximum amount, an approved correction shall be made. Both measurement and correction shall be made at no additional cost to the Government.

3.4 WYE BRANCHES

Commercially manufactured wye branches shall be installed where sewer connections are necessary. Cutting into pipe for connections shall not be done except as approved. When conditions are such that the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete or supported on a concrete cradle as directed. Concrete required due to faulty construction methods or negligence of the Contractor shall be installed at no additional cost to the Government.

3.5 CONNECTIONS TO EXISTING MANHOLES

Pipe connections to existing manholes shall be made in such manner that the finished work shall conform as nearly as practicable to the applicable

requirements for new manholes.

3.6 TESTING

A. General

1. Tests may be conducted on completed pipe line or any completed portion that can be isolated from other sections previously tested or not complete.

B. Testing Manholes

1. Each new manhole shall be tested by plugging connecting pipes and filling with water to at least 0.6 meter above the crown of the highest entering pipe. After the filled manhole has been allowed to stand for 24 hours, no loss of water will be permitted in a four (4) hour period.

2. Air testing of manholes is required. Contractor shall submit proposed procedures to COTR for approval.

C. Low Pressure Air Test

1. The Contractor shall perform an air test on sewers.

2. Approval of COTR is required.

3. Air Test procedure

a. Plug all pipe outlets with suitable test plugs in section to be tested.

b. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.

c. After an internal air pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

d. After the two minute period, disconnect the air supply.

e. When pressure decreases to 3.5 psig, start timing with a stop watch.

f. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psig.

g. Minimum permissible pressure holding times shall be as prescribed in ASTM C828, Low-Pressure Air Test of Vitrified Clay Pipe Lines; in ASTM F1417, Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air; or as recommended by the manufacturer for the type of piping materials being tested.

4. All air tests shall be conducted with the utmost safety precautions, including by not limited to:

   a. Bracing all plugs securely.

   b. Not allowing personnel in manholes during testing.

   c. Installing a pressure-relief system operative at 0.7 kilograms per square centimeter.

F. Deflection Test

1. A deflection test shall be made by pulling through the sewer a rigid ball or mandril having a diameter equal to 95% of the inside diameter of the pipe.

2. Deflection tests shall be performed no sooner than 60 days following completion of backfill.

3. All plastic pipe shall be tested for deflection.

4. Maximum ring deflection of pipe when backfilled shall be equal to or less than 5 percent of average inside diameter.

5. A copy of diameter record shall be submitted to the Engineer.

6. Any pipe showing deflections in excess of 5%, sixty (60) days after installation, shall be replaced at no cost to the Owner.

3.7 ACCEPTANCE

Sections of the sewer found defective in material, alignment, grade, or joints shall be corrected at no additional cost to the Government before acceptance.

-- End of Section --

SECTION 02575

PAVEMENT REPAIR

PART 1 GENERAL

1.1 SUMMARY

The work under this section includes all labor, services, equipment, materials and tools necessary to remove existing asphalt concrete pavement and base, prepare surfaces to receive asphalt concrete paving and to install asphaltic concrete pavements in areas disturbed by other construction activities.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced and as modified by subparagraphs within this specification:

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 251	(1997) Partial Depth Pavement Repair
ODOT 254	(1997) Pavement Planing
ODOT 301	(1997) Bituminous Aggregate Base; and Subparts as Specified
ODOT 304	(1997) Aggregate Base; and Subparts as Specified
ODOT 401	(1997) Plant Mix Pavement General; and Subparts as Specified
ODOT 404	(1997) Asphalt Concrete; and Subparts as Specified
ODOT 407	(1997) Tack Coat; and Subparts as Specified
ODOT 408	(1997) Prime Coat; and Subparts as Specified
ODOT 409	(1997) Seal Coat
ODOT 448	(1997) Asphalt Concrete
ODOT 705	(1997) Concrete Pavement Incidentals; and Subparts as Specifie

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330,

"Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Materials which will be submitted for the following items:

The Contractor-chosen bituminous materials for use under this specification shall be approved by the COTR prior to their use on this project. Manufacturer's information must demonstrate compliance with the referenced specification and be appropriate for the intended application.

SD-01 Data

Equipment

The Contractor shall submit a list of all power-driven construction equipment planned for use under this specification to the COTR for approval prior to start of construction. The COTR will require the equipment to be changed, at no additional charge to the Government, if he determines that the equipment is fundamentally incapable of performing the required tasks and meet this specification.

SD-13 Certificates

Certificates of Compliance shall be submitted for the following items with the weigh tickets as delivered to the site:

All asphalt concrete mix constituent quantities as specified in the ODOT reference specification as modified herein. These materials include bitumen content, aggregate size gradation, aggregate mineralogy, time of day (to the minute) when the truck left the plant and mix temperature when truck left the plant.

Any information missing from the above list shall be considered enough grounds to reject the delivered load as not meeting specifications.

PART 2 PRODUCTS

2.1 AGGREGATE

All aggregate coarser than No. 30 shall consist of limestone only.

All aggregate of sieve size No. 30 or finer shall consist of natural sand and/or limestone dust only.

Slag and reclaimed or recycled pavements shall not be used for any purpose covered by this specification.

2.2 BITUMINOUS AGGREGATE BASE

Bituminous aggregate base shall consist of ODOT 301, modified as follows:

Bitumen content shall be no less than 7 percent.

Mix temperature shall not be less than 325 degrees Fahrenheit when leaving the plant.

2.3 AGGREGATE BASE

Aggregate base shall consist of ODOT 304, modified as follows:

Crushed limestone meeting the required gradation is the only acceptable material.

2.4 ASPHALT CONCRETE

Asphalt concrete shall consist of ODOT 404, modified as follows:

Bitumen content shall be no less than 10 percent.

Mix temperature shall not be less than 325 degrees Fahrenheit when leaving the plant.

ODOT 448 shall not be used as an alternate.

2.5 TACK COAT

Tack coat shall consist of ODOT 407 and as follows:

Cover aggregate shall not be used.

Application temperature range as specified shall be strictly adhered to.

Specific choice of bituminous material shall be by the Contractor but must be from the list in ODOT 407, with weather limitations considered.

2.6 PRIME COAT

Prime coat shall consist of ODOT 408 and as follows:

Cover aggregate shall not be used.

Application temperature range as specified shall be strictly adhered to.

Specific choice of bituminous material shall be by the Contractor but must be from the list in ODOT 408 with weather limitations considered.

Bituminous material shall consist of a rapid curing liquid asphalt (RC-70 or RC-250) or a medium curing liquid asphalt (MC-30 or MC-70). Also permitted is an asphaltic emulsion Primer 20. Temperature of this material shall be between 75 and 120 degrees Fahrenheit at application.

2.7 SEAL COAT

Seal coat shall consist of ODOT 409 and as follows:

Cover aggregate shall not be used.

Application temperature range as specified shall be strictly adhered to.

Specific choice of bituminous material shall be by the Contractor but must be from the list in ODOT 409 with weather limitations considered.

Bituminous material shall consist of a rapid curing liquid asphalt (RC-250) or a medium curing liquid asphalt (MC-800), with an application temperature between 150 and 175 degrees Fahrenheit. Also permitted is an asphaltic emulsion, either anionic (RS-1 or RS-2) or cationic (CRS-1 or CRS-2), with an application temperature between 50 and 160 degrees Fahrenheit.

2.8 BUTT JOINTS

Hot-applied crack and joint sealant conforming to the requirements of ODOT 705,.04, shall be applied to the surface of the joint between new asphalt concrete pavement and all adjoining pavements, curbs and fixtures.

PART 3 EXECUTION

3.1 GENERAL

Installation requirements specified in ODOT 401, .04 through .16.

3.1.1 Compaction of Asphalt Concrete and Base

Smooth steel roller type compactors shall weigh between 8 and 12 tons and/or be capable of producing a minimum load of 200 pounds per inch width on the pavement.

Pneumatic tire rollers shall be capable of a wheel load of 5000 pounds (with a tire contact pressure of 85 pounds per square inch) or capable of a wheel load of 2000 pounds (with a tire contact pressure of 55 pounds per square inch).

3.1.2 Temperature Control

The Contractor shall maintain at the site the capability to accurately measure the temperature of asphaltic materials prior to their application and shall take such measurements whenever the Contractor, NASA field inspector or COTR requires them. These temperature readings shall be taken for the purpose of aiding the Contractor in controlling quality and to verify that the specifications covering this work are being met. Materials whose temperature does not fall within the specified range shall no be applied; until such time as the temperature of the material is corrected.

3.2 SITE PREPARATION

The trench shall be backfilled and compacted to subgrade elevation (no less than 14 inches below finished grade) as specified elsewhere.

The subgrade surface shall be free of all loose materials prior to placing

subbase stone as per subpart entitled, "AGGREGATE BASE."

All milled or planed surfaces shall be thoroughly cleaned of all loose material, dust and water by brooming and vacuuming.

3.2.1 Butt Joints

The Contractor shall line out the pavement repair areas in roughly rectangular zones using chalk lines followed by water-soluble spray paint. All lines shall be straight, neat and true. Small, isolated "islands" of original pavement within zones of repaired pavement shall be removed. All pavement repair areas shall be specifically approved by the NASA field inspector and/or COTR prior to commencing work on that area. Modifications to the line work shall be made at their direction.

All butt joints with adjoining pavements shall be saw cut a minimum of 3 inches depth. All pavement, subbase stone and subgrade soil shall be removed to a depth of 14 inches.

..SUBGRADE
3.3 AGGREGATE BASE

The requirements specified in ODOT 304 shall be followed as modified herein:

Depth of aggregate base shall be 6 inches, placed in two 3 inch lifts.

3.2.2 Compaction

Compaction shall be done with adequate power-driven vibratory compactors approved by the COTR. If the NASA field inspector determines that adequate compaction is not being accomplished, the Contractor shall replace the compaction equipment. It is recommended that back hoe-mounted hydraulic vibratory plates be employed for this purpose.

3.3 BITUMINOUS AGGREGATE BASE

The requirements specified in ODOT 301 shall be followed as modified herein:

Depth of bituminous aggregate base shall be 6 inches, placed in a single lift.

ODOT 408 Prime Coat shall be applied to the underlying aggregate base prior to placing bituminous aggregate base. The prime coat shall completely cover and saturate the underlying material.

3.3.1 Compaction

Compaction shall be done with rollers as specified in ODOT 401, .11, wherever possible. As approved by the NASA field inspector and/or the COTR, back hoe-mounted hydraulic vibratory plate may be used in restricted areas.

3.4 ASPHALT CONCRETE PAVEMENT

The requirements specified in ODOT 404 shall be followed as modified herein:

Depth of asphalt concrete pavement shall be 2 inches, placed in a single lift.

ODOT 407 Tack Coat shall be applied to all adjoining pavements prior to placing asphalt concrete pavement (see butt joint requirements). The application shall completely cover and saturate the surface to which it was applied.

3.4.1 Compaction

Compaction shall be done with rollers as specified in ODOT 401, .11. Variation from this specification shall only be done under on-site direction of the NASA field inspector or the COTR and shall consist of compaction with a back hoe-mounted hydraulic vibratory plate.

3.5 ASPHALT CONCRETE PAVEMENT OVERLAY

Overlays of existing asphalt pavement shall be done only under the specific instructions of the COTR and shall be executed according to the requirements of ODOT 251 Partial Depth Pavement Repair and as follows:

Saw cuts shall be done as previously specified except they shall be 2 inches depth.

Asphalt pavement wearing course shall be removed to a depth of 2 inches according to the requirements of ODOT 254.

Following pavement removal, the resulting surface shall be thoroughly cleaned of all loose material and dust using brooms and vacuum machinery. The NASA field inspector will approve the cleaned surface prior to continuation of construction.

ODOT 407 Tack Coat shall then be applied to all exposed surfaces to receive overlayment. The application shall completely cover and saturate the surface.

A 2 inch wearing course of ODOT 404 shall be placed and compacted as specified herein and shall result in a surface that completely restores the roadway line and grade.

3.6 ASPHALT PAVEMENT SEALING

Asphalt pavement sealing shall only be done in the areas shown on the Contract drawings and as directed by the COTR. Execution shall follow the requirements of ODOT 409 and as specified herein:

Cover aggregate shall not be applied.

Material shall be applied evenly until the entire surface is saturated, but not puddling.

-- End of Section --

SECTION 02585

MEDIUM VOLTAGE UNDERGROUND POWER DISTRIBUTION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1992; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1995) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 48M	(1994; Rev A) Standard Specification for Gray Iron Castings (Metric)
ASTM A 569/A 569M	(1991; Rev A) Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality

FEDERAL SPECIFICATIONS (FS)

FS TT-V-51	(Rev F) Varnish: Asphalt

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997; 11th Ed) UL Standard for Safety - Rigid Metal Conduit

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings shall be submitted for the following by the Contractor in accordance with paragraph entitled, "Drawings," of this section.

Conduit and Fittings
Separators
Markers
Grounding Conductor
Manholes

Installation drawings shall be submitted for Underground Duct Systems and Manholes in accordance with the paragraph entitled, "Installation," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Conduit and Fittings
Separators
Markers
Grounding Conductor
Manholes

Additional data for the following accessories shall be submitted for the following items:

Manhole Frames and Covers
Sump Cover
Pulling Irons
Cable Supports

Material, Equipment, and Fixture Lists shall be submitted in accordance with paragraph entitled, "Underground Duct Systems and Manholes," of this section.

SD-06 Test Reports

Test Reports shall be submitted in accordance with the paragraph entitled,"Reports," of this section.

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted in accordance with paragraph entitled, "Underground Duct Systems and Manholes," of this section.

1.4 DRAWINGS

Fabrication Drawings shall be submitted for Conduit and Fittings, Separators,

Markers, Grounding Conductor and Manholes consisting of fabrication and assembly details to be performed in the factory.

1.5 UNDERGROUND DUCT SYSTEMS AND MANHOLES

Material, Equipment, and Fixture Lists shall be submitted including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Manufacturer's Instructions shall be submitted for the Underground Duct Systems and Manholes including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 CONDUIT AND FITTINGS

Conduit and fittings in duct banks shall be rigid galvanized steel and shall conform to UL 6.

Aluminum conduit shall not be permitted.

2.2 SEPARATORS

Separators or spacing blocks shall be made of concrete, plastic, or other suitable nonmetallic nondecaying material.

2.3 MARKERS

Markers shall be made of 17,000 kilopascal concrete 150 millimeter square or round section by 1220 millimeter, minimum (minimum 920 millimeter above grade and a minimum 3010 millimeter below grade). Top edges of the marker shall have a 153 millimeter chamfer all around.

2.4 GROUNDING CONDUCTOR

A grounding conductor shall be installed above the concrete encasement of the duct banks and shall be no smaller than a 8.25 millimeter diameter (AWG No. 1/0) stranded bare copper conductor.

2.5 MANHOLES

Manholes shall be of the types indicated and shall be constructed in accordance with applicable details as indicated. Concrete shall be 17,000 kilopascal at 28 days.

Precast concrete manholes having the required strength and inside dimensions may be utilized upon approval by the Contracting Officer.

2.5.1 Manhole Frames and Covers

Manhole frames and covers shall be as indicated and shall be gray cast iron with machine finished or nonrocking bearing surfaces in accordance with

ASTM A 48M, Class 30B Gray Iron Castings.

2.5.2 Sump Cover

Sump covers shall be as indicated. Covers shall be gray cast iron conforming to ASTM A 48M, Class 30B Gray Iron Castings.

2.5.3 Pulling Irons

Pulling irons shall be 22 millimeter diameter galvanized-steel bar with an exposed triangular-shaped opening, when set, 230 millimeter on each side. Steel bars shall be merchant quality. Galvanizing shall conform to ASTM A 153/A 153M.

2.5.4 Cable Supports

Cable racks shall be heavy duty, hot-dip galvanized T-section steel, 65 by 57 millimeter by 64 millimeter in size and punched with 14 holes, 40 millimeter on center for attaching cable hooks. Racks shall be hot-rolled merchant-quality steel-bar-size tees. Galvanizing shall conform to ASTM A 123.

Cable hooks shall be 5 millimeter hot-galvanized sheet steel pressed to channel shape. Hooks shall be 65 millimeter wide and 360 millimeter long and shall be vertically pinned to the cable racks. Hooks shall be hot-rolled commercial-quality sheet steel conforming to ASTM A 569/A 569M. Galvanizing shall conform to ASTM A 123.

Insulators for cable support shall be high-glazed wet-process porcelain.

2.6 REPORTS

Test Reports for 17,000 kilopascal concrete shall be submitted to the Contracting Officer.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Duct Banks

Duct banks shall consist of single or multiple conduit assemblies encased in concrete and installed with top of duct or duct bank not less than 800 millimeter below established grade. Duct bank assemblies shall conform to the requirements indicated.

Conduit shall be thoroughly cleaned before using or installing. During construction and after the duct line is completed, the ends of the conduit shall be plugged to prevent water from washing mud into the conduit or manholes. Conduit shall be kept clean and free of concrete, dirt, and any other foreign substance during construction. All conduit runs should be installed so they will drain throughout the run (cable are safe in dry conduits).

Duct lines shall be laid to a minimum grade of 100 millimeter per 30 meter. Grade may be from one manhole to the next or both ways from a high point between manholes, depending on the contour of the finished grade.

Duct banks installed under or adjacent to roads or shoulders of roads shall be encased in reinforced concrete. Duct lines shall be installed so that the top of the concrete in encased ductlines is not less than 460 millimeter, or so that the duct in nonencased ductlines is not less than 600 millimeter below finished grade or finished paving at any point, except at railroad crossings. At railroad crossings, ductlines shall be encased with reinforced concrete. Top of the concrete shall be not less than 1220 millimeter below the base of the rail.

All polyvinylchloride conduits in ductbanks between the last manhole and the tunnel shall be pneumatically pressure tested at 34 kilopascal for five minutes with a maximum 3.0 kilopascal pressure drop. Test to be accomplished prior to concrete encasement. Test results to be submitted and approved by the Contracting Officer's Technical Representative prior to concrete encasement.

Changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long-sweep bends having a minimum radius of 7500 meter, except that manufactured bends may be used at ends of short runs of 30 meter or less and then only at or close to the end of the run. Long-sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 450 millimeter for use with ducts of less than 75 millimeter in diameter and a minimum radius of 920 millimeter for ducts of 75 millimeter in diameter and larger.

Conduit shall terminate in end bells where duct lines enter manholes.

After the duct line has been completed, a standard flexible mandrel not less than 300 millimeter long, with a diameter approximately 6 millimeter less than the inside diameter of the conduit, shall be pulled through each conduit, after which a brush with stiff bristles shall be pulled through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line.

Pneumatic rodding may be used to draw in the lead wire.

Where connection is made to an existing duct that is of a different material and shape from the duct line being installed, a suitable coupling of a type recommended by the duct manufacturer shall be used.

Conduit joints in concrete encasement may be placed side by side horizontally but shall be staggered at least 150 millimeter vertically.

Separators shall be placed not greater than 1200 millimeter on center. Ducts shall be securely anchored to prevent movement during the placement of concrete. At least 75 millimeter of concrete shall be provided at bottom, top, and sides, except that concrete shall be at least 150 millimeter at railroad crossings.

Both concrete bed and cover under railroad tracks, across ditches, or under paving shall be reinforced with two 15 millimeter diameter (No. 4) reinforcing bars. Each single conduit of the duct bank shall be completely encased in concrete. Specified thickness of concrete encasement is minimum and may be increased to fit the actual shape of the trench.

Conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected.

A grounding conductor shall be installed above the concrete encasement. Grounding conductor shall extend along all electrical duct banks including stubs through each electrical distribution system manhole and to each transformer and switching-station installation.

3.1.2 Markers

Duct bank markers, where required, shall be located at the ends of duct banks except at manholes or handholes at approximately every 60 meter along the duct run and at each change in direction of the duct run. Markers shall be placed 600 millimeter to the right of the duct bank, facing the longitudinal axis of the run in the direction of the electrical load.

The letter "D" with two arrows shall be impressed or cast on top of the marker. One arrow shall be located below the letter and shall point toward the ducts. Second arrow shall be located adjacent to the letter and shall point in a direction parallel to the ducts. The letter and the arrow adjacent to it shall each be approximately 75 millimeter long. The arrow under the letter shall be 50 millimeter long. The letter and arrows shall be V-shaped, and shall have a width of stroke at least 6 millimeter at the top and a depth of 6 millimeter.

In paved areas, the top of the duct markers shall be flush with the finished surface of the paving.

Where the duct bank changes direction, the arrow located adjacent to the letter shall be cast or impressed with an angle in the arrow the same as the angular change of the duct bank.

3.1.3 Manholes

Exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. Location of each manhole shall be approved by the Contracting Officer before construction of the manhole is started.

Frame and cover shall be delivered on the job unpainted and, after inspection and approval, shall be given 2 coats of asphalt varnish conforming to FS TT-V-51. Frames shall be securely fastened to manholes with 20 millimeter anchor bolts.

When a manhole sump is required, as indicated, a cast-metal grille sump frame and cover shall be installed over the sump.

In paved areas, the top of manhole covers shall be flush with the finished

surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 15 millimeter above the finished grade and 150 millimeter above unfinished grade.

Where existing grades are encountered that are higher than indicated finished grades, a sufficient number of courses of brick shall be temporarily installed between the top of the manhole and the manhole frame to elevate the manhole cover to the existing grade level.

Where duct lines enter manholes, the sections of duct either may be cast in the concrete or may enter the manhole through a square or rectangular opening of suitable dimensions provided in the manhole walls. Where openings are provided for the entrance of duct lines, the space between ducts and between ducts and manhole walls shall be calked tight with lead wool or an approved equivalent.

Cables shall be supported on walls by hot-dip galvanized steel cable racks equipped with adjustable hooks and insulators. Cable racks shall be installed in each manhole with not less than two spare hooks shall be installed on each cable rack. Insulators shall not be required on spare hooks.

A pulling iron shall be installed in the wall opposite each duct line entrance into the manhole.

In each electrical manhole, at a convenient point close to the wall, a ground rod minimum 3 meter long, shall be driven into the earth before the floor is poured so that approximately 200 millimeter of the ground rod will extend above the manhole floor.

When precast concrete manholes are used, the top of the ground rod may be below the floor and the ground conductor brought into the manhole by means of a 11.7 millimeter diameter (No. 4/0 AWG) cable through a watertight sleeve in the manhole wall or floor.

Grounding and bonding shall meet the requirements of NFPA 70.

-- End of Section --

SECTION 02635

STORM SEWERAGE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN CONCRETE PIPE ASSOCIATION (ACPA)

ACPA O1-103	(1988) Concrete Pipe Installation Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 74	(1994) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A 746	(1994) Standard Specification for Ductile Iron Gravity Server Pipe
ASTM C 387	(1987) Standard Specification for Packaged, Dry Combined Materials for Mortar and Concrete
ASTM C 443M	(1994) Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets (Metric)
ASTM C 76M	(1995) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 923M	(1994) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM D 2321	(1989) Standard Practice for Sewers and Other Gravity-Flow Applications
ASTM D 3034	(1994) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F 1417	(1992) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air
ASTM F 794	(1991) Standard Specification for

	Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

AMERICAN WATERWORKS ASSOCIATION (AWWA)

AWWA C111	(1990) Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fitting

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Mix Designs for Concrete shall be submitted.

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following:

Pipe
Grout
Mortar
Gaskets
Compression Joints
Manhole Frames/Covers
Grating and Frames
Precast Concrete Manholes
Precast Concrete Base Slabs
Concrete Block
Sewer Brick
Bituminous Coating
Cold Bituminous Mastic Sealer

SD-04 Drawings

Contractor shall submit Coordination Drawings interferences for construction. Details of catch basins and manholes shall be shown with proper elevations.

SD-08 Statements

A Sewer Bypass Plan shall be submitted when sewer flow is to be interrupted. The following items shall be noted in the plan:

Proposed Schedules
Methods
Materials
Equipment

SD-09 Reports

Test Reports shall be submitted for the following items in accordance with the applicable paragraphs of this section:

Swelling Test
Infiltration Test
Exfiltration Test
Hydrostatic Test
Pneumatic Plug Test

SD-13 Certificates

Certificates of Compliance for the following items shall be submitted in accordance with the applicable paragraphs of this section for:

Pipe
Grout
Mortar
Gaskets
Compression Joints
Manhole Frames/Covers
Grating and Frames
Precast Concrete Manholes
Precast Concrete Base Slabs
Concrete Block
Sewer Brick
Bituminous Coating
Cold Bituminous Mastic Sealer

1.3 BEDDING

Bedding shall conform to the contract drawings and Section 02225, "Excavation, Backfilling, and Compacting for Utilities."

PART 2 PRODUCTS

2.1 UNDERDRAIN MATERIAL

2.1.1 PVC Underdrains

Underdrains shall be in accordance with ODOT 707.41, perforated per ODOT 707.36. All elbows shall be long sweep.

2.2 FILTER MATERIAL

2.2.1 Filter Fabric

Fabric shall be in accordance with ODOT 712.09, Type A Geotextile Fabric for Underdrains.

2.2.2 Filter Aggregate

Aggregate shall be in accordance with ODOT 605.03(c), No. 8 Limestone.

2.3 MANHOLE FRAMES, COVERS, AND GRATINGS

Frame and cover shall be of heavy design (215 kilograms minimum total weight) when the manhole is placed within the limits of the pavement or shoulder, otherwise the light design (125 kilograms minimum) may be used. Bearing areas shall be finished smooth and fitted so as to provide a firm and even seat for all portions of the over in the frame. Each cover shall seat in its frame without rocking and shall be marked as a matched frame and cover before delivery to the project. The following legend shall be cast in every cover: "STORM". The base of the frame shall be set in a full bed of Portland cement mortar, and so adjusted to conform to the finished pavement or shoulder elevation and slope. Castings shall meet the requirements of ODOT 604 and material shall conform to ODOT 711.13, Ductile Iron Castings.

2.4 CONDUIT PIPING, JOINTS, AND FITTINGS

2.4.1 Reinforced Concrete Pipe (RCP)

Round RCP shall conform to ASTM C 76M, be of Class 3, with wall type and with wire fabric reinforcement and Bell and spigot ends. Acceptability shall be in accordance with ASTM A 746.

2.4.2 Polyvinyl Chloride Pipe (PVC)

Type PSM Polyvinyl Chloride (PVC) Pipe shall be in accordance with ASTM D 3034, SDR 35, up to DN375 diameter. Pipe ends made for joints shall be elastomeric gasket type. PSM PVC Pipe, 450 to 1200 millimeter diameter shall be in accordance with ASTM F 794.

2.4.3 High Density Polyethylene Pipe (HDPE)

Pipe and fitting material shall be high density polyethylene meeting ASTM D3350 minimum cell classification 335420C; or ASTM D1248 Type III, Class C, Category 4, Grade P33.

Pipe shall have a smooth interior and annular exterior corrugations.

1. 12- to 36-inch (300 to 900 mm) shall meet AASHTO M294, Type S.
2. 42- and 48-inch (1050 and 1200 mm) shall meet AASHTO MP6-95.
3. 54- and 60-inch (1350 and 1500 mm) diameters shall have minimum pipe stiffness of 16 and 14 pii (110 and 97 N/M/mm), respectively, and shall meet all other requirements of AASHTO M294.
4. Manning's "n" value for use in design shall not exceed 0.010.

HDPE Pipe Joint :

Pipe shall be joined with the Sure-Lok (bell-and-spigot) joint meeting AASHTO M294 or AASHTO MP6-95. The bell-and-spigot shall incorporate a gasket making it silt-tight. Gaskets shall be installed by the pipe manufacturer.

Pipe Fitting :

Fittings shall conform to AASHTO M294 or AASHTO MP6-95. Fabricated fittings shall be welded on the interior and exterior at all junctions.

2.4.4 Cast-Iron Soil Pipe (CISP) and Fittings

Pipe and fittings shall be in accordance with ASTM A 74, service weight, with bell and spigot ends. Joints shall be in accordance with AWWA C111 push-on type.

2.5 PRECAST CONCRETE MANHOLES

Concrete manholes, risers, base sections, and tops shall be pre-cast and conform to ODOT 706.13.

2.5.1 Manhole Gaskets

Gaskets shall be in accordance with ASTM C 443M for joints between manhole sections.

2.5.2 Manhole Connectors

Connectors shall be in accordance with ASTM C 923M for joints between manhole and pipes.

2.6 MANHOLE AND CATCH-BASIN ACCESS STEPS

Access shall be in accordance with ODOT 711.31, using steps for manholes or catch basins at least 1200 millimeter deep.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL

Excavation, backfill, and removal of unsatisfactory materials shall be in accordance with Section 02225, "Excavation, Backfilling, and Compacting for Utilities." and 02311, "Excavating, Backfilling, and Compacting for Structures."

3.2 GRADING

Grading shall be performed in accordance with Section 02225, "Excavation, Backfilling, and Compacting for Utilities."

3.3 PIPE INSTALLATION

3.3.1 Pipe Installation

Excavations shall be trimmed to required elevations. Objects which impair backfilling or compaction shall be removed. Over excavation shall be corrected with fill material of fine aggregate.

Pipe and fitting shall be inspected for defects before installing.

Defective materials shall be removed from site.

Pipe interior shall be cleaned before installation. Pipe ends shall be sealed when work is not in progress.

Pipe shall be laid to line and grade, with bell end upstream.

Maximum variation from true slope shall not exceed 3.2 millimeter in 3048 millimeter.

Maximum deviation from design elevation shall not exceed 12.2 millimeter at any point in the system.

Maximum deviation from true line shall not exceed 6.1 millimeter for pipe 375 in diameter and smaller, 12.2 millimeter for pipe larger than DN375 in diameter.

Corrections shall be made at a rate not to exceed 30.5 millimeter for one length of conduit.

3.3.2 Reinforced Concrete Pipe Installation

Reinforced concrete pipe and fittings shall be installed in accordance with manufacturer's instructions, and ACPA O1-103.

3.3.3 PVC and HDPE Plastic Pipe Installation

Pipe and fittings shall be installed in accordance with manufacturer's instructions and in accordance with ASTM D 2321.

3.4 PIPE BEDDING

3.4.1 Bedding

Minimum compacted bedding under installed pipe shall be as per contract drawings, and in no case less than 100 millimeter.

Bedding shall be placed in layers not exceeding 150 millimeter in depth and compact. Additional layers shall be added until a minimum elevation of 300 millimeter above the pipe is achieved.

3.4.2 Compaction

Puddling or jetting shall not be permitted when compacting bedding materials.

3.5 JACKING PIPE

Jacking pipe shall not be used.

3.6 UNDERGROUND STRUCTURES

3.6.1 Structures

ASTM C 387, Type M mortar, 13 millimeter thick, shall be applied to both interior and exterior surfaces.

Top of manhole and catch basin covers shall be set flush with finished pavement surfaces. Elsewhere, tops shall be set 75 millimeter above finished surface.

Steps shall be attached into manhole walls with epoxy compound.

Preformed bituminous expansion-joint material shall be provided 19 millimeter thickness around drainage structures in PC concrete pavements and walks.

Joints for concrete risers and tops shall be made with flexible watertight rubber-type gaskets.

Catch basins and curb drop inlets shall be precast.

3.6.2 Concrete Construction

Concrete shall be in accordance with ODOT 499.

3.7 FIELD QUALITY CONTROL

3.7.1 Tests

Contractor shall provide test equipment or engage the services of a firm to provide the necessary testing.

3.7.1.1 Low Pressure Air Test of Conduit

Acceptance tests for installed ferrous and plastic piping shall be in accordance with ASTM F 1417.

Low Pressure Air Test

1. The Contractor shall perform an air test on sewers.

2. Approval of COTR is required.

3. Air Test procedure:

    a. Plug all pipe outlets with suitable test plugs in section to be tested.

    b. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 0.28 kilogram per square centimeter.

    c. After an internal air pressure of 0.28 kilogram per square centimeter is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

d. After the two minute period, disconnect the air supply.

e. When pressure decreases to 0.25 kilogram per square centimeter, start timing with a stop watch.

f. Determine the time in seconds that is required for the internal air pressure to reach 0.18 kilogram per square centimeter.

g. Minimum permissible pressure holding times shall be as prescribed in ASTM C828, Low-Pressure Air Test of Vitrified Clay Pipe Lines; in ASTM F1417, Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air; or as recommended by the manufacturer for the type of piping materials being tested.

4. All air tests shall be conducted with the utmost safety precautions, including but not limited to:

a. Bracing all plugs securely.

b. Not allowing personnel in manholes during testing.

c. Installing a pressure-relief system operative at 0.7 kilogram per square centimeter.

Deflection Test

1. A deflection test shall be made by pulling through the sewer a rigid ball or mandril having a diameter equal to 95% of the inside diameter of the pipe.

2. Deflection tests shall be performed no sooner than 60 days following completion of backfill.

3. All plastic pipe shall be tested for deflection.

4. Maximum ring deflection of pipe when backfilled shall be equal to or less than 5 percent of average inside diameter.

5. A copy of diameter record shall be submitted to the Engineer.

6. Any pipe showing deflections in excess of 5%, sixty (60) days after installation, shall be replaced at no cost to the Owner.

3.7.2 Interior Inspection of Pipe

Installed pipe shall be inspected when 600 millimeter of earth cover is in place and upon completion of project. Displaced or misaligned pipe, infiltration, accumulation of debris, or other defects shall be corrected by the Contractor at no additional cost to the Government.

3.8 ACCEPTANACE

Sections of the sewer found defective in material, alignment, grade, or joints shall be corrected at no additional cost to the Government before acceptance.

-- End of Section --

SECTION 02713

WATER SYSTEMS

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 88	(1989) Seamless Copper Water Tube
ASTM D 1784	(1990) Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

AMERICAN WATERWORKS ASSOCIATION, INC. (AWWA)

AWWA C104	(1990; 1st Ed) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	(1988) Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	(1987) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111	(1990) Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115	(1988) Flanged Ductile-Iron Pipe with Threaded Flanges
AWWA C151	(1986) Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand- Lined Molds, for Water or Other Liquids
AWWA C153	1986 Ductile-Iron Fittings for Water
AWWA C200	(1986) Steel Water Pipe 6 In. and Larger

AWWA C203	(1986) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C205	(1989) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. and Larger - Shop Applied
AWWA C206	(1988) Field Welding of Steel Water Pipe
AWWA C207	(1986) Steel Pipe Flanges for Waterworks Service-Sizes 4 In. Through 144 In.
AWWA C209	(1990) Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines
AWWA C300	(1989) Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
AWWA C301	(1984; Errata) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids
AWWA C302	(1987; Erratum Jan 1988) Reinforced Concrete Pressure Pipe, Non-Cylinder Type, for Water and Other Liquids
AWWA C500	(1986) Gate Valves for Water and Sewerage Systems
AWWA C502	(1985; Errata-August 1985) Dry-Barrel Fire Hydrants
AWWA C509	(1987) Resiliant-Seated Gate Valves for Water and Sewerage Systems
AWWA C550	(1990) Protective Epoxy Interior Coatings for Valves and Hydrants
AWWA C651	(1986; c651a-90) Disinfecting Water Mains
AWWA C900	(1989) Poly (Vinyl Chloride) (PVC) Pressure Pipe, 4 In. Through 12 In. for Water Distribution
AWWA C901	(1988; Errata) Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. Through 3 In., for Water Service

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80 (1987) Bronze Gate, Globe, Angle and Check Valve

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01300, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Cast-Iron/Ductile-Iron Pipe
Pipe Connections
Rubber Gaskets
Reinforced Concrete Pipe
Copper Tubing
Plastic Pipe and Fittings
Steel Pipe
Gate Valves
Vacuum and Relief Valves
Tapped Tees
Corporation Stops
Goosenecks
Service Stops
Service Boxes
Valve Manholes
Fire Hydrants

SD-04 Drawings

Erection/Installation Drawings for the Complete Water System shall be submitted.

SD-04 Drawings

As-Built Drawings shall be submitted for the complete Water System and shall provide current factual information including deviations from, and amendments to drawings and change in the work, concealed and visible.

SD-06 Instructions

Manufacturer's Instructions including special provisions required to install equipment, components, and systems packages shall be submitted for the following. Special notices shall detail impedances, hazards and safety precautions.

Pipe Connections
Rubber Gaskets
Plastic Pipe and Fittings
Gate Valves

Vacuum and Relief Valves
Tapped Tees
Corporation Stops
Service Stops
Service Boxes
Valve Manholes
Fire Hydrants

SD-09 Reports

Test Reports for the following items shall be submitted in accordance with the paragraph entitled, "Testing," of this section.

Hydrostatic Test
Pressure Test
Leakage Test
Sterilizing

SD-13 Certificates

Certificates of Compliance for the following items shall be submitted in accordance with the applicable reference standards and description contained within this section:

Cast-Iron/Ductile-Iron Pipe
Pipe Connections
Rubber Gaskets
Reinforced Concrete Pipe
Copper Tubing
Plastic Pipe and Fittings
Steel Pipe
Gate Valves
Vacuum and Relief Valves
Tapped Tees
Corporation Stops
Goosenecks
Service Stops
Service Boxes
Valve Manholes
Fire Hydrants

PART 2 PRODUCTS

2.1 PIPING

2.1.1 Ductile-Iron Pipe

Ductile-iron pipe shall be as specified in AWWA C151, Pressure Class 350, with push-on joints or restrained/locked push-on joints in accordance with AWWA C111.

Locked joints shall be used within 1 meter of a cap, tee, bend, hydrant branch, or deflection of 22-1/2 degrees or more on 4-inch diameter or larger pipe. All fittings and valves shall have locked joints.

Ductile iron restrained locked joint fittings and the restraining/locking component shall be in accordance with AWWA C110 and/or AWWA C153.

Cement-mortar lining shall conform to AWWA C104.

Polyethylene encasement shall be as specified in AWWA C105.

Flanged and threaded ductile-iron pipe shall be as specified in AWWA C115, thickness Class 53 or above.

Ductile-iron pipe flanges and flanged fittings shall conform to ASME B16.1, and AWWA C110.

Coal-tar protective coating shall conform to AWWA C203.

Cement-mortar lining for pipe 4 inches and larger shall conform to AWWA C205.

Cold-applied tape coating of fittings shall be in accordance with AWWA C209.

2.1.2 Pipe Connections

Bolts, nuts, and washers shall conform to the recommendations of the pipe manufacturer.

2.1.3 Rubber Gaskets

Rubber-gasket and lubricants for ductile-iron pipe shall conform to the applicable requirements of AWWA C111. For asbestos-cement and steel pipe, the gaskets shall be in accordance with recommendations of the pipe manufacturer. For reinforced-concrete pipe, the joints shall be the rubber gasket type using either a bell-and-spigot joint design or a double spigot-and-sleeve joint design of concrete or steel. Joints shall be so designed that, when the pipe is laid and the joint completed, the gasket will be completely enclosed. Rubber gaskets shall be the sole element depended upon for watertightness. Gaskets shall be continuous rings of the necessary size and cross section to fill the recess provided and shall conform to the recommendations of the pipe manufacturer, as applicable. Connections between asbestos-cement pipe and cast-iron fittings or gate valves shall be made with jointing materials as specified for cast-iron pipe or with other approved materials recommended by the pipe manufacturer.

2.1.4 Reinforced-Concrete Pipe

Steel-cylinder reinforced-concrete pipe shall conform to AWWA C300, or AWWA C301, and shall be designed to withstand a minimum working pressure of 150 pounds per square inch (psi). Non-cylinder reinforced concrete pipe shall conform to AWWA C302, and shall withstand a minimum working pressure of 45 psi. Joint rings shall be protected by cement grouting.

Fittings and special sections required for closures, curves, bends, branches, and connections to valves, pipe, or structures shall conform to AWWA C300, AWWA C301, or AWWA C302, as applicable.

2.1.5 Copper Tubing

Copper tubing shall conform to ASTM B 88, Type K, annealed. Joints for underground work shall be compression pattern, flared, for soft copper water tubing, and shall be made with fittings meeting approved standards. Tubing shall be cut off square and expanded with a proper flaring tool.

2.1.6 Plastic Pipe and Fittings

Solvent weld pipe shall be extruded of an improved polyvinylchloride (PVC) virgin pipe compound. Compound shall conform to ASTM D 1784, Cell Classification 12454-B, and have a 2,000 psi hydrostatic design stress rating. Pipe and fittings shall conform to AWWA C900 or AWWA C901, Schedule 80.

Pipe shall bear the following markings: manufacturer's name, nominal pipe size, schedule or class, pressure rating in psi, and NSF (National Sanitation Foundation). The manufacturer shall also mark the date of extrusion on the pipe.

Solvent cement or rubber-gasket joints for pipe and fittings shall be made as prescribed by the manufacturer.

Fittings shall be PVC Schedule 80.

Fittings shall be injection-molded of an improved PVC compound. Fittings shall conform to ASTM D 1784, Cell Classification 12454-B.

Tees and ells shall be side gated.

Fittings shall bear the company's name and trademark, material designation, size, applicable iron pipe size (ips) schedule, and NSF seal of approval.

Threaded nipples shall be standard weight Schedule 80 with molded threads.

2.1.7 Steel Pipe

Steel pipe (6 inches and larger) shall be in accordance with AWWA C200, Schedule 40.

Steel flanges shall conform to AWWA C207.

Field welding of steel pipe shall be as specified in AWWA C206.

2.2 VALVES

2.2.1 Gate Valves

Valves shall be designed for a minimum of 150 psi. Valves shall have restrained push-on joint "or screw" ends. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. The operating nut or wheel shall have an arrow cast in the metal indicating the direction of opening.

Valves smaller than 3 inches shall be all bronze and shall conform to MSS SP-80, Type I.

Valves 4 to 16 inches shall be ductile-iron resilient seat in accordance with AWWA C509 and AWWA C500 and be epoxy coated inside and outside in accordance with AWWA C550.

2.2.2 Vacuum and Relief Valves

Vacuum and relief valves shall be size and type to relieve pressure and prevent the formation of a vacuum. Valves shall automatically remove air from the lines when the lines are being filled and admit air into the lines when water is being withdrawn in excess of the inflow.

2.3 MISCELLANEOUS ITEMS

2.3.1 Tapped Tees

Tees shall be installed where indicated or directed.

2.3.2 Corporation Stops

Corporation stops shall have waterworks standard thread on the inlet end, with flanged-joint couplings or wiped joints for connections to goosenecks.

2.3.3 Goosenecks

Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B 88, Type K, annealed.

2.3.4 Service Stops

Service stops shall be waterworks ground-key type, oval flowway, tee handle, without drain. Pipe connections shall be suitable for the type of service pipe used. Parts shall be cast red brass having a nominal composition of 85-percent copper, 5-percent tin, 5-percent lead, and 5-percent zinc, with female (ips) connections designed for a minimum pressure of 200 psi.

2.3.5 Valve Boxes

Valve boxes shall be cast iron, complete with lock-type covers requiring a special wrench for removal. Cast-iron boxes shall be the extension type with screw or slide adjustments and with flared bases. The word WATER shall be cast in the cover. Boxes shall be installed over each gate valve. Boxes shall be of such a length as can be adapted, without full extension, to the depth of cover required over the pipe at the valve location.

2.3.6 Valve Manholes

Valve manholes shall be constructed in accordance with the details indicated.

2.3.7 Fire Hydrants

Fire hydrants shall conform to AWWA C502, dry barrel fire hydrant. Hydrants shall have a 6-inch bell connection, two 2-1/2-inch hose connections, and one 4-1/2-inch pumper connection. Outlets shall have "Cleveland Standard Thread" fire hose coupling threads. Working parts shall be bronze. Hydrants shall be connected to the mains with 6-inch diameter restrained/locked push-on joint pipe. Design, material, and workmanship shall be similar and equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with one coat of zinc-chromate alkyd paint primer and two finish coats of approved paint of the color directed.

PART 3 EXECUTION

3.1 THE FOLLOWING IS THE EXECUTION OF THE PLACING NEW PIPE

3.1.1 Pipe Handling

Pipe and accessories shall be handled in a manner to ensure delivery to the trench in an undamaged condition. Particular care shall be taken not to injure the pipe coating. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in an approved manner. No other pipe or material shall be placed inside of a pipe or fitting after the coating has been applied. Pipe shall be carried, not dragged, into position. Use of pinch bars and tongs for aligning or turning the pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be cleaned before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects and shall be tapped with a light hammer to detect cracks. Material found to be defective before or after laying shall be replaced with sound material without additional cost to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool dark place out of the direct rays of the sun.

3.1.2 Cutting of Pipe

Cutting of pipe shall be done without damage to the pipe. Unless otherwise authorized or recommended by the manufacturer, cutting shall be done with an approved mechanical cutter. Wheel cutters shall be used when practical.

3.1.3 Location

Where the location of the water pipe is not clearly defined by dimensions, the water pipe shall be laid not closer than 10 feet from a sewer horizontally, except where the bottom of the water pipe will be at least 12-inches above the top of the sewer pipe, in which case the water pipe shall be laid not closer than 6 feet from the sewer horizontally. Where waterlines cross under gravity flow sewer lines, the sewer pipe for a distance of at least 10-feet each side of the crossing shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 3 feet, horizontally, of the crossing. Waterlines shall, in all cases, cross above sewage force mains or inverted siphons and shall be not less than 2-feet above the sewer main. Joints in the sewer main closer

horizontally than 3 feet to the crossing shall be encased in concrete. Waterlines shall not be laid in the same trench with gas lines, fuel lines, or electrical wiring.

3.1.4 Deflection

Maximum allowable deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets, shall be 5 degrees for asbestos-cement or reinforced-concrete pipe, unless otherwise recommended by the manufacturer. For ductile-iron bell-and-spigot pipe and mechanical-joint pipe, the maximum allowable deflection shall be as recommended by the manufacturer.

If the alignment requires deflections in excess of the manufacturer's recommendations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth, as approved. Long-radius curves in reinforced-concrete pipe shall be formed by straight pipe in which spigot rings are placed on a bevel. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflections does not exceed the maximum recommended by the pipe manufacturer. Short-radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated special sections as specified.

Where PVC pipe is used, a single conductor No. 14 AWG wire with Type TW insulation shall be installed above the pipe to facilitate pipe location.

3.1.5 Placing and Laying

Pipe and accessories shall be carefully lowered into the trench by means of derricks, ropes, belt slings, or other suitable equipment. Under no circumstances shall materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Poles used as levers for removing skids across trenches shall be of wood and have broad flat faces to prevent damage to the pipe or coating. Except where necessary in making connections with other lines or as authorized, pipe shall be laid with the bells facing upstream. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that vermin, water, earth, or other substance will not enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense and in an approved manner.

Pipe ends left for future connections shall be valved, plugged, or capped and anchored as indicated. Where connections are made between new work and existing mains, the connections shall be made by using special sections and fittings to suit the actual conditions. Standard methods are readily available for making connections to various types of pipe, either under pressure or in the dewatered condition. Where made under pressure, these connections shall be installed in accordance with the recommendations of

the manufacturer of the pipe being tapped.

Before laying reinforced-concrete pipe, the outside surface of the spigot and the inside surface of the bell shall be cleaned, and an acceptable vegetable-compound lubricant shall be applied to the inside surface of the bell and to the rubber gasket. Where prescribed by the manufacturer of the pipe, the gasket shall be placed in the groove on the end of the pipe before the pipe is placed in the trench. After the pipe has been forced together, the position of the rubber gasket shall be checked with a feeler gage in accordance with the pipe manufacturer's recommendations. Tapping into reinforced-concrete cylinder pipe shall be done in accordance with the manufacturer's recommendations. Where the manufacturer recommends that the taps be made by attaching the rubber-gasketed saddle to the outside of the pipe using U-bolts, the saddle shall be grouted in if necessary, the mortar coating chipped away until even with the hole in the saddle plate, the exposed circumferential wires removed, the cylinder and concrete core drilled out, and the steel saddle and U-bolts protected by concrete encasement.

3.1.6 Rubber Gaskets

Rubber gaskets shall be handled, lubricated, and installed in accordance with the recommendations of the pipe manufacturer. Outside annular space between abutting sections of concrete pipe shall be filled with rich cement mortar. When recommended by the manufacturer, the inside annular joint space shall be filled with rich cement mortar after backfilling has been at least partially accomplished.

3.1.7 Couplings and Joints

Joints for copper tubing shall be compression pattern, flared, for soft copper water tubing and shall be made of fittings meeting approved standards. Tubing shall be cut off square and expanded with an acceptable flaring tool. Installation of asbestos-cement couplings and mechanical joints shall be in accordance with the recommendations of the manufacturer. Connections between different types of pipe and accessories shall be made with transition fittings as recommended by the manufacturer.

3.1.8 Protective Coating

Exposed portions of steel joint rings of reinforced-concrete pipe shall be protected from corrosion by a metallic coating, or by a nonmetallic coating if approved.

3.1.9 Service Lines

Service lines shall include the lines to and connections with, the building service at a point approximately 5-feet outside the building. Where building services are not installed, the Contractor shall terminate the service lines approximately 5 feet from the site of the proposed building at a point designated. Such service lines shall be closed with plugs or caps. Service stops and gate valves shall be provided with extension boxes of the lengths required by the depths of service line stops or valves. Service lines shall be constructed in accordance with the following

requirements: service lines 1-1/2 inches and smaller shall be connected to the main by a corporation-type stop and a copper gooseneck, with a service stop below the frostline. Two-inch service lines shall be connected to the main with a rigid connection or a corporation-type stop and copper gooseneck and a gate valve located below the frostline. Where two or more gooseneck connections to the main are required for an individual service, such connections shall be made with standard quality branch connections in conformance with recognized standard practice. The total clear area of the branches shall be at least equal to the clear area of the service which they are to supply. Service lines larger than 2 inches shall be connected to the main by a rigid connection and shall have a gate valve located below the frostline.

3.1.10 Fire Hydrants, Valves, and Valve Boxes

Fire hydrants shall be located and installed as indicated. Hydrants and valves shall have the interiors cleaned of all foreign matter before installation. Each hydrant shall be connected to the main with a 6-inch branch line having at least as much cover as the distribution main (3-feet minimum). Hydrants shall be set plumb with the pumper nozzle facing the roadway, the center of the lowest outlet not less than 18-inches (.46 meters) above the finished surrounding grade, and the operating nut not more than 4-feet (1.2 meters) above the finished grade. Except where approved otherwise, not less than 14 cubic feet (.4 cubic meters) of broken stone shall be placed around the base of the hydrant to ensure drainage. Backfill around the hydrant shall be compacted to the finished gradeline immediately after installation to obtain beneficial use of the hydrant as soon as practical. Hydrant shall be set upon a slab of concrete not less than 16 inches thick and 3 feet square. Valves and valve boxes shall be installed where indicated or directed and shall be set plumb. Valve boxes shall be centered on the valves. Valves shall be located outside the area of sidewalks, roads, streets, and parking areas. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box or to the undisturbed trench face if less than 4 feet. Stuffing boxes shall be tightened, and the hydrants and valves shall be inspected in open and closed positions to ensure that all parts are in working condition.

3.1.11 Thrust Blocks

Thrust blocks shall be provided where indicated and on all plugs, caps, tees, hydrant branches, bends deflecting 22-1/2 degrees or more on mains 8-inches or larger where joint restraints CAN NOT BE UTILIZED. Blocks shall be concrete of a mix not leaner than 1 part cement to 2-1/2-parts sand to 5-parts gravel. Blocks shall be placed between solid ground and the hydrant or fitting to be anchored. The area of bearing shall be as indicated or as directed. Unless otherwise indicated or directed, blocks shall be so placed that fitting joints will be accessible for repair.

3.1.12 Testing

3.1.12.1 Hydrostatic Tests

Hydrostatic-pressure test shall be made no sooner than 72 hours after installation of thrust blocks, unless otherwise approved.

3.1.12.2 Pressure Tests

After the pipe is laid, the joints completed, the fire hydrants permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 2 hours to a hydrostatic-pressure test of 200 psi. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, valves, and hydrants shall be carefully examined during the open-trench test. Joints showing visible leakage shall be replaced or remade as necessary. Leaking rubber gasketed joints shall be remade using new gaskets if necessary. Pipe, mechanical joints, fittings, valves, or hydrants discovered to be cracked or defective as a consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are approved.

3.1.12.3 Leakage Tests

Leakage tests shall be conducted after the pressure test has been approved. The duration of each leakage test shall be at least 2 hours. During the test, the main shall be subjected to a pressure of 200 psi.Leakage is defined as the additional quantity of water supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula L = 0.00054ND square root of P in which L equals the allowable leakage in gallons per hour, N is the number of joints in the length of pipeline tested, D is the nominal diameter of the pipe in inches, and P is the average test pressure in psi during the leakage test. Allowable leakage in gallons per hour per joint at 200 psi average test pressure shall be as follows:

PIPE DIAMETER (INCHES	ALLOWABLE LEAKAGE (GALLONS PER HOUR)
2	0.0153
3	0.0230
4	0.0306
6	0.0458
8	0.0610
10	0.0765
12	0.0915
14	0.1070

PIPE DIAMETER (INCHES	ALLOWABLE LEAKAGE (GALLONS PER HOUR)
16	0.1225
18	0.1375
20	0.1530
24	0.1830

Should any test of laid pipe disclose a leakage greater than that specified herein, the defective joints shall be located and repaired until the leakage is within the specified allowance, at no additional cost to the Government.

3.1.12.4 Test Timing

Except where concrete-reaction backing necessitates a 72-hour delay, pipelines jointed with rubber gaskets, mechanical, or bolted joints may be subjected to hydrostatic pressure, inspected, and tested for leakage after partial completion of backfill. Concrete pipe shall be filled with water for at least 24 hours before being subjected to the pressure test and subsequent leakage test.

3.1.12.5 Retesting

Before permanent paving is placed over the pipeline, a measured leakage test of the entire pipeline may be required at the option of the Contracting Officer. Leakage loss shall be within the allowances specified.

3.1.12.6 Sterilizing

Water piping, including valves, fittings, and other devices, shall be sterilized with a solution of chlorine and water, and tested according to AWWA C651. After successful sterilization, the piping shall be flushed before placing into service. Water for sterilization will be furnished by the Government, but disposal shall be the responsibility of the Contractor.

-- End of Section --

SECTION 02718

UNDERGROUND WATER SUPPLY SYSTEMS

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 43	(1988) Seamless Red Brass Pipe, Standard Sizes
ASTM B 88	(1989) Seamless Copper Water Tube

AMERICAN WATERWORKS ASSOCIATION, INC. (AWWA)

AWWA C105	(1988) Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids
AWWA C110	(1987) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111	(1990) Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C151	(1986) Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand- Lined Molds, for Water or Other Liquids
AWWA C203	(1986) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C205	(1989) Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. and Larger - Shop Applied
AWWA C500	(1986) Gate Valves for Water and Sewerage Systems
AWWA C502	(1985; Errata-August 1985) Dry-Barrel Fire Hydrants
AWWA C503	(1988) Wet-Barrel Fire Hydrants

FEDERAL SPECIFICATIONS (FS)

FS O-C-114	(Rev B; Am 2) Calcium Hypochlorite, Technical
FS O-S-602	(Rev. E) Sodium Hypochlorite Solution

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-80	(1987) Bronze Gate, Globe, Angle and Check Valves

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01300, "Submittals":

SD-01, Data

Manufacturer's Catalog Data

SD-04, Drawings

As-Built Drawings

PART 2 PRODUCTS

2.1 PIPING

2.1.1 Cast-Iron/Ductile-Iron Pipe

Ductile-iron pipe shall be as specified in AWWA C151, Class 52, with push-on or mechanical joints and cement-mortar lining conforming to AWWA C104 or AWWA C205. Thrust blocks shall be installed except when mechanical joints have retaining glands.

Polyethylene encasement shall be as specified in AWWA C105 and be installed over all underground pipe and fittings.

Cast-iron fittings shall be in accordance with AWWA C110.

Cast-iron pipe flanges and flanged fittings shall conform to ASME B16.1.

Coal-tar protective coating shall conform to AWWA C203 and furnished on exterior of all pipe and fittings.

Cold-applied tape coating of fittings shall be in accordance with AWWA C209.

2.1.2 Pipe Connections

Bolts, nuts, and washers shall conform to the recommendations of the pipe manufacturer.

2.1.3 Rubber Gaskets

Rubber-gasket joints for cast-iron pipe, gaskets, and lubricant shall conform to the applicable requirements of AWWA C111. For asbestos-cement and steel pipe, the gaskets shall be in accordance with recommendations of the pipe manufacturer. Joints shall be so designed that, when the pipe is laid and the joint completed, the gasket will be completely enclosed. Rubber gaskets shall be the sole element depended upon for watertightness. Gaskets shall be continuous rings of the necessary size and cross section to fill the recess provided and shall conform to the recommendations of the pipe manufacturer, as applicable.

2.1.4 Copper Pipe

Type K soft drawn copper pipe shall be used for 2-inch and smaller water lines. Pipe shall conform to ASTM B 88 with solder joint fittings. Solder shall be 95-percent tin and 5-percent antimony or other NO LEA solder as approved by the C.O.R.. Fittings shall be of cast brass conforming to ASTM B 43.

2.2 VALVES

2.2.1 Gate Valves

Valves shall be designed for a minimum of 150 psi. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. Valves smaller than 3 inches shall be all brass and shall conform to MSS SP-80, Type I. Valves 3 inches and larger shall be iron-body, brass-mounted, conforming to AWWA C500and flanged construction for 12 inches and larger.

2.3 MISCELLANEOUS ITEMS

2.3.1 Tapped Tees

Tees shall be installed where indicated or directed.

2.3.2 Corporation Stops

Corporation stops shall have waterworks standard thread on the inlet end, with flanged-joint couplings or wiped joints for connections to goosenecks.

2.3.3 Goosenecks

Copper tubing for gooseneck connections shall conform to the applicable requirements of ASTM B 88, Type K, annealed.

2.3.4 Service Stops

Service stops shall be waterworks ground-key type, oval flowway, tee handle, without drain. Pipe connections shall be suitable for the type of service pipe used. Parts shall be cast red brass having a nominal composition of 85 percent copper, 5 percent tin, 5 percent lead, and 5 percent zinc, with female iron-pipe-size connections designed for a minimum

pressure of 200 psi.

2.3.5 Valve Boxes

Valve boxes shall be cast iron or concrete, complete with lock-type covers requiring a special wrench for removal. Cast-iron boxes shall be the extension type with screw or slide adjustments and with flared bases. Concrete boxes shall be constructed in accordance with details indicated. The letter "W" shall be cast in the cover. Boxes shall be installed over each gate valve. Boxes shall be of such a length as can be adapted, without full extension, to the depth of cover required over the pipe at the valve location. Concrete boxes may be installed only in locations not subjected to vehicular traffic. Valve wrenches shall be furnished for each valve.

2.3.6 Fire Hydrants

Fire hydrants shall conform to AWWA C502, dry barrel fire hydrant, or AWWA C503, wet barrel fire hydrant, as specified. Hydrants shall have a 6-inch bell connection, two 2-1/2-inch hose connections, and one 4-1/2-inch pumper connection. Outlets shall have American National fire-hose coupling threads. The 4-1/2-inch connection shall be furnished with an adapter to convert the outlet to a 4-inch outlet with Cleveland Fire Department threads (4.875-inch by 6-inch outside diameter, male, 6-sharp "V" type threads per inch). Working parts shall be bronze. Hydrants shall be connected to the mains with 6-inch diameter pipes. Design, material, and workmanship shall be similar and equal to the latest stock pattern ordinarily produced by the manufacturer. Hydrants shall be painted with one coat of zinc-chromate alkyd paint primer and two finish coats of approved paint with green top and nozzle cap. (See engineering standard F-5-2 at the end of this section.)

PART 3 EXECUTION

3.1 PIPE HANDLING

Pipe and accessories shall be handled in a manner to ensure delivery to the trench in an undamaged condition. Particular care shall be taken not to injure the pipe coating. If the coating or lining of any pipe or fitting is damaged, the repair shall be made by the Contractor at his expense in an approved manner. No other pipe or material shall be placed inside of a pipe or fitting after the coating has been applied. Pipe shall be carried, not dragged, into position. Use of pinch bars and tongs for aligning or turning the pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be cleaned before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects and shall be tapped with a light hammer to detect cracks. Material found to be defective before or after laying shall be replaced with sound material without additional cost to the Government. Rubber gaskets that are not to be installed immediately shall be stored in a cool dark place out of the direct rays of the sun.

3.2 CUTTING OF PIPE

Cutting of pipe shall be done without damage to the pipe. Unless otherwise authorized or recommended by the manufacturer, cutting shall be done with an approved mechanical cutter. Wheel cutters shall be used when practical.

3.3 LOCATION

Where the location of the water pipe is not clearly defined by dimensions, the water pipe shall be laid not closer than 10 feet from a sewer horizontally, except where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, in which case the water pipe shall be laid not closer than 6 feet from the sewer horizontally. Where waterlines cross under gravity flow sewer lines, the sewer pipe for a distance of at least 10 feet each side of the crossing shall be fully encased in concrete or shall be made of pressure pipe with no joint located within 3 feet, horizontally, of the crossing. Waterlines shall, in all cases, cross above sewage force mains or inverted siphons and shall be not less than 2 feet above the sewer main. Joints in the sewer main closer horizontally than 3 feet to the crossing shall be encased in concrete. Waterlines shall not be laid in the same trench with gas lines, fuel lines, or electrical wiring.

3.4 DEFLECTION

Maximum allowable deflections for cast-iron bell and spigot pipe from a straight line or grade, as required by vertical curves, horizontal curves, or offsets, shall be as recommended by the manufacturer.

If the alignment requires deflections in excess of the manufacturer's recommendations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth, as approved. Long-radius curves in reinforced-concrete pipe shall be formed by straight pipe in which spigot rings are placed on a bevel. Slight deflections may be made by straight pipe, provided that the maximum joint opening caused by such deflections does not exceed the maximum recommended by the pipe manufacturer. Short-radius curves and closures shall be formed by shorter lengths of pipe, bevels, or fabricated special sections as specified.

3.5 PLACING AND LAYING

Pipe and accessories shall be carefully lowered into the trench by means of derricks, ropes, belt slings, or other suitable equipment. Under no circumstances shall materials be dropped or dumped into the trench. Care shall be taken to avoid abrasion of the pipe coating. Poles used as levers for removing skids across trenches shall be of wood and have broad flat faces to prevent damage to the pipe or coating. Except where necessary in making connections with other lines or as authorized, pipe shall be laid with the bells facing upstream. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells, couplings, and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water or when trench conditions are unsuitable for the work. When work is not in progress, open ends of pipe, fittings, and valves shall be

securely closed so that vermin, water, earth, or other substance will not enter the pipes or fittings. Where any part of the coating or lining is damaged, the repair shall be made by the Contractor at his expense and in an approved manner.

3.6 RUBBER GASKETS

Rubber gaskets shall be handled, lubricated, and installed in accordance with the recommendations of the pipe manufacturer. Outside annular space between abutting sections of concrete pipe shall be filled with rich cement mortar. When recommended by the manufacturer, the inside annular joint space shall be filled with rich cement mortar after backfilling has been at least partially accomplished.

3.7 COUPLINGS AND JOINTS

Joints for copper tubing shall be compression pattern, flared, for soft copper water tubing and shall be made of fittings meeting approved standards. Tubing shall be cut off square and expanded with an acceptable flaring tool. Installation of mechanical joints shall be in accordance with the recommendations of the manufacturer. Connections between different types of pipe and accessories shall be made with transition fittings as recommended by the manufacturer.

3.8 SERVICE LINES

Service lines shall include the lines to and connections with, the building service at a point approximately 5 feet outside the building. Where building services are not installed, the Contractor shall terminate the service lines approximately 5 feet from the site of the proposed building at a point designated. Such service lines shall be closed with plugs or caps. Service stops and gate valves shall be provided with extension boxes of the lengths required by the depths of service line stops or valves. Service lines shall be constructed in accordance with the following requirements: service lines 1-1/2 inches and smaller shall be connected to the main by a corporation-type stop and a copper gooseneck, with a service stop below the frostline. Two-inch service lines shall be connected to the main with a rigid connection or a corporation-type stop and copper gooseneck and a gate valve located below the frostline. Where two or more gooseneck connections to the main are required for an individual service, such connections shall be made with standard quality branch connections in conformance with recognized standard practice. The total clear area of the branches shall be at least equal to the clear area of the service which they are to supply. Service lines 3-inches and larger shall be connected to the main by a rigid connection and shall have a gate valve located below the frostline.

3.9 FIRE HYDRANTS, VALVES, AND VALVE BOXES

Fire hydrants shall be located and installed as indicated. Hydrants and valves shall have the interiors cleaned of all foreign matter before installation. Each hydrant shall be connected to the main with a 6-inch branch line having at least as much cover as the distribution main. Hydrants shall be set plumb with the pumper nozzle facing the roadway, the

center of the lowest outlet not less than 18 inches above the finished surrounding grade, and the operating nut not more than 4 feet above the finished grade. Except where approved otherwise, not less than 7 cubic feet of broken stone shall be placed around the base of the hydrant to ensure drainage. Backfill around the hydrant shall be compacted to the finished gradeline immediately after installation to obtain beneficial use of the hydrant as soon as practical. Hydrant shall be set upon a slab of concrete not less than 4 inches thick and 15 inches square Valves and valve boxes shall be installed where indicated or directed and shall be set plumb. Valve boxes shall be centered on the valves. Valves shall be located outside the area of sidewalks, roads, streets, and parking areas. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box or to the undisturbed trench face if less than 4 feet. Stuffing boxes shall be tightened, and the hydrants and valves shall be inspected in open and closed positions to ensure that all parts are in working condition. (See engineering standard F-5-2 at end of this section.)

3.10 THRUST BLOCKS

Plugs, caps, tees, bends deflecting 22-1/2 degrees or more on mains 8 inches in diameter or larger, and fire hydrants shall be provided with concrete thrust blocks. Blocks shall be concrete of a mix not leaner than 1 part cement to 2-1/2 parts sand to 5 parts gravel. Blocks shall be placed between solid ground and the hydrant or fitting to be anchored. The area of bearing shall be as indicated or as directed. Unless otherwise indicated or directed, blocks shall be so placed that fitting joints will be accessible for repair.

3.11 TESTING

3.11.1 Hydrostatic Tests

Hydrostatic-pressure test shall be made no sooner than 72 hours after installation of thrust blocks, unless otherwise approved.

3.11.2 Pressure Tests

After the pipe is laid, the joints completed, the fire hydrants permanently installed, and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic-pressure test of 200 psi. Mains supplying water to individual buildings for fire protection shall be subjected for 2 hours to a hydrostatic-pressure test of 200 psi. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, valves, and hydrants shall be carefully examined during the open-trench test. Joints showing visible leakage shall be replaced or remade as necessary. Leaking rubber gasketed joints shall be remade using new gaskets if necessary. Pipe, mechanical joints, fittings, valves, or hydrants discovered to be cracked or defective as a consequence of this pressure test shall be removed and replaced with sound material, and the test shall be repeated until the test results are approved.

3.11.3 Leakage Tests

Leakage tests shall be conducted after the pressure test has been approved. The duration of each leakage test shall be at least 2 hours. During the test, the main shall be subjected to a pressure of 200 psi. Leakage is defined as the additional quantity of water supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled. No piping installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula L = 0.00054ND square root of P in which L equals the allowable leakage in gallons per hour, N is the number of joints in the length of pipeline tested, D is the nominal diameter of the pipe in inches, and P is the average test pressure in psi during the leakage test. Allowable leakage in gallons per hour per joint at 200 psi average test pressure shall be as follows:

PIPE DIAMETER (INCHES	ALLOWABLE LEAKAGE (GALLONS PER HOUR)
2 (and smaller)	0.0153
3	0.0230
4	0.0306
6	0.0458
8	0.0610
10	0.0765
12	0.0915
14	0.1070
16	0.1225
18	0.1375
20	0.1530
24	0.1830

Should any test of laid pipe disclose a leakage greater than that specified herein, the defective joints shall be located and repaired until the leakage is within the specified allowance, at no additional cost to the Government.

3.11.4 Test Timing

Except where concrete-reaction backing necessitates a 72-hour delay, pipelines jointed with rubber gaskets, mechanical, or bolted joints may be

subjected to hydrostatic pressure, inspected, and tested for leakage after partial completion of backfill. Asbestos-cement pipe and concrete pipe shall be filled with water for at least 24 hours before being subjected to the pressure test and subsequent leakage test.

3.11.5 Retesting

Before permanent paving is placed over the pipeline, a measured leakage test of the entire pipeline may be required at the option of the Contracting Officer. Leakage loss shall be within the allowances specified.

3.12 STERILIZATION

After pressure tests have been completed and before introducing the sterilizing solution, piping to be sterilized shall be flushed with water, for a period of time as designated by the COTR, to remove any entrained dirt.

All potable water piping, including valves, fittings, and other devices, shall be sterilized with a solution of chlorine and water. The chlorinating material shall be liquid chlorine conforming to FS BB-C-120, calcium hypochorite conforming to FS O-C-114, Table I, or sodium hypochorite conforming to FS O-S-602, Grade A or B. The chlorinating material shall provide a dosage of not less than 50 parts per million (ppm) introduced into the piping in a manner approved by the COTR. Treated water shall be retained in the piping for a period of not less than 8 hours to destroy all non-spore-forming bacteria. After the specified minimum time, the solution shall contain not less than 10 ppm of available chlorine or piping shall be resterilized. If the solution contains more than 10 ppm of chlorine, samples of water shall be taken for a bacteria count. The samples of water shall be sent to an independent testing lab for the count in accordance with EPA 40CFR, Chapter 1, Section 141.14. "Maximum microbiological contaminant level" and the results submitted to the COTR for approval. System shall be resterilized until the count is approved. Water for sterilization will be furnished by the Government, but disposal of contaminated water shall be the responsibility of the Contractor.

Upon completion and approval of sterilization and before placing the system into service, the piping shall be flushed with water for a minimum of 2 hours or unit the residual chlorine is reduced to less than 1.0 ppm.

-- End of Section --

SECTION 02720

STORM SEWERAGE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 288	(1992) Standard Specification for Geotextiles Used for Substrate Drainage Purposes
AASHTO M 306	(1990) Standard Specification for Drainage Structure Castings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48M	(1994; Rev A) Standard Specification for Gray Iron Castings (Metric)
ASTM A 74	(1994) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A 849	(1995) Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM C 139	(1995; Rev A) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 270	(1995; Rev A) Standard Specification for Mortar for Unit Masonry
ASTM C 387	(1995) Standard Specification for Packaged, Dry Combined Materials for Mortar and Concrete
ASTM C 478M	(1995) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 564	(1995) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

ASTM D 2321	(1989) Standard Practice for Sewers and Other Gravity-Flow Applications
ASTM D 3034	(1994) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1992) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F 1417	(1992) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air
ASTM F 477	(1995) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 794	(1991) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

AMERICAN WATERWORKS ASSOCIATION (AWWA)

AWWA C111	(1990) Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C210	(1992) Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 604	(1997) Manholes, Catch Basins, Inlets, Inspection Wells, Junction Chambers or Monuments
ODOT 706.13	(197) Precast Reinforceed Concrete Manhole Riser Sections, Catch Basin and Inlet Tops, and Temporary Barrier
ODOT 711.13	(1997) Ductile Iron Castings

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Mix Designs for Concrete shall be submitted.

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following:

Pipe
Gaskets
Compression Joints
Manhole Frames/Covers
Grating and Frames
Precast Concrete Manholes
Precast Concrete Base Slabs

1.3 BEDDING AND BACKFILL

Bedding and backfill shall conform to Section 02225, "Excavation, Backfilling, and Compacting for Utilities."

PART 2 PRODUCTS

2.1 BONDING AND SEALING MATERIALS

2.1.1 Bituminous Coating and Sealing

Coating shall be in accordance with ASTM A 849.

Coating shall be in accordance with ASTM A 849, when using materials previously coal-tar coated and for each uncoated ferrous piece used underground.

Cold mastic sealer shall be in accordance with ASTM A 849 trowel consistency.

2.1.2 Epoxy Bonding

Epoxy adhesive shall be in accordance with AWWA C210.

2.2 FILTER MATERIAL

2.2.1 Filter Fabric

Fabric shall be in accordance with AASHTO M 288, and be water pervious, made of polyester materials.

2.2.2 Filter Aggregate

Aggregate shall be clean No. 8 free from organic materials, clay, or other deleterious materials.

2.3 MANHOLE AND CATCH-BASIN MATERIALS

Water, for use with concrete block and brick, shall be clean and potable.

2.3.1 Concrete Block and Mortar

Concrete block shall be in accordance with ASTM C 139.

Concrete mortar shall be in accordance with ASTM C 387, Type MASTM C 270, Type S.

2.4 CONDUIT PIPING, JOINTS, AND FITTINGS

2.4.1 Cast-Iron Soil Pipe (CISP) and Fittings

Pipe and fittings shall be in accordance with ASTM A 74, service weight, with bell and spigot ends.

2.4.2 Cast-Iron Soil Pipe Joints

Joints shall be in accordance with AWWA C111 push-on type.

Gaskets shall be in accordance with ASTM C 564, neoprene type.

2.4.3 Plastic Piping

2.4.3.1 Type PSM Poly(Vinyl Chloride) (PVC) Pipe

Pipe shall be in accordance with ASTM D 3034, SDR 35, up to DN375 diameter.

Pipe ends made for joints shall be elastomeric gasket type.

PSM PVC Pipe, 450 to 1200 millimeter diameter shall be in accordance with ASTM F 794.

2.4.3.2 PVC Pipe Joints

Joints shall be in accordance with ASTM D 3212, push-on type.

Gaskets shall be in accordance with ASTM F 477.

2.5 FRAMES, COVERS, AND GRATINGS

Manhole, catch-basin, and sump frames, covers, and gratings shall be of heavy design in accordance with AASHTO M 306.

Cast-iron materials shall be provided. Cast iron shall conform to ASTM A 48M, Class 30B, minimum.

2.5.1 Manhole Frames, Covers, and Gratings

Frame and cover shall be heavy design (215 kilogams min. total weight) when the manhole is placed within the limits of the pavement or shoulder, otherwise the light design (125 kilogrms min. total weight) may be used. Bearing areas shall be finished smooth and fitted so as to provide a firm and even seat for all portions of the cover in the frame. Each cover shall seat in its frame without rocking and shall be marked as a matched frame

and cover before delivery to the project. The following legend shall be cast in every cover: "STORM". The base of the frame shall be set in a full bed of Portland cement mortar, and so adjusted to conform to the finished pavement or shoulder elevation and slope. Castings meeting ODOT 604 requirements and designed essentially the same and equally as strong as those shown here on shall be provided anad conform to ODOT 711.13.

2.6 PRECAST CONCRETE MANHOLES

Concrete manholes, risers, base sections, and tops shall be pre-cast and conform to ODOT 706.13.

2.7 MANHOLE AND CATCH-BASIN ACCESS LADDER

Access shall be in accordance with ASTM C 478M, using ladders for manholes or catch basins at least 1200 millimeter deep.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL

Excavation, backfill, and removal of unsatisfactory materials shall be in accordance with Section 02225, "Excavation, Backfilling, and Compacting for Utilities."

3.2 GRADING

Grading shall be performed in accordance with Section 02200, "Earthwork."

3.3 PIPE INSTALLATION

3.3.1 Pipe Installation

Excavations shall be trimmed to required elevations. Objects which impair backfilling or compaction shall be removed. Over excavation shall be corrected with fill material of fine aggregate.

Pipe and fitting shall be inspected for defects before installing. Defective materials shall be removed from site.

Pipe interior shall be cleaned before installation. Pipe ends shall be sealed when work is not in progress.

Pipe shall be laid to line and grade, with bell end upstream.

Maximum variation from true slope shall not exceed 3.2 millimeter in 3048 millimeter.

Maximum deviation from design elevation shall not exceed 12.2 millimeter at any point in the system.

Maximum deviation from true line shall not exceed 6.1 millimeter for pipe DN375 in diameter and smaller, 12.2 millimeter for pipe larger than DN375 in diameter.

Corrections shall be made at a rate not to exceed 30.5 millimeter for one length of conduit.

3.3.2 Cast-Iron Pipe Installation

Install cast iron pipe and fittings in accordance with manufacturer's instructions. Mechanical joints shall be assembled in accordance with AWWA C111, Appendix A.

3.3.3 PVC Plastic Pipe Installation

PVC pipe and fittings shall be installed in accordance with manufacturer's instructions and in accordance with ASTM D 2321.

3.4 PIPE BEDDING

3.4.1 Bedding

Minimum compacted bedding under installed pipe shall be one-fourth of the pipe diameter in thickness, and in no case less than 100 millimeter or more than 300 millimeter.

Bedding shall be placed in layers not exceeding 150 millimeter in depth and compact. Additional layers shall be added until a minimum elevation of 300 millimeter above the pipe is achieved.

3.4.2 Trench Pipe Cradle

Trench pipe cradle shall be constructed monolithically of 21 Megapascal, air entrained concrete.

3.4.3 Concrete Encasement

Pipe shall be encased in 21 Megapascal air-entrained concrete to a level of not less than 150 millimeter above the top of pipe.

3.4.4 Compaction

Puddling or jetting shall not be permitted when compacting bedding materials.

3.5 JACKING PIPE

Jacking pipe shall not be used.

3.6 UNDERGROUND STRUCTURES

3.6.1 Structures

13 millimeter thick ASTM C 387, Type M mortar shall be applied to both interior and exterior surfaces.

Top of manhole and catch basin covers shall be set flush with finished

pavement surfaces. Elsewhere, tops shall be set 75 millimeter above finished surface.

Attach steps into manhole walls with epoxy compound.

Preformed bituminous expansion-joint material shall be provided 19 millimeter thickness around drainage structures in pavements.

Joints for concrete risers and tops shall be made with flexible watertight rubber-type gaskets.

Catch basins and curb drop inlets shall be constructed.

3.6.2 Concrete Construction

Concrete shall be in accordance with Section 03305, "Cast-in-Place Concrete (Short Section)."

3.6.3 Invert Channel Installation

Invert channels shall be smooth and fitted to each inlet, outlet, or transition for correct hydraulic flow.

3.7 STORM SEWER CONNECTIONS AND WYES

Pipe connections to existing conduit and manholes shall be provided.

Wyes for branch connections shall be provided. Field-cutting into conduit shall not be permitted. Wyes shall be sprung into existing lines. Entire wye shall be encased in concrete.

Epoxy shall be used to secure each interface connecting new and existing conduit.

3.8 FIELD QUALITY CONTROL

3.8.1 Tests

Contractor shall provide test equipment or engage the services of a firm to provide the necessary testing.

3.8.1.1 Low Pressure Air Test of Conduit

Acceptance tests for installed ferrous and plastic piping shall be in accordance with ASTM F 1417.

3.8.2 Interior Inspection of Pipe

Installed pipe shall be inspected upon completion of project. Displaced or misaligned pipe, infiltration, accumulation of debris, or other defects shall be corrected by the Contractor at no additional cost to the Government.

-- End of Section --

SECTION 02730

SANITARY SEWERAGE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1989) Standard Specification for Portland Cement
ASTM C 923	(1989) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM D 3034	(1989) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 603	(1996) Pipe Culverts, Sewers and Drains; and Subparts as Specified
ODOT 604	(1996) Manholes, Catch Basins, Inlets, Inspection Wells, Junction Chambers, or Monuments; and Subparts as Specified
ODOT 703	(1996) Aggregate; and Subparts as Specified

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-04 Drawings

As-Built Drawings for the complete Sanitary Sewer System.

SD-18 Records

Record of Existing Conditions shall be submitted after a thorough inspection of the area by the Contractor in the presence of the Contracting Officer.

PART 2 PRODUCTS

2.1 BRICK FOR MANHOLES

Brick shall conform to ODOT 704.

2.2 CEMENT MORTAR

Mortar shall consist of 1 part Portland cement and 2 parts fine sand with enough water to produce mortar of the proper consistency for the type of joint.

2.3 CONCRETE AGGREGATES

Aggregates shall conform to ODOT 703 except that granulated slag (ODOT 703.08) shall not be permitted.

2.4 PIPE

Pipe shall be as follows:

Polyvinylchloride (PVC) pipe and fittings shall conform to ASTM D 3034, Cell Classification 12454-B.

2.5 PORTLANT CEMENT

Cement shall conform to ASTM C 150, Type 1.

2.6 FRAMES AND COVERS

Ductile iron frames and covers shall be in accordance with ODOT 711.13. The following legend shall be cast-in on every cover: SANITARY.

Deviations in standard castings shall be acceptable only when prior approval has bee granted. Frames and covers shall have a combined weight of not less than 215 kilograms.

2.7 JOINTING

Cement mortar shall not be used as a pipe-jointing materials except for wye branches.

Pipe joints shall be sealed with:

A rubber gasket configuration,as recommended by the pipe manufacturer for the particular type of pipe joint. Gaskets shall be installed to provide a tight fit. Rubber gaskets may be used with PVC pipe.

2.8 PRECAST MANHOLES

Manholes shall be precast in accordance with ODOT 604.

Concrete manholes, risers, base sections, and tops shall be pre-cast and

conform to ODOT 706.13.

2.8.1 Manhole Gaskets

Gaskets for joints between manhole sections shall be in accordance with ASTM C 443.

2.8.2 Manhole Connectors

Connectors shall be in accordance with ASTM C 923 for joints between manhole and pipes.

2.8.3 Manhole Access Steps

Access shall be in accordance with ODOT 711.31. Reinforced propylene plastic manhole steps, using steps for manholes at least 1200 millimeters deep.

2.8.4 Invert Channels

Inverts shall be cast directly on the concrete of the manhole base.

2.9 CONNECTIONS TO STRUCTURES

New manholes shall have predesigned factory installed rubber boots with Stainless Steel (S.S.) band pipe connectors. The pipe inserted in the opening around the pipe shall be neatly and permanently closed (water tight) with non-shrinking and non-corrosive grout.

Pipes connecting to an existing manhole without a stub, shall be with a water tight connection. Sewers shall be designed to enter an existing manhole at an elevation so that core bore is not any closer than 150 millimeters to any manhole joint.

Connections to unlike types and sizes of pipe shall be accomplished using the proper adapter.

PART 3 EXECUTION

3.1 LOCATION

The location shall be as shown on the contract drawings.

3.2 PIPE INSTALLATION

Pipe installation shall be accordance with ODOT 603 and in accordance to the contract drawings..

3.3 WYE BRANCHES

Commercially manufactured wye branches shall be installed where sewer connections are necessary. Cutting into pipe for connections shall not be

done except as approved. When conditions are such that the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete or supported on a concrete cradle as directed. Concrete required due to faulty construction methods or negligence of the Contractor shall be installed at no additional cost to the Government.

3.4 CONNECTIONS TO EXISTING MANHOLES

Pipe connections to existing manholes shall be made in such a manner that the finished work shall conform as nearly as practicable to the applicable requirements for new manholes.

3.5 ACCEPTANCE

Sections of the sewer found defective in material, alignment, grade, or joints shall be corrected at no additional cost to the Government before acceptance.

-- End of Section --

SECTION 02841

MAINTENANCE OF TRAFFIC

PART 1 GENERAL

1.1 SUMMARY

The work under this section shall include all labor, materials, equipment, tools and services required to maintain and protect vehicular and pedestrian traffic and the work while the contract is in force in accordance with the provisions of ODOT 614.

1.2 REFERENCES

Wherever the abbreviation ODOT appears in these specifications it should be understood to mean the State of Ohio Department of Transportation Construction and Material Specifications. The "Method of Measurement" and "Basis of Payment" paragraphs shall not apply to this project. Wherever the word "Engineer" appears in the ODOT Specifications, it shall be construed to mean the Contracting Officer's Technical Representative (COTR).

Wherever the word OMUTCD appears in these specifications it should be understood mean the Ohio Manual of Uniform Traffic Control Devices with addendum.

The publications listed below form a part of this section to the extent referenced:

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 614	(1997) Maintaining Traffic and Subparts as Specifie

1.3 SUBMITTALS (Not Applicable)

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 TRAFFIC CONTROL

The installation, maintenance, and operation of all traffic controls and traffic control devices shall conform to the requirements of the OMUTCD and shall conform to ODOT 614. Temporary pavement markings, traffic signs and channelizing devices will be required.

Vehicular and pedestrian traffic shall in general be maintained during the construction of work except as noted on the contract drawings or elsewhere in the specifications. Short periods of closings are permitted for

installation of temporary crossings over trenches. All closings permitted shall be provided with detour routes by the use of signage and barricades; warning lights shall be provided during hours of darkness.

3.2 TEMPORARY VEHICULAR CROSSING

Temporary vehicular crossing shall be provided in areas as shown on the plans or as may be directed by the COTR. Any crossing provided shall be designed for H20-44 (M18) loading. Shop drawings shall be submitted for all crossings for approval to the COTR prior to installation and use. Necessary protective devices, flashers, barricades or other shall be provided to insure proper channelization of vehicles over same. All such crossings shall meet local, State and Federal codes and law.

Such temporary crossings may be portable for use in different areas as work progresses.

3.3 TEMPORARY PEDESTRIAN CROSSING

Temporary pedestrian crossings shall be provided in areas as shown on the plans or as may be directed by the COTR. Any crossing provided shall be designed for a minimum 391 kilograms per square meter loading. Protective railings shall be provided as a part of the structure; minimum width of travelled part shall be 1.2 m or 2.4 m for double-wide crossings. Shop drawings of all crossings shall be submitted for approval to the COTR prior to fabrication and use.

Such temporary crossings may be portable for use in different areas as work progresses. All necessary signage, barricades, lighting or other shall be provided to insure proper channelization of pedestrians over same. All such crossings shall meet local, State or Federal codes and law.

-- End of Section --

SECTION 02920

LAWNS AND GRASSES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 92	(1991) Wire-Cloth Sieves for Testing Purposes

STATE OF OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

ODOT 659	(1997) Seeding and Mulching; and Subparts as Specified

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-09 Reports

Laboratory Analysis of Grass Seed for percent pure, percent germination, and percent weed seed, along with laboratory analysis of Proposed Top Soil shall be submitted.

1.3 SAMPLING AND TESTING

Sampling and testing of grass seed and topsoil shall be by an approved testing service and show compliance with all specified requirements.

1.4 DELIVERY AND STORAGE

1.4.1 Seed and Fertilizer

Grass seed and fertilizer shall be delivered in sealed containers or bags, each labeled in accordance with the applicable federal and state regulations and bearing the name, trade name or trademark, and certification of the producer.

Packaged materials shall be stored off the ground, under watertight cover, and away from damp surfaces.

1.5 WEATHER LIMITATIONS

Topsoil shall not be placed when the subgrade is frozen, excessively wet or in a condition detrimental to grass seed planting or finish grading.

Seeding shall be done between August 15 and October 1 or between April 1 and May 30 unless otherwise permitted by COTR.

PART 2 PRODUCTS

2.1 TOPSOIL

Topsoil previously removed and stockpiled shall be used in the work. Topsoil shall be free from subsoil, litter, and other objectionable material.

Topsoil shall be fertile, friable, natural surface soil obtained from well-drained areas and possessing characteristics of representative soils in the project vicinity that produce heavy growths of crops, grass, or other vegetation. Topsoil shall be free of material that might be harmful to plant growth or hindrances to planting or maintenance operations.

Chemical and physical properties of topsoil proposed for use in the work shall be as follows:

Organic matter shall be at least 6 percent as determined by loss on ignition of moisture-free samples of topsoil.

The pH range shall be from 5.0 to 7.0.

The physical analysis of the topsoil shall be within the following limits: (AASHTO M 92)

SIEVE SIZ	PERCENT PASSING
25 millimeter	99 to 100
6.3 millimeter	97 to 99
150 micrometer	40 to 60
75 micrometer	20 to 40

2.2 TOPSOIL BLEND

Where insufficient topsoil is removed from the project site, the topsoil removed shall be stockpiled and blended with compost at the site to achieve the required volume.

2.3 GRASS SEED

Grass seed for lawn areas shall be as follows:

KIND OF GRASS SEE	GRASS SEED IN MIXTURE BY WEIGHT PERCENTAG	GRASS SEED PURITY MINIMUM PERCENTAG	GRASS SEED GERMINATION MINIMUM PERCENTAGE
Annual rye grass	20	98	90
Kentucky fescue Fescue	40	97	85
Creeping red fescue	40	97	85

Grass seed which has become wet, moldy, or otherwise damaged in transit or storage will not be acceptable.

2.4 LIME

Lime shall conform to ODOT 659.02.

2.5 FERTILIZER

Fertilizer shall be commercial Grade 12-12-12 mixed fertilizer.

2.6 MULCH

Mulch shall be fresh, shredded straw of wheat, rye, oats, or barley and shall be clean and free of seeds.

Mulch that is fresh and excessively brittle or that is in such an advanced stage of decomposition as to smother or retard the growth of grass will not be acceptable.

PART 3 EXECUTION

3.1 TOPSOIL PREPARATION

3.1.1 Subgrade

Before topsoil is placed, the subgrade surface shall be cleared of all materials that might hinder the performance of the work or subsequent maintenance operations.

3.1.2 Grading

Grades on areas that have been previously established shall be maintained in a true and even condition.

Where grades have not been established and where improperly graded, areas shall be uniformly graded. Finished surfaces shall be smooth within a tolerance of 30.5 millimeter above or below the indicated subgrade elevations, with uniform levels or slopes between the points where elevations are indicated or between such points and existing grades and free from irregular surface changes to prevent the formation of depressions where water will accumulate.

3.1.3 Tillage

Immediately prior to placing the topsoil, the subgrade, wherever excessively compacted by traffic or other cause, shall be loosened to a depth of at least 75 millimeter by plowing, discing, harrowing, or other approved means.

3.1.4 Placing Topsoil

Suitable topsoil shall be placed in the top 100 millimeter of all grassed areas stripped under this project. All areas to receive topsoil, including cut and fill areas, shall be shaped to provide a minimum of 100 millimeter topsoil. Prior to placement of the topsoil, the subgrade shall be scarified to a depth of 50 millimeter. Topsoil shall be uniformly distributed and evenly spread to an average thickness of 100 millimeter. Spreading shall be performed in such a manner that planting can proceed with little additional soil preparation or tillage, and the area shall be left smooth and suitable for lawns. Irregularities in the surface from topsoiling or other operations shall be corrected so as to prevent the formation of depressions where water will stand. Topsoil shall not be hauled and placed when wet or when the subgrade is frozen, excessively wet, or in a condition otherwise detrimental to the proposed planting or to proper grading. Topsoil shall be spread uniformly but shall not be compacted. Where any portion of the surface becomes gullied or otherwise damaged, the affected area shall be repaired to establish the condition and grade prior to topsoiling, and then shall be re-topsoiled.

3.1.5 Application of Lime

The application of lime shall conform to ODOT 659.08.

Lime shall be uniformly distributed over the topsoil surface at a rate of25 kilogram per 100 square meter and incorporated into the topsoil to a depth of at least 75 millimeter by discing, harrowing, or other approved means.

3.1.6 Application of Fertilizer

The application of fertilizer shall conform to ODOT 659.08.

Fertilizer shall be uniformly distributed over the topsoil surface at a rate of 12 kilogram per 100 square meter, and incorporated into the topsoil to a depth of at least 25 millimeter by discing, harrowing, or other approved means not more than 48 hours before the seed is sown.

Fertilizer may be applied mixed with seed and water as specified in paragraph entitled, "Seeding."

3.1.7 Smooth Grading

Undulations or irregularities in the topsoil surface resulting from operations shall be leveled.

Topsoil surface shall be made smooth and uniform.

3.1.8 Cleanup

After smooth grading, the topsoil surface shall be cleared of stones or other objects that might be a hindrance to planting or maintenance operations.

Topsoil or other material that has been brought upon the surfacing of paved areas by operations shall be removed daily.

3.2 SEEDING

3.2.1 Method of Sowing

Seeding, making use of a mixture of seed, fertilizer, and water applied by special mobile equipment designed for the purpose, may be employed subject to approval. When the above method of seeding is employed, covering seed and compaction operations specified will be waived.

3.2.2 Preparation of Seedbed

Preparation of seedbed shall confrom to ODOT 659.09.

Seedbed shall be loose and porous at the time of seeding. When necessary, the seedbed shall be loosened to a depth of at least 75 millimeter by harrowing or other suitable means and the surface smooth-graded and cleared of objectionable material as specified.

3.2.3 Planting Seed

Seed planting shall conform to ODOT 659.09.

Grass seed shall be uniformly distributed over the prepared seed bed.

For lawn areas, the rate of seeding shall be 2 kilogram per 100 square meter.

Immediately after seed planting, the area shall be lightly raked or lightly harrowed to cover the seed to an average depth of 6 millimeter.

3.3 MULCHING

3.3.1 Placing Mulch

Placement of mulch shall conform to ODOT 659.09.

Not more than 48 hours after the completion of seeding operations, mulch shall be spread uniformly over the entire area in a continuous blanket having a depth of not more than 38 millimeter loose measurement.

Mulch shall be spread by hand or approved equipment. Mulching shall be started at the windward side of relatively flat areas, at the upper part of steep slopes, and shall continue uniformly until the area is completely covered.

3.3.2 Anchoring Mulch with Machinery

Mulch shall be anchored in place by a Coulter disc mulch-anchoring machine or other suitable equipment that will secure the mulch firmly in the ground to form a soil-binding mulch and prevent loss or bunching of the mulch by the wind. The number of passes over the mulch needed to secure it firmly to the soil shall in no case exceed three.

3.4 GRASS ESTABLISHMENT

3.4.1 General

The period of grass establishment shall begin immediately after the completion of mulching in an area and shall continue for a period of 2-months after the completion of seeding on the entire project unless the desired grass cover is established in a shorter period of time and shortening of the grass-establishment period is authorized.

3.4.2 Watering

Contractor shall provide and maintain temporary piping and lawn-watering equipment required to convey water from the water source to uniformly water the seeded areas. Water shall be free from substances detrimental to the growth of vegetation. Water sources located on Government property will be subject to approval prior to use. Temporary watering equipment shall be removed after grass area acceptance.

Watering schedules shall be arranged and lawn-watering equipment laid out in a manner to avoid the necessity of walking over muddy and newly seeded areas.

Watering shall be done in a manner to prevent the displacement of seed and mulch and to prevent puddling and water erosion.

Immediately after the completion of mulching in an area, the area shall be moistened to a depth of 75 millimeter or more.

After the initial watering, the seeded areas shall be watered as required to maintain the soil in a moist condition for the entire grass-establishment period.

3.4.3 Mowing

When the average height of grass reaches 60 millimeter, seeded lawn areas shall be mowed with approved mowing equipment to a grass height of 40 millimeter. When the amount of cut grass is heavy, the cuttings shall be removed to prevent smothering the grass.

3.4.4 Weeding

Weeds or other undesirable vegetation that threaten to smother the grass shall be uprooted and removed from the area.

3.4.5 Refertilizing

After the first mowing and during a period when the grass is dry, fertilizer shall be uniformly distributed over the seeded area at a rate of 1.0 kilogram of actual nitrogen per 93 square meter. Fertilizer shall be as specified.

3.4.6 Reseeding

After the first mowing, bare areas shall be reseeded.

Reseeding shall be with the grass seed specified for each seeded area and shall be sown at the rate specified and in a manner that will cause a minimum of disturbance to the existing stand of grass and mulch.

3.4.7 Remulching

In areas where mulch has been disturbed sufficiently to nullify its purpose, new mulch shall be added and anchored as specified.

3.5 ACCEPTANCE PROVISIONS

3.5.1 Acceptance Requirements

Completed grass areas shall have been recently mowed and be covered with a uniform stand of the specified grass, be free of rank growths of weeds or other undesirable vegetation, and be free of irregular surface changes and other depressions where water will accumulate.

Scattered bare spots not larger than 150 millimeter in any dimension will be allowed, up to a maximum of 3 percent of any grass area.

Condition of grass areas at the time of inspection will be noted and a determination, made whether the grass-establishment period shall be extended for any area.

3.5.2 Repairs

If, before completion and acceptance of the entire work, portions of the surface become gullied or otherwise damaged following seeding or the grass seedings have been destroyed, the affected area shall be repaired to re-establish the condition and grade of the soil prior to seeding and then re-seeded, remulched, and the grass established as specified.

3.6 PROTECTION

Seeded areas shall be protected against traffic or other use by erecting barricades around each area immediately after seeding is completed and by placing warning signs of an approved type on each seeded area.

-- End of Section --

SECTION 03300

CAST-IN-PLACE CONCRETE (SHORT SECTION)

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 308	(1992) Standard Practice for Curing Concrete
ACI 315	(1992) Details and Detailing of Concrete Reinforcement
ACI 318	(1989; 318R-89) Building Code Requirements for Reinforced Concrete
ACI 347	(1989) Formwork for Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1994) Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615/A 615M	(1995; Rev A) Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 143	(1990) Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 172	(1990) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 183	(1995) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C 260	(1986) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	(1994) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 39	(1994) Standard Test Method for Compressive Strength of Cylindrical

	Concrete Specimens
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 618	(1994; Rev A) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 94	(1994) Standard Specification for Ready-Mixed Concret

1.2 GENERAL

All work shall be in accordance with ACI 318.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation Drawings shall be provided for the following:

Concrete Placement
Forms
Steel Reinforcement
Accessories

SD-05 Design Data

Mix design data shall be submitted in accordance with the paragraph entitled, "Ready-Mix Concrete," of this section.

SD-06 Test Reports

Test reports shall be in accordance with tests as described in the paragraph entitled, "Field Testing," of this section for the following items:

Slump Tests
Air-Entrainment Tests
Concrete Temperature Tests
Compressive Strength Tests

SD-07 Certificates

Bill of Lading for Ready-Mix Concrete deliveries.

SD-07 Certificates

Certificates of compliance shall be provided showing conformance

with referenced standards contained in this section for the following:

Proposed Ready-Mix Concrete
Fly Ash
Air-Entraining Admixtures
Steel Reinforcement
Waterstops
Curing Compound

1.4 INSTALLATION DRAWINGS

Installation drawings for Concrete Placement and Steel Reinforcement shall show locations, dimensions, and arrangement, and indicated locations of expansion, contraction and control joints for cast-in-place concrete sections.

PART 2 PRODUCTS

2.1 READY-MIX CONCRETE

Concrete shall be ready-mix concrete and mix design data shall conform to ASTM C 94, minimum Compressive Strength 28 Megapascal at 28 days. Slump shall be between 102 and 152 millimeter, according to ASTM C 143.

Air-Entraining Admixtures shall conform to ASTM C 260.

Water-reducing admixtures, retarding admixtures, accelerating admixtures, water-reducing and accelerating admixtures, and water-reducing and retarding admixtures shall conform to ASTM C 494.

Fly Ash or other pozzolans used as admixtures shall conform to ASTM C 618, Class F with 4 percent maximum loss on ignition and 20 percent maximum cement replacement by weight.

2.2 STEEL REINFORCEMENT

2.2.1 Deformed Steel Bars

Steel bars shall conform to ASTM A 615/A 615M, Grade 60 and ACI 318.

2.2.2 Welded Wire Fabric

Welded wire fabric shall conform to ASTM A 185.

2.3 FORMS

Forms shall be of wood, steel, or other approved material and shall conform to ACI 318.

Form release shall conform to ACI 347.

2.4 ACCESSORIES

2.4.1 Chemical Floor Hardener

Hardener shall be a colorless aqueous solution containing a blend of magnesium fluorosilicate and zinc fluorosilicate combined with a wetting agent. Solution shall contain not less than 120 gram of fluorosilicates per liter (approx. 0.5 kilogram per 4 liter). An approved proprietary chemical hardener may be used provided hardener is delivered ready for use in manufacturer's original containers.

2.4.2 Curing Compound

Curing compound shall conform to ASTM C 309.

PART 3 EXECUTION

3.1 FORM WORK

Form work shall be in accordance with ACI 318.

3.1.1 Preparation of Form Surfaces

Forms shall be true to line and grade, mortar-tight, and sufficiently rigid to prevent objectionable deformation under load. Form surfaces for permanently exposed faces shall be smooth, free from irregularities, dents, sags, or holes. Exposed joints and exposed edges shall be chamfered. Internal ties shall be so arranged that when the forms are removed, the form ties will be not less than 50 millimeter from concrete surfaces permanently exposed to view or exposed to water on the finished structure.

3.1.2 Form Coating

Forms for exposed surfaces shall be coated with a nonstaining form release coating which shall be applied shortly before concrete is placed. Forms for unexposed surfaces may be wetted in lieu of coating immediately before the placing of concrete, except that in freezing weather form release coating shall be used.

3.1.3 Removal of Forms

Forms shall be removed carefully to prevent damage to the concrete. Forms shall not be removed before the expiration of the minimum time indicated below:

Columns and walls (lifts 4.5 meter and under)	24 hours
Columns and walls (lifts over 4.5 meter)	48 hours

3.2 STEEL REINFORCING

3.2.1 General

Reinforcement shall be free from loose, flaky rust and scale, and free from oil, grease, or other coating which might destroy or reduce the reinforcement's bond with the concrete.

3.2.2 Fabrication

Steel reinforcement shall be shop fabricated in accordance with ACI 315. Shop details and bending shall be in accordance with ACI 318.

3.2.3 Splicing

Splices shall be in accordance with ACI 318.

3.2.4 Supports

Reinforcement shall be secured in place by the use of metal or concrete supports, spacers, or ties.

3.3 EMBEDDED ITEMS

Before placing concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place. Embedded items shall be free of oil and other foreign matter such as loose coatings of rust, paint and scale. Embedding of wood in concrete will be permitted only when specifically authorized or directed.

3.4 BILL OF LADING

Bill of Lading for each ready-mix concrete delivery shall be in accordance with ASTM C 94.

3.5 CONCRETE CONVEYING

Concrete shall be conveyed from mixers to forms as rapidly as practical by methods that will prevent segregation or loss of ingredients.

3.6 CONCRETE PLACING

3.6.1 General Placing Requirements

Concrete shall be placed in accordance with ACI 318.

Concrete shall be worked into the corners and angles of the forms and around reinforcement and embedded items without permitting the materials to segregate. Concrete shall be placed within 90 minutes after it has been mixed. It shall be placed on clean, damp surfaces free from water, ice, frost, mud, debris, or objectionable coatings. Concrete shall be consolidated with the aid of mechanical vibrating equipment supplemented by handspading and tamping. Vibrating equipment shall be of the internal type.

3.6.2 Lifts in Concrete

Concrete shall be deposited in horizontal layers not to exceed 600 millimeter in thickness. Placement shall be carried on at a rate that will prevent the formation of cold joints. Slabs shall be placed in one lift.

3.7 FINISHING

Defective concrete, voids left by the removal of tie rods, and ridges and local bulging on concrete surfaces permanently exposed to view or exposed to water on the finished structure shall be repaired immediately after the removal of forms. Voids left by the removal of the tie rods shall be reamed and completely filled with dry-patching mortar. Defective concrete shall be repaired by cutting out the unsatisfactory material and placing new concrete secured with keys, dovetails, or anchors. Excessive rubbing of formed surfaces will not be permitted. Unformed surfaces of concrete exposed in the completed work shall have a wood float finish without additional mortar and shall be true to indicated elevations. Other surfaces shall be brought to specified elevations and left true and regular.

3.8 TROWEL FINISH

A trowel finish shall be applied to slab surfaces that are to be exposed to view or covered with resilient flooring, paint, or other finish coating systems.

Final troweling shall be started when a ringing sound is produced as trowel is moved over the surface. Surface shall be consolidated by hand troweling operation. Finished surfaces shall be free of trowel marks, uniform in texture and appearance, and plane to a tolerance not exceeding 6 millimeter in 3000 millimeter when tested with a 3000 millimeter straightedge placed on the surface in any direction. Surface defects of sufficient magnitude to show through floor covering shall be removed by grinding.

3.9 CURING AND PROTECTION

Concrete shall be cured in accordance with ACI 308.

Curing shall be accomplished by moist curing, by moisture-retaining cover curing, by membrane curing, or by combinations thereof.

Moist curing shall be accomplished by keeping surface of concrete wet or by covering with absorptive cover saturated with water and kept wet.

Moisture-retaining cover curing shall be accomplished by covering concrete surfaces with moisture-retaining cover for curing concrete.

Membrane curing shall be accomplished by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared.

3.10 FIELD TESTING

Testing shall conform to ASTM C 39. Quality-control during construction shall be by the Contractor.

Specimens shall be tested for Compressive Strength at 7 days and at 28 days for each design mix.

Slump shall be tested at the site for each design mix Air-Entrainment Concrete Temperature according to ASTM C 143.

Test frequency according to ASTM C 183 and ASTM C 172.

-- End of Section --

SECTION 03413

STRUCTURAL PRECAST, PRETENSIONED CONCRETE-PLANT CAST

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A48.1	(1986) Concrete Construction - Forms for One Way Concrete Joist Construction
ANSI A48.2	(1986) Concrete Construction - Forms for Two Way Concrete Joist Construction

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 305R	(1991) Hot Weather Concreting
ACI 306R	(1988) Cold Weather Concreting
ACI 315	(1992) Details and Detailing of Concrete Reinforcement
ACI 318	(1989; 318-99) Building Code Requirements for Reinforced Concrete
ACI 347	(1989) Formwork for Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 153/A 153M	(1995) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 185	(1994) Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 322	(1991) Steel Bars, Alloy, Standard Grades
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel

ASTM A 370	(1995) Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 416	(1994; Rev A) Uncoated Seven-Wire Stress-Relieved Steel Strand for Prestressed Concrete
ASTM A 421	(1991) Uncoated Stress-Relieved Wire for Prestressed Concrete
ASTM A 615/A 615M	(1995; Rev A) Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 675/A 675M	(1990; Rev A) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
ASTM A 82	(1994) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C 109/C 109M	(1995) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C 1107	(1991; Rev A) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
ASTM C 114	(1994) Standard Test Method for Chemical Analysis of Hydraulic Cement
ASTM C 115	(1994) Standard Test Method for Fineness of Portland Cement by the Turbidimeter
ASTM C 117	(1995) Standard Test Method for Materials Finer than 75-micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	(1994) Standard Test Method for Lightweight Pieces in Aggregate
ASTM C 126	(1994) Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units
ASTM C 127	(1988; R 1993) Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1993) Standard Test Method for Specific Gravity and Absorption of Fine Aggregate

ASTM C 131	(1989) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1995; Rev A) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138	(1992) Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
ASTM C 142	(1978; R 1990) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C 143	(1990) Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C 150	(1995) Standard Specification for Portland Cement
ASTM C 151	(1993; Rev A) Standard Test Method for Autoclave Expansion of Portland Cement
ASTM C 172	(1990) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 183	(1995) Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C 185	(1995) Standard Test Method for Air Content of Hydraulic Cement Mortar
ASTM C 191	(1992) Standard Test Method for Time of Setting Hydraulic Cement by Vicat Needle
ASTM C 192	(1990; Rev A) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 204	(1994; Rev A) Standard Test Method for Fineness of Portland Cement by Air Permeability Apparatus
ASTM C 231	(1991; Rev B) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 232	(1992) Standard Test Method for Bleeding of Concrete
ASTM C 233	(1993) Standard Test Method for

	Air-Entraining Admixtures for Concrete
ASTM C 260	(1986) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 266	(1989) Standard Test Method for Time of Setting of Hydraulic-Cement Paste by Gillmore Needles
ASTM C 29/C 29M	(1991) Standard Test Method for Unit Weight and Voids in Aggregate
ASTM C 31	(1991) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1993) Standard Specification for Concrete Aggregates
ASTM C 330	(1989) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C 39	(1994) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	(1992) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 403/C 403M	(1995) Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C 404	(1994) Standard Specification for Aggregates for Masonry Grouts
ASTM C 42	(1994) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 451	(1989) Standard Test Method for Early Stiffening of Portland Cement (Paste Method)
ASTM C 535	(1989) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 566	(1989) Standard Test Method for Total Moisture Content of Aggregate by Drying
ASTM C 70	(1994) Standard Test Method for Surface Moisture in Fine Aggregate

ASTM C 78	(1994) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C 88	(1990) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 94	(1994) Standard Specification for Ready-Mixed Concrete
ASTM D 1149	(1991) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D 2240	(1991) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D 312	(1995) Standard Specification for Asphalt Used in Roofing
ASTM D 3744	(1994) Standard Test Method for Aggregate Durability Index
ASTM D 395	(1989; R 1994) Rubber Property - Compression Set
ASTM D 412	(1992) Rubber Properties in Tension
ASTM D 4397	(1991) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 471	(1995) Rubber Property - Effect of Liquids
ASTM D 573	(1988; R 1994) Rubber-Deterioration in an Air Oven
ASTM D 75	(1987; R 1992) Standard Practice for Sampling Aggregates
ASTM D 797	(1982; R 1989) Rubber Property - Young's Modulus at Normal and Subnormal Temperatures
ASTM E 165	(1995) Standard Test Method for Liquid Penetrant Examination
ASTM E 621	(1994) Standard Practice for Use of Metric (SI) in Building Design and Construction
ASTM E 709	(1995) Standard Guide for Magnetic Particle Examination

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1	(1991) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1	(1994) Structural Welding Code - Steel
AWS D1.4	(1992) Structural Welding Code - Reinforcing Steel

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI DA4	(1992) Manual of Standard Practice

FEDERAL SPECIFICATIONS (FS)

FS MMM-A-001993	(Basic) Adhesive, Epoxy, Flexible, Filled (For Binding, Sealing, and Grouting)
FS UU-B-790	(Rev A; Int Am 1) Building Paper, Vegetable Fiber: Kraft, Waterproofed, Water Repellent and Fire Resistant

NATIONAL INSTITUTE FOR STANDARDS AND TECHNOLOGY (NIST)

NIST PS 58	(1973) Basic Hardboard

UNDERWRITERS LABORATORIES (UL)

UL-05	(1995) Electrical Construction Materials Directory
UL-07	(1995) Fire Resistance Directory

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings be submitted in accordance with the paragraphs entitled, "Fabrication" and "Drawings," of this section.

Installation Drawings be submitted in accordance with the paragraph entitled, "Drawings," of this section.

SD-05 Design Data

Mix design data shall be submitted in accordance with the paragraph entitled, "Concrete Design Mixes," of this section.

Normal Weight Concrete

SD-06 Test Reports

Test reports for the following items shall be submitted in accordance with paragraph entitled, "Concrete Sampling and Testing," of this section. Each report shall contain the project name and number, date, name of Contractor, name of precast-concrete manufacturer, name of concrete testing service, type of concrete, structural-member identification letter and number, design compressive strength at 28 days, concrete-mix proportions and materials, compressive breaking strength and type of break, a record of gage pressures or dynamometer readings, compression strength of concrete at time of detensioning, and type of reinforcement. Design mix reports shall be approved at least 15 days prior to start of work.

Air Content
Air Entrainment
Compressive Strength
Slump
Moisture Content
Design Mix
Unit Weight

SD-07 Certificates

Certificates of Compliance for the following items shall include qualifications of personnel, location of plant, concrete batching facilities, manufacturer equipment and facilities, a list of projects similar to specified work, handling and erection equipment, and performance requirements. Certificates for welder qualifications shall be in accordance with the paragraph entitled, "Qualifications for Welding Work," of this section.

Installers
Manufacturer
Aggregate
Pretensioning
Detensioning

SD-07 Certificates

Welding Procedures shall be submitted in accordance with AWS D1.1.

SD-08 Manufacturer's Instructions

Installation Instructions shall indicate the manufacturer's recommended sequence and methods of installation for the following items:

Welding Sequence and Procedure
Epoxy-Resin Grout
Epoxy-Resin Adhesive

1.3 QUALIFICATIONS FOR PRECAST-CONCRETE MANUFACTURER

Precast structural concrete sections shall be manufactured by an organization experienced in the manufacture of precast concrete.

A written description of the Manufacturer shall be submitted giving the qualifications of personnel, location of plant, concrete batching facilities, manufacturing equipment and facilities, list of projects similar to specified work, and other information as may be required.

1.4 QUALIFICATIONS FOR INSTALLER

Members shall be installed by an organization experienced in the installation of precast structural-concrete sections.

A written description of Installers shall be submitted giving the qualifications of personnel, handling and erection equipment, list of projects similar to specified work, and other information as may be required.

1.5 QUALIFICATIONS FOR WELDING WORK

Welding Procedures shall be in accordance with AWS D1.1.

Installation instructions for the Welding Sequence and Procedure shall be provided by the Contractor which indicates the manufacturer's recommended sequence and method of intallation.

1.6 PERFORMANCE REQUIREMENTS

1.6.1 Design Methods

Design shall be in accordance with ACI 318.

1.6.2 Allowable Design Loads and Deflections

Allowable design loads and deflections shall be as indicated in drawing.

1.6.3 UL Fire-Resistance Listing and Label

Sections indicated requiring a fire-resistance classification shall be listed in UL-07, part entitled, "Precast Concrete Units (CFTV)," and each section shall bear the UL label and marking.

1.6.4 Electrical Raceway UL Listing and Label

Hollow-core floor slabs indicated as electrical raceways shall be listed in UL-05, part entitled, "Raceways (RGKT) Cellular Concrete Floor (RGYR)," and each section shall bear the UL label and marking.

1.7 CONCRETE SAMPLING AND TESTING

1.7.1 Tests for Concrete Materials

Concrete materials proposed for use in the work shall be sampled and tested as follows:

MATERIA	REQUIREMEN	TEST METHO	NUMBER OF TESTS
Concrete aggregates for normal-weight concrete	Sampling	ASTM D 75	One for each material source and grading size
	Sieve analysis	ASTM C 136	
	Calculating fineness modulus	ASTM C 126	
	Amount of material passing 75 micrometer sieve	ASTM C 117	
	Amount of friable particles	ASTM C 142	
	Amount of organic impurities	ASTM C 40	
	Amount of coal and lignite	ASTM C 123	
	Magnesium sulfate soundness test	ASTM C 88	
	Aggregate durability	ASTM D 3744	
	Compact unit weight of slag (coarse aggregate)	ASTM C 29/C 29M	
	Resistance to abrasion test of small size coarse aggregate	ASTM C 131 or ASTM C 535	
Hydraulic cement	Sampling	ASTM C 183	One for each material source, type, and color
	Chemical analysis	ASTM C 114	
	Fineness	ASTM C 115 or	

MATERIA	REQUIREMEN	TEST METHO	NUMBER OF TESTS
		ASTM C 204	
	Autoclave expansion	ASTM C 151	
	Time of setting	ASTM C 191 or ASTM C 266	
	Air content of mortar	ASTM C 185	
	Compressive strength	ASTM C 109/C 109M	
	Heat of hydration	ASTM C 185	
	False set	ASTM C 451	
Air entraining admixture using air-entraining concrete made of the proposed concrete materials	Materials for tests	ASTM C 233	One set of tests for each type of portland cement proposed for use and for each type of concrete
	Number of specimens	ASTM C 233, Table 1	
	Bleeding	ASTM C 232	
	Time of setting	ASTM C 403/C 403M and ASTM C 233	
	Compressive-strength test specimen	ASTM C 192 and ASTM C 233	
	Compressive-strength test at 3, 7, and 28 days	ASTM C 39 and ASTM C 233	

1.7.2 Concrete Design Mixes

Concrete Design Mix for concrete used shall be determined and tested as follows:

TYPE OF CONCRET	REQUIREMEN	TEST METHO	NUMBER OF TESTS
Normal	Specific	ASTM C 128	As required for

TYPE OF CONCRET	REQUIREMEN	TEST METHO	NUMBER OF TESTS
weight concrete	gravity and absorption of fine aggregate		the concrete aggregates for each trial mix
	Specific gravity and absorption of coarse aggregate	ASTM C 127	
	Moisture Content tent of both fine and coarse aggregate	ASTM C 70 and ASTM C 566	
	Dry-rodded Unit Weight of coarse aggregate	ASTM C 29/C 29M	
	Trial mixes using at least three different water/cement ratios, minimum allowable cement content, maximum allowable slump; all with Air Entrainment	ACI 211.1	As required to determine the concrete mix having the properties specified in the paragraph entitled, "Quality of Concrete"
	Making and curing concrete specimens in the laboratory	ASTM C 192	Two sets of three specimens for each design mix
	Sampling fresh concrete in the laboratory	ASTM C 192	One for each set of design mix specimens
	Slump	ASTM C 143	
	Air Content	ASTM C 231	
	Yield	ASTM C 138	
	Compressive strength	ASTM C 39	Three specimens tested at 28 days

From the results of the tests for normal-weight concrete, plot a curve showing the relationships between water/cement ratios and compressive strengths. Maximum permissible water/cement ratio shall be the value not exceeding the maximum water/cement ratio specified for normal-weight concrete properties shown by the curve to produce a design-minimum laboratory Compressive Strength at 28 days not less than that specified.

1.7.3 Quality Control Testing During Fabrication

Concrete shall be sampled and tested for quality control during fabrication as follows:

TYPE OF CONCRET	REQUIREMEN	TEST METHO	NUMBER OF TESTS
Normal weight concrete	Sampling of fresh concrete	ASTM C 172 except modified for slump per ASTM C 94	As required for each test
	Slump test	ASTM C 143	One for each concrete load at point of discharge and one for each set of compressive strength test
	Air Content by pressure method	ASTM C 231	One for each set of compres-sive-strength tests
	Compression test specimens	ASTM C 31	One set of six standard cyl-inder speci-mens for each compressive strength test

Curing of compression test specimens shall be the same as the curing method used for the precast-concrete structural members.

Concrete temperature		Each time a set of compression-test specimens is made
Compressive strength tests	ASTM C 39	One set for every ten structural mem-bers, or frac-

TYPE OF CONCRET	REQUIREMEN	TEST METHO	NUMBER OF TESTS
			tion thereof, cast in any one day; two specimens tested at 7 days, three specimens tested at 28 days, and one specimen retained in reserve for testing if required

The curing of Compressive Strength test specimens shall be the same as the curing method used for the precast-concrete structural members.

Concrete temperature		Each time a set of compression test specimens is made
Compressive-strength tests	ASTM C 39	One set for every ten structural members, or fraction thereof, cast in any one day; two specimens tested at 7 days, three specimens tested at 28 days, and one specimen retained in reserve for testing if required
Air-dried Unit Weight at 28 days	ASTM C 330	One for each compressive strength test

Test results shall be submitted on the same day that tests are made.

1.8 DRAWINGS

Fabrication Drawings for precast structural concrete sections shall show type and location of all reinforcement, size and spacing of welds.

Installation Drawings for precast structural concrete sections shall indicate type and location of all anchorage devices, size and spacing of all welded connections, grouting and joint sealant details, and dimensions and locations of all openings in structural concrete sections.

PART 2 PRODUCTS

2.1 QUALITY OF CONCRETE

2.1.1 Normal-Weight Concrete Properties

PROPERT	VALUE
Design Compressive Strength at 28 days	Not less than 34.5 Megapascal
Maximum Aggregate size	19 millimeter
Maximum water/cement ratio	16 liter per 42.5 kilogram sack of cement
Slump at point of concrete discharge	Not to exceed 75 millimeter
Total air content by volume at point of concrete discharge	Not less than 4 percent nor more than 8 percent

2.2 CONCRETE MATERIALS

2.2.1 Aggregates

Aggregates shall be fine and coarse conforming to ASTM C 33 and the following:

Aggregates for normal-weight concrete shall be fine and coarse conforming to ASTM C 33 and the following:

Where a structural member will be exposed to the weather, concrete aggregates shall meet the requirements of ASTM C 33 for fine aggregate subject to abrasion, for coarse aggregate subject to severe exposure, and for all concrete aggregates where surface appearance of the concrete is important.

Maximum size of coarse aggregate shall be as specified.

2.2.2 Portland Cement

Cement shall conform to ASTM C 150, Type I or Type II. One brand and type of cement shall be used.

2.2.3 Air-Entraining Admixture

Admixture shall be free of sodium chloride and nitrates and shall conform to ASTM C 260.

2.2.4 Water

Water shall be potable.

2.3 REINFORCEMENT MATERIALS

2.3.1 Reinforcement Bars

Bars shall be deformed and shall conform to ASTM A 615/A 615M, Grade 60.

Bars for structural sections exposed to the weather shall be galvanized in accordance with ASTM A 153/A 153M.

2.3.2 Cold-Drawn Steel Wire

Wire shall conform to ASTM A 82.

2.3.3 Welded-Wire Fabric

Fabric shall be uncoated wire conforming to ASTM A 185.

Fabric shall be wire conforming to ASTM A 185. Fabric in structural sections exposed to the weather shall be galvanized. Elsewhere, fabric shall be uncoated.

2.3.4 Supports for Concrete Reinforcement

Supports shall include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcement bars and wire in place.

Supports shall be wire conforming to ACI 347, ANSI A48.1, ANSI A48.2, ASTM E 621, ACI 315 and CRSI DA4.

Legs of supports in contact with formwork for sections that will be exposed to weather shall be hot-dip galvanized after fabrication, plastic coated, or corrosion-resistant steel bar supports.

2.4 PRESTRESSING MATERIALS

2.4.1 Strand Tendons

Tendons shall be uncoated, 7-strand, stress-relieved, steel wire conforming to ASTM A 416.

2.4.2 Wire Tendons

Tendons shall conform to ASTM A 421, Type BA or Type WA, as required to suit the steel-wire anchorage method used.

2.4.3 Steel-Bar Tendons

Tendons shall be uncoated, round steel bars conforming to ASTM A 322.

Tensile properties of the bars after processing, when tested in accordance with ASTM A 370, shall be as follows:

TENSILE PROPERT	VALUE NO.	VALUE NO. 2
Ultimate tensile strength	1000 Megapascal min	1100 Megapascal min
Yield strength (0.2-percent offset)	900 Megapascal min	970 Megapascal min
Elongation at rupture in 20 diameters	4 percent min	4 percent min
Reduction on area at rupture	25 percent min	20 percent min

2.4.4 Tendon Anchorages for Pretensioning

Tendon anchorages shall be capable of anchoring reinforcement without slippage after seating.

Steel cases for prestressing steel strand shall be prooftested by the manufacturer to at least 90 percent of the ultimate tensile strength of the strand.

2.4.5 Tendon Anchorages for Post Tensioning

Anchorages shall be capable of developing 100 percent of the guaranteed ultimate tensile strength of the reinforcement for prestressed concrete without excessive deformation. Anchorage plates shall be of sufficient size to keep bearing pressures within the stress allowed by ACI 318 for the specified concrete strength at stressing.

Test data confirming the adequacy of anchorages shall be submitted.

2.5 CONNECTION MATERIALS

2.5.1 Steel Plates, Shapes, and Bars

Plates shall conform to ASTM A 36/A 36M.

Structural-steel shapes shall conform to ASTM A 36/A 36M.

Bar shapes, flats, and rounds shall conform to ASTM A 675/A 675M, Grade 65, or ASTM A 36/A 36M.

2.5.2 Steel Anchor Bolts

Anchor bolts shall be steel with steel hexagon nuts and steel washers.

2.5.3 Electrodes for Welding

Electrodes for manual shielded metal-arc welding connections consisting of structural quality carbon-steel members shall conform to the AWS Code and shall be covered mild-steel electrodes conforming to AWS A5.1, E60 series.

Electrodes for welding steel bars for concrete reinforcement shall conform to AWS D1.4.

2.5.4 Flexible Bearing Pads

Pads shall be tempered hardboard, not less than 3 millimeter in thickness, smooth-two-sides, conforming to NIST PS 58.

Pads shall be molded or cut from elastomeric material. Pad dimensions shall be as indicated and shall be within the following tolerances: thickness, plus or minus 1.5 millimeter; width, minus 3 to plus 6.5 millimeter; length, plus or minus 3 millimeter. Material shall be a vulcanized, chloroprene elastomeric compound conforming to the following tests:

PROPERT	TEST METHO	PERFORMANCE
Hardness Shore A durometer	ASTM D 2240	70 plus or minus 5 points
Tensile strength	ASTM D 412, Die C	Not less than 17.2 Megapascal
Ultimate elongation	ASTM D 412, Die C	Not less than 300 percent
Resistance to oil aging: change in volume after 70-hour immersion in ASTM oil No. 3 at 100 degrees C	ASTM D 471	Not more than plus 120 percent
Resistance to heat aging: change in original properties after 70 hours at 100 degrees C tensile strength ultimate elongation hardness	ASTM D 573	Plus 15 percent, minus 40 percent, 0 to plus 15 points
Resistance to permanent set: compression set after 22 hours at 100 degrees C	ASTM D 395 Method B	Not more than 35 percent
Resistance to ozone: condition after exposure of a sample kept under a surface tensile strain of 20 percent to an ozone concentration of 100 parts	ASTM D 1149	No cracks

PROPERT	TEST METHO	PERFORMANCE
per million of air by volume in air for 100 hours at 40 degrees C		
Low-temperature stiffness: maximum Young's modulus at minus 7 degrees C	ASTM D 797	68.9 Megapascal
		Not less than 91 kilogram per 25 linear millimeter

2.6 GROUTING MATERIALS

Portland cement shall conform to ASTM C 150, Type I.

Aggregate for cement grout shall conform to ASTM C 404, Size No. 2.

Shrinkage-resistant grouting compound shall be premixed and packaged ferrous aggregate conforming to ASTM C 1107, for expansive grouts.

Water shall be potable.

Epoxy-Resin Grout shall be two-component, mineral-filled, epoxy-polysulfide conforming to FS MMM-A-001993, Type I.

Epoxy-Resin Adhesive shall be two-component, epoxy-polyamide cured type conforming to AASHTO M 200.

2.7 BITUMINOUS JOINT SEALING MATERIALS

Bituminous cement shall be asphalt conforming to ASTM D 312, Type IV.

Joint sealing tape shall be 150 millimeter wide, multilayered, asphalt treated, glass-fiber reinforced, conforming to ASTM D 4397 and FS UU-B-790, Type I, Grade C, Style 4, with the following modification:

Dry tensile strength shall be not less than 6130 newton per meter width, both directions.

2.8 FABRICATION

2.8.1 Fabrication Tolerances

Sections shall be fabricated within the following tolerances:

Overall dimensions	Plus or minus 3 millimeter per 3048 millimeter but not greater than 19.1 millimeter overall
Cross-sectional dimensions of	Plus or minus 3 millimeter

up to 150 millimeter	
Over 150 to 460 millimeter	Plus or minus 4.8 millimeter
Over 460 to 915 millimeter	Plus or minus 6.4 millimeter
Over 915 millimeter	Plus or minus 9.5 millimeter
Deviation from straight line parallel to centerline of section up to 12.2 meter in length	Not over 9.5 millimeter
12.2 to 18.3 meter in length	Not over 12.7 millimeter
Over 18.3 meter in length	Not over 19.1 millimeter
Deviation from camber indicated on the drawings	Plus or minus 3 millimeter per 3 meter
Ends out of square, up to 305 millimeter in width or depth	0.80 millimeter per 25.4 millimeter of width or depth
Over 300 millimeter in width or depth	0.80 plus 0.40 millimeter per 25.4 millimeter of width or depth
Position of block-outs	Plus or minus 12.7 millimeter
Position of voids in hollow cored flat slabs, for both vertical and horizontal dimensions	Plus or minus 12.7 millimeter
Concrete cover over reinforcement	Plus 6.4, minus 0 millimeter
Position of tendons for pre-stressed concrete	Plus or minus 3.2 millimeter
Position of deflection points for deflected strand tendons for prestressed concrete	Plus or minus 152 millimeter
Position of weld plates	Plus or minus 25.4 millimeter
Position of lateral anchorage points	Plus or minus 25.4 millimeter
Position of pickup devices	Plus or minus 152 millimeter

2.8.2 Forms

Forms and form-facing materials shall be wood, metal, plastic, or other

approved material that is nonreactive with concrete. Completed sections shall conform to the shapes, lines, and dimensions indicated and shall be within the limits of the specified fabrication tolerances.

2.8.3 Reinforcement

Reinforcing bars shall be of types, sizes, and arrangement as indicated on the approved drawings. Details of reinforcement shall be in accordance with ACI 318, unless otherwise specified.

Steel bars, welded-wire fabric, and other reinforcement shall be placed and secured by means of metal bar supports and spacers.

Tendons and anchorages shall be placed in accordance with ACI 318. End anchorages that will be permanently protected with concrete shall be free of loose rust, grease, oil, paint, and other foreign matter. Bearing surface between anchorages and concrete shall be perpendicular to and concentric with the tendons and the line of action prestressing force.

Concrete cover for reinforcement shall be in accordance with ACI 318.

2.8.4 Built-In Anchorage Devices

Anchorage devices shall be positioned, anchored, and located where they do not affect the position of the main reinforcement or placing concrete. Bearing plates shall be set level, aligned properly, and anchored in the exact location indicated.

2.8.5 Lifting Devices

Lifting devices shall be provided, shall be designed for 100-percent impact, and shall be of materials sufficiently ductile to ensure visible deformation before fracture.

2.8.6 Blockouts

Blockouts shall be provided as indicated.

2.8.7 Pretensioning

Pretensioning of tendons may be accomplished either by the single-strand or multiple-strand tensioning method. Prestressing force shall be determined by measuring the tendon elongation, either by checking the jack pressure on a recently calibrated gage or by use of a recently calibrated dynamometer. Any discrepancy that exceeds 5 percent shall be corrected. Elongation requirements shall be based on the load-elongation curves for the type of tendon used. The total loss of prestress due to unreplaced broken tendons shall not exceed 2 percent of the total prestress.

2.8.8 Concrete Mixing and Conveying

Measuring concrete materials, concrete batching plant, concrete mixers, and concrete mixing shall be in accordance with ASTM C 94.

Concrete shall be handled to prevent segregation and loss of concrete mix materials.

2.8.9 Preparations for Placing Concrete

Form interiors and reinforcement shall be free of accumulations of hardened concrete, form-parting compound, standing water, ice, snow, or other deleterious substances. Reinforcement and other embedded items shall be secured in position, inspected, and approved.

2.8.10 Weather Limitations

Concrete shall not be placed when temperature of the atmosphere is below 5 degrees C nor during rain, sleet, and snow unless adequate protection is provided. Protection during inclement weather shall prevent the entry of rain, sleet, or snow into the forms or into the fresh concrete.

2.8.11 Concrete Placing

Concrete shall be deposited so that no concrete will be placed on concrete that has hardened sufficiently to cause formation of seams or planes of weakness. Concrete shall be consolidated in a manner that will prevent segregation and will produce concrete free of honeycomb or rock pockets and with the required surface finish.

2.8.12 Identification Markings

Each structural section shall be clearly marked in a permanent manner to indicate its location and orientation in the building and the pickup points.

Each structural section shall have the date of casting plainly indented in the unexposed face of the concrete.

2.8.13 Finishing Unformed Surfaces

Unformed surfaces shall have a trowel finish unless otherwise specified. Surface shall be smooth, free of trowel marks, uniform in texture and appearance, and shall be plane to a tolerance not exceeding 3.2 millimeter in 3048 millimeter when tested with a 3000 millimeter straightedge.

2.8.14 Curing

Concrete shall be cured by keeping the concrete damp for not less than 7 days if made of Type I portland cement and for not less than 3 days if made of Type III portland cement. For each decrease of 3 degrees below 21 degrees C in the average curing temperature, the curing period shall be increased by 4 days for concrete made of Type I portland cement and by 2 days for concrete made of Type III portland cement.

Curing by low-pressure steam, steam vapor, radiant heat and moisture, or other acceptable process may be employed provided that the compressive strength of the concrete is equal to that obtained by moist curing and the 28-day compressive strength of the concrete meets the requirements specified, as determined by test cylinders of the same concrete cured by

the same curing process.

Sections shall not be removed from their casting beds until the curing period is completed or concrete has attained at least 75 percent of its design compressive strength.

2.8.15 Protection of Concrete After Placing

Protection shall meet the requirements of ACI 305R or ACI 306R for hot or cold weather, as applicable.

2.8.16 Detensioning

Detensioning of tendons shall not be done until the concrete compressive strength, as indicated by test cylinders, is as follows:

TYPE OF REINFORCEMEN	TRANSFER STRENGTH OF CONCRETE
Concentrically stressed sections	Not less than 20 Megapascal
Eccentrically stressed sections	Not less than 24.1 Megapascal
Beams or other sections in which camber must be minimized	Not less than 27.6 Megapascal

Test cylinders to be used to establish the compressive strength of the concrete shall be removed from the casting bed at least 1 hour prior to the start of the detensioning operation. Test cylinders from heat-cured casting beds shall be allowed to cool for approximately 1/2 hour prior to capping, and caps of sulfur compound shall be allowed to cure for 1/2 hour prior to the compressive-strength test.

If concrete has been heat cured, the detensioning operation shall be done following the curing period while the concrete is still warm and moist to avoid cracking or undesirable stresses in the concrete.

Prior to detensioning operations, forms, ties, inserts, holddowns, or other devices that would restrict the longitudinal movement of the sections along the casting bed shall be removed or loosened to provide free movement of the structural section. Alternately, detensioning shall be performed so that longitudinal movement is precluded.

In detensioning operations, prestressing forces shall be kept nearly symmetrical about the vertical axis of the section and shall be applied in a manner that will minimize sudden or shock loading. Maximum eccentricity about the vertical axis shall be limited to one strand. Detensioning of pretensioned tendons may be accomplished either by gradual release of the tensioning jacks or by heat-cutting the tendons in accordance with an approved pattern and sequence to prevent severe unbalancing of the loading.

2.8.17 Finishing Formed Surfaces

Upon removal of forms, defective areas shall be repaired and patched. Defective areas shall be limited to holes left by tie rods and other temporary inserts and to honeycomb or rock pockets not deep enough to expose the reinforcement and not located in bearing areas. Defective areas shall be cut out to solid concrete and cleaned. Patches on lower side of sections, near the center or in areas of variable tensile strength, shall be bonded by a two-component epoxy-polysulfide or epoxy-polyamine bonding adhesive. Other areas shall be dampened with water and patched with portland cement grout. Where the concrete surface will be exposed to view, the patches, when dry, shall match the surrounding concrete.

Formed surfaces of sections that will be concealed by other construction shall have the standard smooth finish. The standard smooth finish shall be the concrete surface having the texture imparted by the forms. Defective areas shall be repaired and patched as specified and all fins and other projections removed.

Formed surfaces of sections that are to be exposed-to-view after installation shall have grout finish. Final color of the grout, when dry, shall be the same for all concrete surfaces. Grout shall be spread over dampened concrete surface with clean burlap pads, carpet, or sponge rubber floats to fill pits, air bubbles, and surface holes. Excess grout shall be removed by scraping and then rubbing the surface with clean burlap or carpet to remove visible grout film. In hot dry weather, grout shall be kept damp by means of fog-spraying during the setting period.

PART 3 EXECUTION

3.1 GENERAL

Sections shall be installed in accordance with the approved drawings and as specified.

3.2 ANCHORAGE ITEMS EMBEDDED IN OTHER CONSTRUCTION

Items shall be delivered to the site before the start of other construction. Setting drawings, templates, instructions, and directions shall be provided for the installation of anchorage items.

3.3 INSTALLATION OF FLEXIBLE BEARING PADS

Pads shall be installed where indicated, set in correct position, and have a uniform bearing. Pads shall be kept in the correct position while placing sections.

3.4 STRENGTH OF STRUCTURAL SECTIONS AT INSTALLATION

Sections shall not be installed until concrete has attained the specified minimum laboratory strength at 28 days.

Sections shall not be installed before 28 days from the date of casting has elapsed unless approval has been obtained to make one compressive-strength test, ASTM C 39, and one flexural strength test using simple beam with

third point loading, ASTM C 78, on field cured concrete test specimens, ASTM C 31, for each individual structural section to determine the strength of the concrete.

3.5 INSTALLATION TOLERANCES

Sections shall be installed within the following tolerances:

Deviation in location from indicated	Plus or minus 6.4 millimeter
Deviation from plumb for columns in any story or 6.1 meter maximum	Not over 6.4 millimeter
In 12.2 meter or more	Not over 12.7 millimeter
Deviation from elevations indicated for girders, beams, joists, and slabs in any bay or 6.1 meter maximum	Not over 6.4 millimeter
In 12.2 meter or more	Not over 12.7 millimeter
Difference between adjacent structural sections in erected position	Plus or minus 1.6 millimeter per 3000 millimeter but not greater than 6.4 millimeter overall

3.6 PLACING FRAMING STRUCTURAL SECTIONS

Supporting sections, including anchorage items attached to or embedded in other construction, shall be in place before placing sections is started.

Installation of precast concrete columns with attached steel bearing plates shall be as follows:

Concrete and steel plate bearing surfaces shall be cleaned of laitance, dirt, oil, grease, and other foreign materials. Concrete surface shall be roughened.

Space between the top of the concrete bearing surface and the bottom of the steel plate shall be approximately 1/24 of the width of the bearing plate, but not less than 12.7 millimeter for bearing plate that is less than 300 millimeter wide. Bearing plate shall be supported and aligned on steel wedges or shims.

After precast concrete columns have been positioned and braced and anchor bolts tightened, the space between the top of the bearing surface and the bottom of the steel bearing plate shall be grouted.

Wedges or shims shall not be removed but, when protruding, shall be cut off flush with the edge of the steel bearing plate prior to grouting.

Sections shall be installed plumb, level, and in alignment within the limits of the installation tolerances specified.

3.7 PLACING SLAB STRUCTURAL SECTIONS

Supporting sections, including bearing pads or plates, shall be in place before placing sections is started. Slab structural sections shall be placed on supporting construction with ends bearing on the structural framing sections or bearing walls as indicated. End bearings shall be not less than 75 millimeter. Slabs shall be accurately aligned end to end with sides and ends butted together. Grouting void shall be provided at sides and ends of the slabs as indicated.

3.8 WELDED CONNECTIONS

Welding reinforcing steel, metal inserts, and connections in precast-concrete structural-member construction shall be in accordance with AWS D1.4.

Welding structural steel connections shall be in accordance with AWS D1.1 Code.

3.9 GROUTING CONNECTIONS AND JOINTS

After sections have been placed and connected, open spaces at connections and joints shall be grouted.

Cement grout shall be of 1 part cement, 2-1/2 parts of specified aggregate for cement grout, and not more than 17 liter of water per 42.6 kilogram sack of cement.

Shrink-resistant grout compound shall be mixed with water to provide a flowable mixture without segregation or bleeding.

Forms or other approved methods shall be provided to retain the grout in place. Spaces to be grouted shall be packed with grout until the voids are completely filled. At slab structural sections, grout shall finish level with top surface of the slab. Excess grout shall be removed. Grout shall be kept damp for not less than 24 hours.

Epoxy-resin grout or adhesive may be used in lieu of shrink-resistant grout. Installation of epoxy-resin grout or adhesive shall be in accordance with the manufacturer's printed instructions.

3.10 SEALING JOINTS IN ROOF SLABS

After precast-concrete roof slab sections have been placed and connected, open spaces at connections and the top portion of joints shall be sealed.

Keyways and joints at ridges, hips, and connections shall be filled with cement grout. Grout shall be level with the top surfaces of slabs. Excess grout shall be removed, and the grout surface shall be given a smooth finish.

Other joints shall be sealed with bituminous joint-sealing material. Joint-sealing tape shall be centered over the joint and embedded in hot bituminous cement. End laps shall be not less than 100 millimeter. Excess bitumen shall be removed; the tape surface shall be smooth.

3.11 OPENINGS IN SLAB STRUCTURAL SECTIONS

Cutting and fitting sections shall be performed as required for other work projecting through, or adjacent to, the members. Cuts shall be straight and at 90 degrees to the surfaces without breaking or spalling the edges.

Openings in hollow-core flat-slab sections having any dimension more than the inside diameter of the hollow cores and not exceeding the width of the slab structural section shall be reinforced by means of hung steel angle saddle headers. Headers shall be shop prime-coat painted and shall be as indicated on the approved drawings.

3.12 TOUCHUP PAINTING

After sections have been installed, scarred surfaces on steel supporting members and weld plates shall be wire brushed, cleaned, and touchup painted.

3.13 PROTECTION AND CLEANING

Exposed-to-view surfaces shall be protected against staining and other damage until completion of the work.

Upon completion of installation, slab surfaces shall be swept clean and left ready to receive concrete floor topping, roofing, or other covering.

3.14 INSPECTION AND ACCEPTANCE PROVISIONS

3.14.1 Evaluation of Compressive Strength Tests

Concrete quality control tests will be evaluated as specified.

Normal-weight concrete delivered to the point of placement having a slump or total air content outside the values specified shall not be used in the work.

Compressive-strength tests will be considered satisfactory if the average of any group of 5 consecutive compressive-strength tests that may be selected is in each instance equal to or greater than the 28-day design compressive strength or if not more than one compressive-strength test in 10 has a value less than 90 percent of the 28-day design compressive-strength.

If the compressive-strength tests fail to meet the minimum requirements specified, the sections fabricated of concrete represented by such tests will be considered deficient in strength and subject to the provisions specified.

3.14.2 Dimensional Tolerances

Members having any dimension outside the limits for fabrication tolerances specified will be rejected.

3.14.3 Surface-Finish Requirements

Sections will be rejected for any of the following surface-finish deficiencies:

Exposed-to-view surfaces having architectural finishes that do not match the color, aggregate size and distribution, and texture of the approved sample for the exposed-to-view finish

Exposed-to-view formed surfaces that contain cracks, spalls, air bubbles, honeycomb, rock pockets, or stains or other discoloration that cannot be removed by cleaning

Concealed formed surfaces that contain cracks in excess of 0.25 millimeter wide; cracks or any other surface deficiency that penetrates to the reinforcement regardless of the width of crack or size of other deficiency; honeycomb and rock pockets located in bearing surfaces; and spalls except minor breakage at corners

Unformed surfaces that contain cracks and other surface deficiencies as specified for concealed formed surfaces

3.14.4 Strength of Structural Members

Strength of precast structural-concrete sections will be considered potentially deficient if they fail to comply with the requirements that control the strength of the structural members, including the following conditions:

Failure to meet compressive strength tests

Reinforcement and pretensioning and detensioning of tendons of prestressed concrete not conforming to the requirements specified

Concrete curing and protection of structural sections against extremes in temperature during curing not conforming to the requirements specified

Structural sections damaged during handling and erection

3.14.5 Testing Structural Sections for Strength

When there is evidence that the strength of precast structural-concrete sections does not meet specification requirements, cores drilled in hardened concrete for compressive strength determination shall be made in accordance with ASTM C 42 and as follows:

At least three representative cores shall be taken from the precast structural concrete sections that are considered potentially deficient.

Cores shall be tested saturated-surface-dry if the concrete they

represent will be wet at all times during the use of the completed structure.

Cores shall be tested air-dry if the concrete they represent will be dry at all times during the use of the completed structure.

Strength of cores will be considered satisfactory if their average is equal to or greater than the 28-day design compressive strength of 150 by 300 millimeter cylinders.

Core holes shall be solidly filled with patching mortar and finished to match the adjacent concrete surfaces.

If the results of the core tests are unsatisfactory or if core tests are impractical to obtain, static load tests shall be made of a structural section and will be evaluated in accordance with ACI 318, except that the superimposed test load shall be as specified for the proof-test method of strength design.

Sections that are found inadequate by the core tests or by the results of static load tests shall be replaced with sections that meet the specified requirements.

3.14.6 Inspection of Welding

Inspection of welding shall be performed in accordance with AWS D1.1, Section entitled, "Inspection," and as follows:

Liquid-penetration inspection of welds shall conform to ASTM E 165.

Magnetic-particle inspection of welds shall conform to ASTM E 709.

3.14.7 Structural Sections-in-Place

Sections-in-place will be rejected for any one of the following deficiencies:

Sections not conforming to the requirements for installation tolerances specified

Sections that are damaged during construction operations

Sections having exposed-to-view surface finishes that develop surface finish deficiencies specified

-- End of Section --

SECTION 03435

PRECAST CONCRETE DECK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(1991) Standard Specification for Burlap Cloth made from Jute or Kenaf

AMERICAN CONCRETE INSTITUTE (ACI)

ACI COMP 21	(1993) Elevated Slabs

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B18.22M	(1981; R 1990) Metric Plain Washers

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 150	(1995) Standard Specification for Portland Cement
ASTM C 171	(1992) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 33	(1993) Standard Specification for Concrete Aggregates
ASTM C 387	(1987) Standard Specification for Packaged, Dry Combined Materials for Mortar and Concrete
ASTM C 514	(1994) Standard Specification for Nails for the Application of Gypsumboard
ASTM D 312	(1995) Standard Specification for Asphalt Used in Roofing

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.4M	(1979; Rev 1989) Metric Hex Nuts
ASME B18.6.7M	(1985; R 1993) Metric Machine Screws

FEDERAL SPECIFICATIONS (FS)

FS TT-W-571	(Rev J) Wood Preservation: Treating Practices
FS UU-B-790	(Rev A; Int Am 1) Building Paper, Vegetable Fiber: Kraft, Waterproofed, Water Repellent and Fire Resistant

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings and Installation Drawings shall be submitted for the following items in accordance with paragraph entitled, "Drawings," of this section.

Precast Concrete Roof Slabs
Cast-in-Place Curb Units

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following, including all accessories including nails, threaded fasteners, and joint sealing compounds for the following items:

Precast Concrete Roof Slabs
Precast Curb Units
Packaged Concrete Materials
Absorption Cover
Moisture-Retaining Cover

SD-05 Design Data

Design analysis and calculations shall be in accordance with the paragraph entitled, "Precast Concrete Roof Slabs," of this section.

SD-06 Test Reports

Test Reports for the following shall be in accordance with paragraph entitled, "Precast Concrete Roof Slabs," of this section.

Nail Driving and Nail Pulling Tests
Strength Tests

SD-07 Certificates

Certificates of compliance shall be submitted for the following items showing conformance with referenced standards contained in this section.

Precast Concrete Roof Slabs
Precast Curb Units
Clips and Nails
Threaded Fasteners
Cement Grout Joint Sealing Materials
Bituminous Joint Sealing Materials

SD-08 Manufacturer's Instructions

Installation Instructions shall be submitted in accordance with paragraph entitled, "Precast Concrete Roof Slabs," of this section.

1.3 DRAWINGS

Fabrication Drawings for precast concrete deck units shall show dimensions, and size and number of openings to be cut.

Installation Drawings for Precast Concrete Roof Slabs and Cast-in-Place Curb Units shall include details and layouts indicating structural framing, location and length of concrete slabs corresponding with the sequence and procedure to be followed in placing and fastening roof slabs, and location and type of fasteners. Drawings shall also show details of curb units indicating location of cants, crickets, drainage saddles, and other sloping surfaces.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Precast Concrete Roof Slabs

Installation Instructions shall indicate the manufacturer's recommended installation methods and sequence.

Test Reports for precast concrete roof slabs regarding Nail Driving and Nail Pulling Tests and Strength Tests shall be in accordance with ACI COMP 21.

Roof slabs shall be flat or plank-shape and shall conform to ACI COMP 21, Type I or Type II, with the following modifications:

Flat slabs shall have wire mesh reinforcing in both top and bottom of the slab.

Slabs shall have nailing edges.

Flat slabs shall have tongue-and-groove edges on sides and square edges on ends, except that edges for exposed roof sides shall be square.

Flat slabs shall have tongue-and-groove edges on sides and ends, except that edges for exposed roof sides and ends shall be square.

Precast Concrete Roof Slabs shall be channel-shaped and shall conform to

ACI COMP 21, Type I or Type II, with the following modifications:

Channel slabs shall be reinforced with steel-wire mesh in the web section and one 12.7 millimeter steel reinforcing bar in each flange.

Slabs shall have nailing edges.

Roof slabs not suitable for nailing shall have wood inserts. Wood shall be pressure treated using a water-borne preservative and attain the minimum net retention of the solid preservative for lumber to be used in protected locations, in accordance with FS TT-W-571. Inserts shall be at least 25 by 75 millimeter in section, shall be placed in rows on 600 millimeter on center, and shall be parallel with the roof slope. Inserts shall be set flush with surfaces of slabs and rigidly secured in place with anchors designed and spaced to provide the holding strength required for subsequent nailing of roofing.

2.2 PRECAST CURB UNITS

Curb units shall be of same material and reinforced for same strength requirements as precast concrete roof slabs. Precast curb units shall be designed to fit securely in the anchorage provided by structural framing members.

2.3 CLIPS AND NAILS

Clips shall be zinc- or cadmium-plated steel strip not less than 0.76 millimeter thick (manufacturer's standard 0.76 millimeter), formed to fit the top flange of steel beam purlins or steel joists having steel angle top chords, and shall be of design recommended by the precast concrete roof slab manufacturer.

Nails shall be 32 millimeter long, galvanized steel, roofing nails conforming to ASTM C 514, Type II, Style 20.

2.4 THREADED FASTENERS

Fasteners shall consist of machine screws, nuts, and washers.

Machine screws shall be slotted, flathead, galvanized, carbon steel conforming to ASME B18.6.7M, Type I, Style 2s.

Nuts shall be hexagon, galvanized, carbon steel conforming to ASME B18.2.4M, Type II, Style 10.

Washers shall be round-type, galvanized, carbon steel, general-purpose assembly washers conforming to ANSI B18.22M, Type A, Grade I, Class A.

2.5 CEMENT GROUT JOINT SEALING MATERIALS

Portland cement shall conform to ASTM C 150, Type I.

Aggregate for cement grout shall be clean, sharp, uniformly graded, natural or manufactured sand conforming to ASTM C 33.

2.6 BITUMINOUS JOINT SEALING MATERIALS

Bituminous cement shall be steep asphalt for use in constructing built-up roof coverings conforming to ASTM D 312, Type IV.

Joint-sealing tape shall be composed of two layers of uncreped kraft paper united by steep asphalt with approximately 13 by 8 millimeter glass-fiber reinforcement embedded in the asphalt laminate. Tape shall meet requirements of FS UU-B-790, Type I, Grade C, Style 4, with the following modifications:

Width shall be 150 millimeter.

Dry tensile strength shall be not less than 35 pounds per inch width, both directions.

Dry tensile strength shall be not less than 6150 newton per meter width, both directions.

2.7 PACKAGED CONCRETE MATERIALS

Concrete materials shall be packaged, dry, combined materials for concrete conforming to ASTM C 387, lightweight concrete (using natural sand), and shall have the following properties:

PROPERT	VALUE
Compressive strength at 28 days	Not less than 20 Megapascal
Maximum aggregate size	9.5 millimeter
Slump	Not more than 75 millimeter
Total air content by volume	Not less than 6 nor more than 10 percent

2.8 WATER FOR MIXING CEMENT GROUT AND CONCRETE

Water shall be potable.

2.9 CONCRETE CURING MATERIALS

Absorption Cover for curing concrete shall be burlap cloth made from jute or kenaf, conforming to AASHTO M 182, Class 3.

Moisture-Retaining Cover for curing concrete shall be white waterproof paper or white opaque polyethylene sheet conforming to ASTM C 171.

PART 3 EXECUTION

3.1 GENERAL

Precast roof slabs and accessories shall be installed in accordance with the approved drawings and as specified.

3.2 PLACING ROOF SLABS

Supporting walls, purlins or joists, and other supporting members shall be in place before the placing of precast roof slabs is started. Precast roof slabs shall not be placed during, or while there is a threat of, rain or snow.

Each roof slab shall be placed on structural framework to bear on at least two structural framing members. End bearing shall be not less than 50 millimeter. Ends of roof slabs having square edges shall occur over a structural framing member. Where installation requires cutting roof slabs, cut ends shall occur over supports at the wall or at openings. Roof slabs shall be cut as specified.

Ends of roof slabs having tongue-and-groove edges on ends do not need to occur over a structural framing member; such end joints in adjacent rows shall be staggered.

Roof slabs in each row shall be aligned end to end, and adjacent rows shall be parallel. Alignment shall not depend on adjacent walls or structural framing members being accurately square.

3.3 FASTENING ROOF SLABS

Roof slabs shall be fastened to each structural framework member by means of clips and nails. Where possible, clips shall alternate in position so that each clip is facing in the opposite direction of the next clip. Clips shall be secured to roof slabs with one nail per clip and shall be fitted to the top flange or chord of structural framework member by slots in the clips formed for this purpose.

When the roof slope is greater than a 1 t0 4 ratio, roof slabs shall be fastened to supporting members by threaded fasteners in addition to the clips specified. Threaded Fasteners shall be not less than 13 millimeter in diameter. Fastener heads shall be countersunk. Fasteners shall be attached to the top flange or chord of supporting members by means of offset clips or other approved method. Threaded fasteners shall be spaced not less than one fastener per 3 square meter of roof area.

3.4 CUTTING AND FITTING

Roof slab cutting and fitting shall be performed as required for passage of other work projecting through or adjacent to the roof decking. Cuts shall be straight and clean through roof slabs and at 90 degrees to severed surfaces without breaking, spalling, or appreciable crumbling at edges.

3.5 SEALING JOINTS

After roof slabs have been placed and fastened, the top portion of joints shall be sealed as specified.

Joints at ridges and hips and tongue-and-groove joints shall be filled with cement grout. Cement grout shall consist of portland cement, sand, and water mixed to the consistency of thick cream. Grout shall be placed so as to be even with the top surface of roof slabs. Excess grout shall be removed and grout surface shall be given a smooth finish.

Other joints shall be sealed with specified bituminous joint sealing materials. Joint sealing tape shall be centered over the joint and embedded in hot bituminous cement applied at the rate of 6 to 8 kilogram per 10 square meter of joint sealing tape. End laps shall be not less than 100 millimeter. Excess bitumen shall be removed and the joint sealing tape surface shall be smooth and free of wrinkles.

3.6 INSTALLATION OF PRECAST CURB UNITS

Precast curb units shall be installed in accordance with approved drawings.

3.7 FILL FOR SLOPING SURFACES

Fill for curb cants and other sloping surfaces shall consist of the specified packaged concrete materials mixed with water.

Concrete shall be mixed either manually or by mechanical mixer, using the quantity of water indicated on packaged concrete materials. Water used in manual mixing shall be accurately measured. Mechanical mixer shall be equipped with a device to measure and control the amount of water used. Mixer drums, mixing boxes, tools, and other mixing equipment shall be kept clean and free from hardened lumps of concrete.

Concrete mixture shall be handled from the point of mixing and transferred to concrete conveying equipment and to locations of final deposit as rapidly as possible by methods that will prevent segregation and loss of concrete mix materials. Mechanical equipment for conveying concrete mixtures shall be of such size and design as to ensure a uniform, continuous flow of concrete mixture at the delivery end. Inner surfaces of concrete conveying equipment shall be maintained free of hardened concrete, debris, water, snow, ice, and other deleterious materials.

Concrete mixture shall be placed and screeded in a continuous operation until placing a section is completed. Finished surface shall be free of humps or hollows; sloped to drains; uniform, smooth, even plane; and of granular texture.

Immediately following the concrete finishing operation, concrete shall be kept continuously moist for at least 72 hours by covering the concrete surface with a specified absorptive cover for curing concrete kept continuously wet, by covering concrete surface with a specified moisture-retaining cover for curing concrete, or by a combination of both curing methods.

During the concrete curing period, concrete shall be protected from damage caused by rain or running water, by excessively cold or hot temperatures, and from damaging mechanical disturbances.

3.8 COLD-WEATHER LIMITATIONS

Sealing joints and concrete mixing or placing shall not be performed when the ambient temperature is 5 degrees C or below.

3.9 CLEANING AND PROTECTION

Upon completion of roof decking work, roof surfaces shall be swept clean of debris and other foreign matter and left ready to receive roofing.

Finished roof decking shall be protected from damage by weather and construction operations until the start of installation of roofing.

-- End of Section --

SECTION 04200

MASONRY UNIT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 306R	(1988) Cold Weather Concreting
ACI 530.1	(1992) Reference Manual: Specifications for Masonry Structures

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-05	(1995) Handbook, HVAC Applications (SI Edition)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 116	(1988) Standard Specification for Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
ASTM A 153/A 153M	(1995) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(1994; Rev A) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 575	(1989) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 615/A 615M	(1995; Rev A) Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 641M	(1991) Standard Specification for Zinc Coated (Galvanized) Carbon Steel Wire (Metric)
ASTM A 82	(1994) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement

ASTM C 140	(1995; Rev A1) Standard Methods of Sampling and Testing Concrete Masonry Units
ASTM C 216	(1995) Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 270	(1991) Standard Specification for Mortar for Unit Masonry
ASTM C 33	(1993) Standard Specification for Concrete Aggregates
ASTM C 331	(1994) Standard Specification for Lightweight Aggregates for Concrete Masonry Units
ASTM C 387	(1987) Standard Specification for Packaged, Dry Combined Materials for Mortar and Concrete
ASTM C 426	(1995) Standard Test Method for Drying Shrinkage of Concrete Block
ASTM C 55	(1995) Standard Specification for Concrete Building Brick
ASTM C 641	(1982; R 1991) Standard Test Method for Staining Materials in Lightweight Concrete Aggregates
ASTM C 67	(1994) Standard Test Methods of Sampling and Testing Brick and Structural Clay Tile
ASTM C 90	(1995) Standard Specification for Load-Bearing Concrete Masonry Units
ASTM C 91	(1995) Standard Specification for Masonry Cement
ASTM D 1056	(1992) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1752	(1984; R 1992) Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 2000	(1996) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 226	(1994) Standard Specification for

	Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM E 84	(1995) Standard Test Method for Surface Burning Characteristics of Building Materials

BRICK INSTITUTE OF AMERICA (BIA)

BIA Tech Note 20	(1990) Cleaning Brick Masonry

BUILDING OFFICIALS & CODE ADMINISTRATORS (BOCA)

BOCA-01	(1995) The BOCA International Plumbing Code

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-02	(1993) Architectural Sheet Metal Manua

1.2 MASONRY-WALL PANEL

Before starting installation of masonry work, the Contractor shall erect a sample masonry wall in an approved location for approval.

Exterior brick faced walls shall be open-cavity construction.

Sample wall shall be 1200 millimeter high by 1800 millimeter long, with a corner return of 600 millimeter. Wall shall consist of an exterior wythe of face bricks and an interior wythe of masonry units representative of the type required. Facing brick shall be from the same production run as the brick to be used for construction. Wall shall be constructed with anchors or ties, insulation, concealed flashing, weep slots, and cavity typical of the construction.

Sample wall shall show the full color range, texture, type of bond, joint treatment. Wall shall be pointed and cleaned.

Sample wall panel shall be approved before commencing work. Unsatisfactory sample walls shall be removed and additional sample walls erected until approval is obtained. Approved sample wall shall remain and shall be properly protected until completion and acceptance of the work.

Approved sample wall panel shall be the standard of quality for workmanship and materials. Masonry work shall be at least equal in quality to that of the sample wall panel.

Brick Sample Panels provided for facing brick shall be 1200 millimeter high by 1800 millimeter long, and shall show the size, texture, and complete range of colors.

Block Sample Panels provided shall be 1200 millimeter high by 1800 millimeter long, and shall show complete range of size, texture, and color.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Erection Drawings for the following items shall be furnished in accordance with the paragraph entitled, "Quality Control During Construction," of this section.

Reinforcing Steel in Lintels
Reinforcing Steel in Beams
Reinforcing Steel in Piers
Reinforcing Steel in Walls
Special Block
Special Brick
Special Masonry Shapes
Unit Sizes and Wall Patterns
Anchoring Methods

SD-04 Samples

Submit the following samples in sufficient numbers to show full range in color, texture, shapes and sizes (minimum of three each).

Block Masonry
Concrete Brick
Split Block

Joint Reinforcement - one piece of each type of reinforcement 450 millimeter long, showing at least two cross joints.

Brick Sample Panels shall be constructed according to the paragraph entitled, "Masonry-Wall Panel," of this section.

Block Sample Panels shall be constructed according to the paragraph entitled, "Masonry-Wall Panel," of this section.

Anchors and Ties - one of each type.

SD-06 Test Reports

Test reports shall be furnished for the following items in accordance with the paragraph entitled, "Sampling and Testing," of this section.

Brick Materials
Block Masonry Units
Prefaced Block Masonry Units
Mortar

SD-07 Certificates

Certificates shall be furnished stating that Brick Materials furnished have been produced from sources known from experience to be nonexpansive. Brick materials shall conform to applicable reference standards contained within this section.

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted for the following in accordance with paragraph entitled, "Protection of Materials and Work," of this section.

Special Block
Special Brick Shapes
Anchor Devices
Detergent Cleaning Compounds

1.4 SAMPLING AND TESTING

1.4.1 Testing Services

Laboratory testing and inspection service shall be provided as part of the work. Testing services shall be approved and shall include quality control sampling and testing of block masonry and mortar during construction.

1.4.2 Quality Control During Construction

Erection Drawings for Reinforcing Steel in Lintels, Reinforcing Steel in Beams, Reinforcing Steel in Piers, Reinforcing Steel in Walls, Special Block, Special Brick, Special Masonry Shapes, Unit Sizes and Wall Patterns and Anchoring Methods shall be furnished meeting all design specifications as required by referenced standards within this section. Methods of anchoring masonry work to other trades shall be shown.

Brick Materials, Block Masonry Units, Prefaced Block Masonry Units and Mortar shall be sampled and tested for quality control during construction as follows:

MATERIA	REQUIREMEN	TES	NUMBER/TESTS
Brick materials	Material, workmanship, finish, texture, color range, and size	ASTM C 216 and ASTM C 67	One test each 10,000 bricks or fraction thereof
	Efflorescence	ASTM C 67	One test each 10,000 bricks or fraction thereof
	Compressive strength	ASTM C 67	One test each 10,000 bricks or fraction thereof

MATERIA	REQUIREMEN	TES	NUMBER/TESTS
Block masonry units	Visual inspection	ASTM C 90	3 units each shipment
and prefaced block masonry units	Dimensional variation	As specified*	3 units each shipment
	Face shell and web thickness	ASTM C 90	3 units each shipment
	Compressive strength	ASTM C 140	One test each 10,000 blocks or fraction thereof
	Absorption	ASTM C 140	One test each 10,000 blocks or fraction thereof
MATERIA	REQUIREMEN	TES	NUMBER/TESTS
	Drying shrinkage	ASTM C 426	One set per project. Additional test when material or source changes
Mortar	Air entrainment	ASTM C 91	One test set for each 10,000 bricks or each 3,000 block masonry units
	Compressive strength	ASTM C 91	
	Water retention	ASTM C 91	

*Specified under paragraph entitled, "Quality."

1.4.3 Quality Control Reports

Testing service shall report test results in writing.

1.4.4 Evaluation of Test Results

Materials that do not conform to specifications shall be removed from the site.

When the tests indicate nonconformance, additional tests of units in the shipment shall be made. When 10 percent or more of the additional units tested also indicate nonconformance, the shipment will be rejected.

1.5 DELIVERY AND STORAGE

Masonry units shall be delivered, carefully stacked on pallets to avoid chipping, and stored to prevent soiling. Masonry units shall be kept dry until placed by storing in a weathertight structure or, when stored in the open, shall be covered with approved moisture-resistant covers, completely enclosing the material.

Facing brick shall be packed in substantial containers or banded on pallets for delivery and storage.

Cement materials shall be furnished in bags displaying the manufacturer's trademark and type. Material shall be dry and free of lumps when delivered. Upon delivery, material shall be stored in dry, weathertight, properly ventilated structures. Different brands or types of mortar shall be stored separately and shall not be intermixed.

Aggregates shall be stored and handled in such manner as to prevent intermixing with foreign matter.

Masonry reinforcement shall be protected from contact with the soil. Anchors and ties shall be stored in containers in a weathertight structure.

1.6 PROTECTION OF MATERIALS AND WORK

Contractor shall protect materials from damage when stored and during construction.

Top of masonry walls shall be kept dry by covering when work is not in progress. Covers shall be lapped at least 150 millimeter at joints and shall overhang the top of the wall at least 600 millimeter on each side. Exposed ends of walls shall be covered and the covers lapped at least 600 millimeter on each side of the wall.

After erection, finished masonry walls shall be protected from damage due to subsequent building operations. Damaged facing units shall be removed and replaced.

Manufacturer's Instructions for Special Block, Special Brick Shapes, Glass Block, Anchor Devices and Detergent Cleaning Compounds shall be submitted for each type of item previously listed, including manufacturer's recommended methods for handling, installation and cleaning of the products when applicable.

PART 2 PRODUCTS

2.1 BRICK

2.1.1 Concrete Brick and Split Block

Concrete brick and split block shall conform to ASTM C 55, Type I, Moisture-Controlled Units, and may, at the option of the Contractor, be used in lieu of common Clay or Shale Brick. Concrete brick and split block shall not be used for exterior facing unless such facing is indicated as

concrete brick or split block. Grade N units, Sand-Lime Brick, shall be used for exterior facing and for work below grade. Grade N-I units shall be used for masonry backup. Units shall be delivered to the job site in an air-dry condition, shall conform to grade and physical requirements, and shall be classified into group 1 and group 2, depending upon the linear-shrinkage potential as follows:

GRAD	CONCRETE DENSITY KILOGRAM PER CUBIC METR	MAXIMUM LINEAR SHRINKAGE, PERCENT (ASTM C 426) GROUP	GROUP 2
N-I	1922 or more	0.065	0.03
	less than 1922	0.065	0.04
S-I	1922 or more	0.065	0.04

2.2 CONCRETE MASONRY UNITS

2.2.1 Unit Types

Units shall be normal concrete, load-bearing, hollow and shall conform to ASTM C 90, Type I, for hollow units and solid units.

2.2.2 Grade

Units shall be Grade N-1, manufactured from aggregates conforming to ASTM C 33.

Units used in the work shall be Grade N-1, manufactured from aggregates conforming to ASTM C 331.

Units used in fire-rated wall assemblies shall have applicable UL classification.

Aggregate used in making masonry units, concrete brick, and split block shall conform to ASTM C 331. Grading of aggregates as stipulated in ASTM C 331, and testing of lightweight aggregates for drying shrinkage as stipulated in ASTM C 331, will not be required.

2.2.3 Quality

Units shall be modular in size and shall include special shapes as required for corners, sash, control joints, jambs, heads, lintels, headers, and bonding block.

Net overall dimensions: Width, height, or length shall differ by not more than 3.2 millimeter from the specified standard dimensions. Units shall be uniform as to dimension, with arrises and exposed vertical edges free from warp. Face surface shall be planar, with no variations greater than 1.0 millimeter.

Units shall have a face shell thickness conforming to ASTM C 90, and shall

be sufficient to adequately embed masonry reinforcement.

Units exposed to view shall be selected for smoothness and uniformity in appearance and texture and shall be free of imperfections, spalls and chips larger than 13 millimeter, chipped corners, cracks, or defects.

External corners and window and door openings throughout habitable spaces shall have 25 millimeter radius bullnose corners.

Lightweight aggregates used in the manufacture of masonry units shall not exceed "light stain" classification when tested by the visual classification method of ASTM C 641. Units shall be free of deleterious materials that stain plaster, bleed through paint, or corrode metal.

When determined by the chemical-analysis method, the iron stain deposited on the filter paper from a 200-gram sample shall not exceed 1.5 milligrams of ferric oxide.

2.3 MORTAR

2.3.1 Mortar Materials

Mortar materials and proportions shall conform to ASTM C 270, with the following amendments:

Portland cement shall be Type I or II.

2.3.2 Types of Mortar

Type S mortar, as defined in Table 2 of ASTM C 270, shall be used.

2.3.3 Premixed Packaged Color Mortar

Mortar for facing brick and limestone joints shall be custom colored, premixed, packaged, dry, combined materials conforming to ASTM C 91. Mortar color shall match existing mortar color. Pigments shall be non-reactive, and color fast to sunlight, alkalies and weak acids.

2.3.4 Packaged Materials for Mortar and Concrete

Packaged, dry, combined materials for mortar and concrete shall conform to ASTM C 387, with the following amendments:

Cement materials shall be limited to portland cement, Type I or II.

Maximum size of coarse aggregate shall not exceed 19 millimeter.

Mortar shall be limited to Type S, ASTM C 270.

2.3.5 Admixtures for Mortar

Calcium chloride admixtures, antifreeze liquids, and salts shall not be used.

2.4 MASONRY ANCHORS AND TIES

2.4.1 Zinc Coating

Zinc coating of anchors and ties shall conform to ASTM A 153/A 153M, Class B-1, B-2, or B-3 as required. Zinc coating of wire for joint reinforcing shall conform to ASTM A 116, Class 1.

2.4.2 Dovetail Slots, Anchors, and Ties

Dovetail slots shall be 1.0 millimeter galvanized steel, 25 millimeter wide by 16 millimeter face by 25 millimeter deep.

Dovetail anchors shall be 2.0 millimeter galvanized steel crimped brick anchors, 25 millimeter wide by length as required for masonry unit, turned up 6 millimeter at outer end.

Dovetail brick ties for cavity walls with 50 millimeter air space between brick facing and concrete shall be 3.9 millimeter hot-dip-galvanized steel wire ring.

Dovetail-type anchors for use with embedded slots or inserts shall be sheet steel not lighter than 1.6 millimeter thick, 25 millimeter wide, flat anchors for block masonry units and structural-clay-tile facing, and steel wire not lighter than 3.9 millimeter diameter for brick and split-block facing.

2.4.3 Individual and Adjustable Wall Ties

Individual cavity wall ties and adjustable wall ties shall be galvanized steel rods, 6 millimeter diameter, in rectangular shape.

2.4.4 Column Anchors, Beam Anchors, and Ties

Column anchors shall be galvanized steel rods, 6 millimeter in diameter, in triangular shape.

Beam anchors shall be steel bar shapes, formed from carbon steel conforming to ASTM A 575, 5 by 25 millimeter, shop painted, length as required by wall thickness.

Column clips for ties between masonry fireproofing and steel columns shall be 3.5 millimeter galvanized steel wire clips. Clips shall be installed 600 millimeter on center.

2.4.5 Reinforcing Steel

Reinforcing bars shall be deformed billet steel bars conforming to ASTM A 615/A 615M, Grade 40.

2.5 WALL REINFORCEMENT

2.5.1 Joint Reinforcement

Joint reinforcement shall be cold-drawn steel wire conforming to ASTM A 82. Deformations shall be in accordance with ASTM A 615/A 615M. Wire shall have a tensile strength of 550 Megapascal. Side rods shall be deformed steel wire. Cross ties or truss members may be plain or deformed steel wire.

Joint reinforcement shall be ladder or truss design, with side rods and cross ties flush-welded in a single plane.

Truss design reinforcement shall not be used in cavity wall construction.

Joint reinforcement shall be galvanized after fabrication with 0.24 kilogram per square meter zinc coating in accordance with ASTM A 641M, Class 3.

Joint reinforcement for corners and intersecting walls shall be fabricated as corner and T-shapes and shall be the same thickness in millimeter and finish wire.

Outside width of side rods shall be approximately 50 millimeter less than the nominal width of the wall. Cross ties or rods shall be spaced not more than 400 millimeter on center.

Joint reinforcement shall be furnished in flat sections in maximum practical length. Reinforcement furnished in rolls shall not be permitted.

Joint reinforcement for cavity walls may be of two-part construction, with ladder and eye section, and with pintle section.

2.5.2 Gage of Joint Reinforcement

Cross ties or cross rods shall be 3.9 millimeter, spaced not more than 400 millimeter on center, either plain or deformed steel wire.

2.6 CONTROL-JOINT MATERIAL

2.6.1 Flexible-Joint Filler Strip

Flexible-joint filler strips for use in control joints formed with sash blocks or built-in between block masonry and concrete or brick shall be molded from natural or synthetic rubbers conforming to ASTM D 2000, Grade 4AA730B13l14, and neoprene conforming to ASTM D 1056, Grade SCE 42. Strips shall be T-shaped, approximately 67 millimeter long by 37 millimeter wide, with 17 millimeter flanges. Strips shall have factory-applied adhesive on one face.

2.6.2 Bond Breaker Strips

Bond breaker strips for use in end webs of concrete masonry units at indicated control joints shall be 7.5 kilogram per 10 square meter asphalt roofing felt, conforming to ASTM D 226.

2.6.3 Steel and Masonry Isolation Liners

Isolation liners for use between masonry and structural steel frame shall be treated asphalt-impregnated cellular paper, 6 millimeter (single thickness) and 13 millimeter (double thickness). Material shall be applied in double thickness, except where wall dimensions do not permit.

2.6.4 Expansion-Joint Material

Material shall be preformed, nonextruding and nonbituminous, sponge-rubber joint filler, thickness as indicated, conforming to ASTM D 1752, Type I.

2.6.5 Joint Fillers and Sealants

Externally applied joint fillers, back-up materials for sealants, and joint sealants are specified in the Section 07920, "Sealants and Calkings."

Expansion joint fillers, metal expansion strip isolation liners, and bond breakers shall be built-in as the masonry wall is laid up.

2.7 FLASHING

2.7.1 Materials

Sheet-metal flashing shall be standard electrolytic tough-pitch copper, Sheet-metal flashing shall be 0.38 millimeter thick, corrosion-resisting chromium-nickel steel conforming to ASTM A 167, Type 304, No. 2D finish, annealed temper, as required for end use.

2.7.2 Location

Through-wall flashing of masonry walls with a cavity over 19 millimeter wide between inner and outer wythes, and the head and sill flashing of masonry wall openings with a cavity over 19 millimeter wide, shall consist of 0.38 millimeter thick corrosion-resistant steel flashing.

Termite barriers shall be 0.38 millimeter corrosion-resistant steel flashing.

Through-wall flashing below copings shall be 0.38 millimeter corrosion-resistant steel. Flashings shall be crimped, ribbed, or corrugated to provide an integral mortar key and shall be formed to preclude pockets of water.

2.7.3 Flashing Mastic

Mastic for lap joints of corrosion-resistant steel flashings shall be a non-skinning, non-sagging, flexible butyl sealant.

2.8 INSULATION MATERIALS

2.8.1 Board Insulation

Board insulation shall be rigid and not more than 38 to 50 millimeter thick to provide a coefficient-of-heat transmission of U-value through the completed wall construction air-to-air not in excess of 1.02 watt per

square meter per degree K (0.18 Btu hour/square foot/degree F) temperature difference when determined for winter conditions in accordance with recognized methods in agreement with ASHRAE-05. Computations to determine insulation thickness shall be approved. Flame-spread rating shall not exceed 25 when tested in conformance with ASTM E 84.

PART 3 EXECUTION

3.1 ERECTION OF MASONRY WALLS

3.1.1 Masonry Work

Masonry work shall be laid out before installation to ensure proper location of openings, joints, building returns, and offsets. Dimensions shall be adjusted only when approved and when required by variations in the masonry unit dimensions.

Masonry work shall be plumb and true to line, with courses level and spaced to the vertical dimensions indicated. Except where stack bond is indicated, each course shall break joint with the course below. Bond pattern shall be kept plumb throughout.

Masonry walls shall be bonded in each course and bonded or anchored to connecting work with metal reinforcement ties. Masonry header ties shall be used only where indicated.

In unexposed masonry, deviations from running bond in vertical joints shall be less than 50 millimeter.

Walls abutting or touching steel columns shall be anchored thereto with flexible steel anchors or ties spaced not more than 400 millimeter on center vertically. Nonbearing walls or partitions abutting exterior walls shall be anchored thereto with metal anchors or ties spaced not more than 400 millimeter on center vertically.

Masonry walls shall be isolated from the structural steel frame by means of asphalt-impregnated cellular-paper isolation liners. Ties and anchors shall be the flexible type to permit independent movement of each material.

Wall chases and recesses shall be plumb and smooth and shall have at least 200 millimeter of masonry between the edge of chase and jamb openings.

Size of any two adjacent units shall be within permitted tolerances so that the difference between the vertical faces shall not exceed 3.2 millimeter for block masonry or 2.0 millimeter for brick masonry when used in exposed-to-view or painted walls.

Units in exposed-to-view locations or painted walls shall be free from chipped edges or other imperfections detracting from the appearance of the finished work.

Any masonry unit that is moved or disturbed after laying shall be removed, cleaned thoroughly, and relaid in fresh mortar.

Unfinished masonry work shall be racked or stepped back. Toothing will not be permitted without prior approval.

Units having 25 millimeter minimum radius bullnose shall be provided throughout interior spaces at vertical external corners of interior block-masonry-unit walls and partitions that will be exposed to view or painted, except at door jambs, window jambs, and at external corners in attics, crawl spaces, and closets.

3.1.2 Height of Interior Partitions

Interior masonry walls and partitions shall be carried to the full height of the story to the bottom of the floor above or roof deck, and the joint filled with mortar.

3.1.3 Built-In Work

Electrical piping and equipment, expansion strips, wall flashings, anchors, ties, wall plugs, reglets, flashing receivers, and accessories shall be built in as the masonry work progresses. Spaces around metal door frames shall be solidly filled with mortar. Built-ins shall be solidly bedded in mortar or grout.

3.1.4 Fire-Rated Walls and Partitions

Construction of fire-rated masonry walls shall be in accordance with BOCA-01.

3.1.5 Cold-Weather Provisions

Unless proper precautions are taken, masonry shall be erected only when the ambient temperature is at least 5 degrees C and rising. Approved methods shall be provided to protect the work from freezing. Use of admixtures or antifreeze agents to lower the freezing point of mortars is prohibited.

Along with the following requirements, approved methods shall comply with the cold weather construction ACI 306R and ACI 530.1.

All materials, including brick, block and mortar ingredients shall be maintained at a minimum temperature of 5 degrees Cprior to and during erection, and for a period of 24 hours after erection of the masonry wall.

Temperature of materials shall be measured as required. Mortar ingredients shall be heated when required to produce mortar temperatures between 4 and 38 degrees C. Sand shall be heated when required to 21 to 27 degrees C. Water shall be heated when required to 32 to 38 degrees C. Masonry units shall be kept dry, and heated when required to 4 to 10 degrees C.

Protective enclosures and supplemental heat shall be provided when required to provide a minimum ambient air temperature of 4 degrees C during erection and for a period of 24 hours after erection of the masonry wall.

3.1.6 Mortar

Mortar shall be mixed in accordance with ASTM C 270.

Hand mixing, when permitted, shall be performed in a tight mortar mixing box. Mixing time shall be not less than that required to reproduce results obtained by machine mixing after the required amount of water has been added.

Mortar shall be used and placed in final position within 1-1/2 hours after mixing. Mortar not used within the specified time limit shall be discarded.

3.1.7 Joints

Except for joints to be calked or raked, all exposed joints shall be tooled evenly to a dense concave profile, with surface and edges compacted and sealed. Tooling shall be performed after joints are "thumbprint" hard.

Exterior joints below grade shall be trowel pointed. Concealed joints and walls to receive plaster or plastic wall covering shall have flush mortar joints.

Joints to be tuck pointed shall be raked out to a depth of 13 millimeter. Immediately before pointing, the joint shall be saturated with clean water and filled solidly with mortar.

Joint thickness shall average 10 millimeter or where required to match adjacent coursing in an existing structure. Joints shall have a minimum thickness of 6 millimeter and a maximum thickness of 13 millimeter. Where approved, joint thickness shall be gradually increased or decreased to meet indicated wall dimensions and to avoid cutting, squeezing, or opening of joints at ends of runs or lifts.

Exterior and interior joints between metal frames and masonry, wood frames and masonry, joints between mechanical equipment and masonry, and between other joints indicated shall be raked out to the required depth and left ready for sealant.

3.1.8 Control Joints

A movement joint shall be provided through the outer wythe of a cavity wall on each side of an external corner when the wall extending into it is 15.2 meter or more in length and at intersecting cavity wall junctions, pilasters, and concealed and exposed columns.

Expansion joints in brick masonry shall be complete with joint fillers and left ready for sealant.

Control joints in straight wall runs of block masonry shall be constructed by using standard stretcher units to provide a continuous unbroken vertical joint, 13 millimeter wide, through the entire thickness of the wall. One side of the joint shall be lined with roofing felt and a flexible joint filler installed where indicated. Core space shall be completely filled with mortar and the joint raked clean and ready for sealant.

Control joints in block masonry at intersecting partitions, between block masonry and reinforced concrete, and between block masonry and brick

masonry shall be constructed with sash block and flexible joint filler.

To secure freedom of movement at control joints, slip-planes of building paper or other approved material shall be placed in mortar joints between the portion of prefabricated or block masonry lintels required for bearing and supporting jamb sections that form a part of control joint and between the adjacent end face of such lintels and adjoining masonry units. Control jointing carried above such openings shall be located in the same vertical plane as the slip joint formed at the end of the lintel.

3.1.9 Weep Holes

Weep holes shall be provided at 600 millimeter intervals. Holes shall be joint width and brick height.

Weep holes shall be provided at lintels, at flashed wall openings, at top of wall, and at foundations in cavity-wall construction.

Removable weep hole fillers shall be preformed sponge-rubber joint filler material, conforming to ASTM D 1752, Type I. Filler shall be full vertical joint height, 10 millimeter thick, by 200 millimeter long.

3.1.10 Flashing

Flashing shall be provided beneath copings, over wall openings, at spandrels, under sills, at building expansion joints, for termite barriers, and in locations where flashing is built into the masonry.

Flashing of wall openings and through-wall flashings shall conform to SMACNA-02. Flashing shall extend 100 millimeter or more beyond edge of lintels and sills and turn up edge on sides and back to form pan and to direct moisture to exterior. Flashing shall terminate 13 millimeter from the face of the wall.

Joints in concealed flashing shall be made by interlocking or laps. Lap joints shall be sealed with mastic. Spaces around dowels and openings in flashings shall be sealed with mastic before covering the flashing with mortar.

Building expansion-joint flashing shall be formed as shown in SMACNA-02. Unit lengths shall be not less than 2438 millimeter sections and shall be continuous from top of wall to bottom of footing. Joints shall be lapped 100 millimeter in the direction of water flow. Joints below grade shall be soldered or welded. A folded edge on each flange shall be provided and the flange shall be built 100 millimeter into masonry.

Continuous concealed flashing shall be provided in cavity walls and at the bottom of the cavity.

3.1.11 Facing Brick

Facing brick shall be laid in running bond, with the better face of the brick exposed. Face and ends, corners, and reveals shall be uniformly straight and true, free from chips and spalls, and uniform in color and

texture.

Where indicated as stack-bond pattern, facing brick shall be selected for uniform size, color, and texture and shall be laid with plumb and uniform vertical joints.

Face brick shall be laid out and adjusted to each wall space. No course shall finish at external corners or at jambs with less than a full header. Header shall center on the stretcher or on the joints of adjoining courses.

Closers shall be avoided where possible. When necessary to maintain bond, closers shall be placed symmetrical with the center line of openings. No closer shall be less than 50 millimeter wide.

Brick masonry units shall be wetted prior to laying. When being laid, units shall have sufficient suction to hold the mortar and to absorb excess moisture but shall leave mortar plastic and workable.

Bricks shall be laid with bed and vertical joints evenly and solidly filled with mortar. Mortar beds shall be spread smooth and the ends of the brick shall be buttered with sufficient mortar to completely fill the end joint when the brick is in place.

Vertical longitudinal joints in all exterior walls, except cavity walls, shall be completely filled by pargeting, either the face of the masonry backup, or back of the facing, or by pouring the vertical joint full of grout, or by shoving to obtain a wall entirely free from voids or open joints.

Interior face-brick walls shall be laid as specified, with full bed and vertical mortar joints; the vertical longitudinal joint between inner and outer wythes need not be pargeted or filled.

3.1.12 Installation of Joint Reinforcement

Joint reinforcement shall be installed in bed joints at 400 millimeter vertical spacing starting at 400 millimeterabove the first course. Reinforcement shall also be in the first and second bed joints, 200 millimeter apart, immediately above lintels and below sills of openings. Reinforcement in the second bed joint above and below openings shall extend 600 millimeter beyond jambs. All other reinforcement shall be continuous except that it shall not pass through vertical masonry control or expansion joints. Side rods shall be lapped 150 millimeter at splices. Reinforcement shall be placed to ensure a minimum of 16 millimetermortar cover on the exterior face of the wall and 13 millimeter mortar cover on interior faces.

3.1.13 Installation of Masonry Anchors and Ties

3.1.13.1 Individual and Adjustable Wall Ties

Individual and adjustable wall ties shall be installed 600 millimeter on horizontal center and 400 millimeter on vertical center.

3.1.13.2 Column and Beam Anchors and Ties

Anchors shall be installed a maximum of 1200 millimeter on center.

Column clips shall be installed 600 millimeter on center.

3.1.14 Block Masonry

Block masonry units shall be handled carefully to protect edges and exposed surfaces from damage.

Block masonry units shall not be dampened or wet before laying or during the process of laying in the wall.

Block masonry units shall be laid in running bond except in walls where stack bond or special shapes are indicated. Walls, corners, and reveals shall be laid plumb, true to line, and leveled in accurately spaced courses. Each course shall be bonded and interlocked at corners and intersections. Vertical joints shall be broken at 75 millimeter, minimum.

Intersecting nonbearing block masonry walls shall be tied to other masonry walls by strips of galvanized metal lath or 6.3 millimetermesh galvanized hardware cloth placed across the joint between the two walls in alternate courses. When walls are exposed-to-view finished walls, a vertical control joint shall be constructed where the two walls meet. Control joint shall be raked out to a depth of 19 millimeter and left ready for sealant.

Intersecting bearing walls shall not be tied together in masonry bond except at corners. One wall shall terminate at the face of the other wall with a control joint at that point. Walls shall be tied together with a steel tie bar, 7 by 32 by 711 millimeter long, with 50 millimeter bends at each end, spaced 800 millimeter on vertical center. Bars shall be embedded at each end in mortar-filled cores. When walls are exposed at finished walls or walls subject to weather, the control joint shall be raked out to a depth of 19 millimeter and left ready for sealant.

Block masonry units shall be laid in a full, mortar bed, full thickness of the face shell, except that full mortar bedding shall be provided under the first or starter course of units laid on footings and solid foundation walls and in all courses of piers, columns, and pilasters. Mortar shall be applied over the full thickness and height of the face shell to form the vertical mortar joint.

Horizontal and vertical joints of solid units and concrete building brick shall be filled solid. Mortar shall be spread over the full horizontal and end areas of the unit.

Joint thickness and tooling shall be as specified in paragraph entitled, "Joints."

Block masonry walls shall be reinforced with continuous wire joint reinforcement. Building brick, solid block masonry, or concrete brick shall be provided at the top of walls and under joists, beams, and concentrated loads, unless a bond beam or other structural member is

indicated. Top course of block masonry units shall be filled with mortar or concrete. A layer of metal lath shall be used in the joint below to positively hold the mortar when rodded into the core space.

Where block masonry is the finished wall surface, bearing for metal joists, structural steel, or concrete shall be three courses of solid concrete brick or block masonry the same color and texture as adjacent block masonry.

3.1.15 Bond Beams

Units filled with concrete of the indicated design shall be provided. Concrete fill shall have a minimum compressive strength of 21 Megapascal at 28 days. Bond beam reinforcement shall be placed as necessary.

3.1.16 Cavity Walls

Inner and outer wythes of cavity walls shall be completely separated by a continuous air space not less than 50 millimeter nor more than 100 millimeter wide, except for masonry returns indicated at jambs of openings. Two wythes shall be securely tied together by continuous wire reinforcement spaced not to exceed 400 millimeter apart vertically. Additional cavity wall ties shall be placed within 200 millimeter of the jambs of all openings and not more than 600 millimeter apart vertically except where the wythes are bonded together with masonry returns at jambs. Inner and outer wythes of cavity walls shall be provided with control joints and joint reinforcement. At control joints, the alignment of both wythes shall be maintained by ties 400 millimeter on center vertically along each side of the control joint. Parge the outerface of the block backing with mortar 10 millimeter thick, troweled to a smooth, dense surface. Air space between the facing and backing wythes shall be kept clear and clean of mortar droppings by temporary wood strips laid on the wall ties and carefully lifted out before the next row of ties or anchors is placed.

Weep holes shall be provided 600 millimeter on center in mortar joints of the exterior wythe along the bottom of the cavity over foundations, bond beams, and other water stops in the wall, above grade line. Weep holes shall also be provided near the top of the cavity.

Weep holes and flashing for cavity walls shall be in accordance with paragraphs entitled, "Weep Holes" and "Flashing."

3.1.17 Cutting, Fitting, and Patching

Cutting and fitting masonry as required to meet building dimensions or to accommodate mechanical and electrical piping and equipment shall be performed by masonry mechanics.

Work shall be performed such that edges are unbroken and cut plumb and true.

Patching shall be performed such that original adjacent surfaces shall be matched in materials and workmanship.

3.1.18 Stone Coping and Sill Installations

Stone coping and sills shall be laid in full mortar bed with thru-wall flashing placed in the center of mortar bed.

Dowels shall attach ends of each coping unit.

Joints shall be "soft" with backer rod and sealant at each joint in coping.

Stone sill shall have solid mortar joints.

3.2 INSULATING OF EXTERIOR MASONRY WALLS

3.2.1 Insulation

Exterior cavity walls shall be insulated by installing rigid board-type insulation in the airspace against the inner wythe.

Insulation shall be completely brought up to the elevations indicated for the underside of door and window sills, bond beams, lintels, through-wall flashing, and similar interruptions through the cavity before installing these items.

3.2.2 Rigid-Board Insulation

Rigid-board insulation shall be applied directly to the masonry with adhesive. Impaling of insulation on cavity-wall ties or anchors will not be permitted. Insulation shall be applied in parallel courses with joints breaking midway over the course below, shall be applied in moderate contact with adjoining units without forcing, and shall be cut to fit neatly against adjoining surfaces.

3.3 POINTING AND CLEANING

Masonry walls shall be dry brushed at the end of each day's work.

Upon completion of the work, holes and defects in exposed mortar joints shall be raked as required, filled with fresh mortar, and tooled.

After mortar is set and cured, mortar particles shall be removed with wood paddles, brushes, and scrapers before wetting the wall.

Brick masonry walls shall be cleaned in accordance with BIA Tech Note 20.

Detergent cleaning compound shall be type formulated to reduce metallic stains. Cleaning compounds shall be used in accordance with the manufacturer's instructions.

Glazed brick limestone units and prefaced masonry units shall be carefully wiped clean with a soft cloth immediately after laying. At completion of work, surfaces shall be given a final cleaning with water and a cleaning compound applied with a soft sponge or brush as recommended by the manufacturer.

Block masonry shall be cleaned with stiff brushes and clear water. Acid

shall not be used in the cleaning process. Joints shall be rubbed with a carborundum stone to remove burrs and rough edges.

Sandblasting techniques for cleaning will be permitted only when approved.

-- End of Section --

SECTION 04220

CONCRETE MASONRY UNITS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 615/A 615M	(1995; Rev A) Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 82	(1994) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C 144	(1993) Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	(1995) Standard Specification for Portland Cement
ASTM C 207	(1991; R 1992) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C 270	(1991) Standard Specification for Mortar for Unit Masonry
ASTM C 404	(1994) Standard Specification for Aggregates for Masonry Grouts
ASTM C 476	(1991) Standard Specification for Grout Masonry
ASTM C 90	(1995) Standard Specification for Load-Bearing Concrete Masonry Units

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with reference standards contained within this section.

Concrete Masonry Units
Mortar
Sand
Pea Gravel
Lime
Grout
Reinforcement
Precast Lintels

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS

Concrete masonry units shall include all special shapes and sizes required to complete the work. Concrete masonry units shall conform to ASTM C 90, Type I, Grade N, normal weight.

2.2 MORTAR

Mortar shall be mixed in proportions as specified in ASTM C 270.

2.3 GROUT

Grout shall conform to ASTM C 476. Compressive strength at 28 days shall be 13790 kilopascal minimum.

2.4 PORTLAND CEMENT

Portland cement shall conform to ASTM C 150, Type II.

2.5 AGGREGATE

Sand for mortar shall conform to ASTM C 144. Pea Gravel for grout shall conform to ASTM C 404.

2.6 LIME

Hydrated lime shall conform to ASTM C 207, Type S.

2.7 WATER

Water shall be potable.

2.8 REINFORCEMENT

2.8.1 Joint Reinforcement

Joint reinforcement shall be fabricated from steel wire conforming to ASTM A 82. Longitudinal wires shall be not lighter than 2.8 millimeter (0.1483-inch) nominal diameter. Cross wires shall be not lighter than 2 millimeter (0.1055-inch) nominal diameter. Joint reinforcement shall be furnished in flat sections.

2.8.2 Reinforcing Steel Bars

Reinforcing steel bars shall conform to ASTM A 615/A 615M, Grade 60, deformed, free of loose rust and scale.

PART 3 EXECUTION

3.1 MORTAR

Mortar shall be thoroughly machine mixed for a period of 3 to 5 minutes after all materials are in a mixer designed for this purpose.

Mortar shall be used and placed in final position within 1-1/2 hours after mixing when air temperature is less than 27 degrees C. No mortar shall be placed when air temperature is 4 degrees C and falling.

Mortars that have stiffened within the allowable time may not be retempered to restore workability by adding water as frequently as needed.

3.2 LAYING CONCRETE BLOCK

Block shall be laid dry and cut accurately to fit other construction. All cutting of units shall be done with power saws with abrasive blades.

Block work shall be laid plumb, level, and true to line and grade.

Running bond pattern shall be used.

Mortar joints shall be 10 millimeter thick. Full mortar coverage of bed joints shall be provided at shells.

3.3 GROUT

Grout shall be thoroughly machine mixed for a period of at least 5 minutes after all materials are in a mixer designed for this purpose.

Cells shall be grouted solid in maximum 1200 millimeterlifts. The pour shall be stopped 40 millimeter below the top of the block. A cleanout shall be provided at the bottom of cells where the pour of grout is in excess of 1200 millimeter. Continuous unobstructed cell area of not less than 50 by 75 millimeter shall be maintained. Anchors, bolts, inserts, etc., shall be solidly grouted in place. Where required, filling of cells that are to remain open shall be prevented by means of a metal lath or a shield and by mortaring cross-webs where adjacent cells or cavities are to be grouted.

Grouting shall be performed in one continuous operation.

3.4 REINFORCEMENT

Reinforcement shall be placed straight, centered in cells, and tied at laps and intersection of bars. Vertical steel shall be braced at 192 bar diameters maximum spacing and at top and bottom to ensure alignment.

Dowels shall be provided of the same size for each vertical and horizontal

bar required on the anchorage.

Steel shall be encased in grout with at least 13 millimeter between any bar and masonry.

At least one 5 millimeter (No. 4) bar shall be provided at each vertical side of openings exceeding 600 millimeter.

3.5 JOINT REINFORCEMENT

Control joints shall be constructed with continuous lengths of joint reinforcing through expansion relief cuts. Reinforcement shall be placed to ensure a minimum of 16 millimeter mortar cover on the exterior face of the wall and 13 millimeter mortar cover on interior faces.

3.6 JOINTING AND POINTING EXPOSED MASONRY

Joints shall be pointed and tooled before mortar is set and brushed with a fiber brush after tooling. Exterior joints shall be concave; interior joints shall have flush packed joints.

3.7 EMBEDDED ITEMS

Embedded items shall be set in accordance with the construction drawings. Anchors shall be surrounded by grout.

3.8 METAL DOOR JAMBS

Metal door jambs in masonry walls shall have frames filled solidly with mortar as the work progresses.

3.9 CURING, PROTECTION, AND CLEANING

Curing by saturation with water will not be permitted. Exposed exterior surfaces shall be protected from sun and heat with light fog spray for a period of 3 days.

Exposed masonry surfaces shall be protected from mortar droppings. Sills, ledges, and projecting courses shall be covered with water-repellent covering.

Grout or mortar stains shall be cleaned by removing immediately with clear water, stiff fiber brushes, or wooden scrapers, and rinsed before final acceptance.

-- End of Section --

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC M013	(1983; 8th Ed) Detailing for Steel Construction
AISC M014	(1984; 1st Ed) Engineering for Steel Construction a Source Book on Connections
AISC M016	(1989; 9th Ed) Manual of Steel Construction, Allowable Stress Design
AISC M017	(1992) Manual of Steel Construction, Volume II, Connections
AISC S303	(1992) Code of Standard Practice for Buildings and Bridges

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 153/A 153M	(1995) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 307	(1994) Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325M	(1993) Standard Specification for High Strength Bolts for Structural Steel Joints (Metric)
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 500	(1993) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 514/A 514M	(1994; Rev A) High-Yield-Strength, Quenched and Tempered Alloy Steel Plate,

	Suitable for Welding
ASTM A 53	(1996) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM C 1107	(1991; Rev A) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
ASTM C 150	(1995) Standard Specification for Portland Cement
ASTM C 404	(1994) Standard Specification for Aggregates for Masonry Grouts
ASTM C 658	(1993) Chemical-Resistant Resin Grouts for Bricks or Tile
ASTM E 164	(1994; Rev A) Ultrasonic Contact Examination of Weldments

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1	(1994) Structural Welding Code - Steel

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 25	(1991) Paint Specification No. 25, Red Iron Oxide, Zinc Chromate, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC SP 10	(1994) Joint Surface Preparation, Near-White Blast Cleaning (Nace No. 2)

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings for the following items shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

Structural Steel
Accessories

Installation Drawings shall be submitted in accordance with

paragraph entitled, "Drawings," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Bolts and Nuts
Washers
Primer
Welding Electrodes and Rods
Shrink-Resistant Grout
Epoxy-Resin Grout
Cement Grout

SD-07 Certificates

Welding Procedures and certifictes for Welder Qualifications shall be submitted in accordance with paragraph entitled, "Qualifications for Welding Work," of this section.

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Structural Steel
Washers
Bolts and Nuts
Primer
Welding Electrodes and Rods
Shrink-Resistant Grout
Epoxy-Resin Grout
Cement Grout

1.3 QUALIFICATIONS FOR STRUCTURAL STEEL WORK

Structural steel fabrication and erection shall be performed by an organization experienced in structural steel work of equivalent magnitude.

Structural steel fabricator shall be certified by AISC to perform structural steel work at level I.

1.4 QUALIFICATIONS FOR WELDING WORK

Welding Procedures shall be in accordance with AWS D1.1.

Certificates for Welder Qualifications shall include the type of welding and positions each operator is qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests.

Welders shall be certified to have been qualified by tests in accordance with AWS D1.1 or under an equivalent approved qualification test.

In addition, tests shall be performed on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, an immediate retest of two test welds shall be made and each test weld shall pass. Failure in the immediate retest will require that the welder be retested after further practice or training and that a complete new set of test welds be made.

1.5 FABRICATION REQUIREMENTS

AISC M016 and AISC S303 shall govern all work.

Design of members and connections for any portion of the structure not indicated shall be completed by the fabricator and indicated on detail drawings.

Substitution of sections or modification of details, or both, and the reasons for the action shall be submitted with the detail drawings for approval.

Structural steel shall be fabricated and assembled in the shop to the greatest extent possible. Parts not assembled in the shop shall be secured by bolts for shipment.

Shop splices of members between field splices will be permitted only where indicated. Splices not indicated must be approved. Field splices in compound joints will not be permitted.

1.5.1 Tolerances

Tolerances in fabrication and erection shall be in accordance with AISC S303.

1.5.2 Connections

One-sided or other types of eccentric connections will not be permitted, unless indicated in detail and approved.

Shop connections shall be welded.

Field connections shall be bolted, except where welded connections are indicated, as follows:

High-strength threaded fasteners shall be used for bolted connections, except where otherwise specified.

Low carbon steel threaded fasteners may be used only for bolted connections of secondary members to primary members (such as, purlins, girts, and other framing members carrying only nominal stresses) and for temporary bracing to facilitate erection.

High-strength bolting shall conform to AISC M017 and shall be friction-type connections as modified by the bonding and grounding requirements.

Holes shall be cut, drilled, or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Holes in base or

bearing plates shall be drilled. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling or reaming operation shall be removed with a tool making a 1.6 millimeter bevel.

Bolts shall be inserted into holes without damaging thread. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, beveled washers shall be provided to give full bearing to the head or nut.

Low carbon steel threaded fasteners shall be of length that will extend through, but not more than 7 millimeter beyond, the nuts. Bolt heads and nuts shall be drawn tight against the work with a suitable wrench not less than 380 millimeter long. Bolt heads shall be tapped with a hammer while the nut is being tightened. Nuts shall be locked after tightening. Where self-locking nuts are not furnished, bolt threads shall be upset.

1.5.3 Column Bases and Bearing Plates

Column bases shall be provided under columns.

Bearing plates shall be provided under beams, resting on footings, piers, or masonry walls.

Column bases shall be milled and attached to columns as indicated.

1.6 BONDING AND GROUNDING

Where indicated, bonding of joints and connections shall be accomplished as specified in Section 16065, "Secondary Grounding." In friction-type joints, faying surfaces shall be clean and abrasive-blasted to near-white metal. Faying surfaces shall be coated to avoid crevice corrosion.

1.7 DRAINAGE HOLES

Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be 13 millimeter and location shall be shown on the detail drawings. Hole size and location shall not affect structural integrity.

1.8 DRAWINGS

Fabrication Drawings for Structural Steel and Accessoriesshall be in accordance with AISC M016, AISC M013 and AISC M014. Drawings shall show standard welding symbols in accordance with AWS A2.4.

Installation Drawings for structural steel units shall indicate the members and connection areas not to be painted, sequence of erection, and detailed sequence of welding including each welding procedure. Shoring and temporary bracing shall be designed and sealed by a registered professional engineer and provided for record purposes.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

2.1.1 Carbon Grade Steel

Carbon grade steel shall conform to ASTM A 36/A 36M.

2.1.2 High-Strength Alloy Steel Plate

High-strength alloy steel plate shall conform to ASTM A 514/A 514M.

2.2 STRUCTURAL TUBING

Structural tubing shall conform to ASTM A 500, Grade B.

2.3 STEEL PIPE

Steel pipe shall conform to ASTM A 53, Grade B.

2.4 HIGH-STRENGTH THREADED FASTENERS

High-strength Washers, Bolts and Nuts shall conform to ASTM A 325M. Galvanize according to ASTM A 153/A 153M for galvanized members.

2.5 ANCHOR BOLTS

Anchor Washers, Bolts and Nuts shall be stainless steel Type 304 ASTM A 307.

2.6 WELDING MATERIALS

Welding materials, to include Welding Electrodes and Rods, shall conform to AWS D1.1.

2.7 PROTECTIVE COATING

Steelwork shall be shop primed with red oxide Primer in accordance with SSPC Paint 25.

Steelwork shall be shop primed as indicated in accordance with Section 09970, "Coatings for Steel," except surfaces of steel to be encased in concrete, surfaces to be welded, contact surfaces to be high-strength bolt connected, and surfaces of crane rails.

2.8 BEDDING MATERIALS

2.8.1 Shrink-Resistant Grout

Shrinkage-resistant grout shall be a premixed and packaged ferrous aggregate grouting compound conforming to ASTM C 1107.

2.8.2 Cement Grout

Portland cement grout shall conform to ASTM C 150, Type I.

Aggregate for cement grout shall be clean, sharp, uniformly graded natural

abrasive conforming to ASTM C 404, Size No. 2.

2.8.3 Mixing Water

Water shall be potable.

2.8.4 Epoxy-Resin Grout

Epoxy-Resin grout shall conform to ASTM C 658.

PART 3 EXECUTION

3.1 GENERAL

Erection of structural steel shall be in accordance with the AISC S303, with modifications and additional requirements as specified.

3.2 ERECTING EQUIPMENT

Equipment shall be suitable and safe for workers. Falsework shall be maintained in a safe and stable condition until the steel structure is fully self-supporting.

3.3 ANCHOR BOLTS

Bolts and other connections between structural steel and foundations or existing structural steel shall be performed as part of the work.

Bolts and anchors shall be accurately located and built into connecting work and shall be preset by the use of templates or other methods as may be required to locate bolts and other connections.

3.4 SETTING COLUMN BASES AND BEARING PLATES

Loose and attached column base plates and bearing plates for beams and similar structural members shall be aligned with wedges or shims and shall be bedded with damp-pack bedding. Installation of base and bearing plates shall be as follows:

Concrete and masonry bearing surfaces shall be cleaned free of laitance, dirt, oil, grease, and other foreign material. Concrete surfaces shall be roughened, but not enough to interfere with placing bedding. Bottom surface of base or bearing plates shall be cleaned free of dirt, oil, grease, and other foreign materials.

Space between top of bearing surface and bottom of base or bearing plate shall be approximately 1/24 of the width of the base or bearing plate but not less than 13 millimeter for base or bearing plates that are less than 300 millimeter wide. Base or bearing plate shall be supported and aligned on steel wedges or shims.

Bedding shall be a mix composed of the specified shrinkage-resistant grout and enough water to provide a flowable mixture without segregation or bleeding.

Forms shall be provided to retain bedding until sufficiently hard to support itself.

3.5 FIELD ASSEMBLY

Structural steel frames shall be assembled to lines and elevations indicated. Various members forming parts of a completed frame or structure after being assembled shall be aligned and adjusted before being fastened. Fastening of splices of compression members shall be done after abutting surfaces have been brought completely into contact. Bearing surfaces and surfaces that will be in permanent contact shall be cleaned before members are assembled.

Splices will be permitted only where indicated. Erection bolts used in welded construction shall be removed and the holes shall be filled with plug welds.

Bracing, adequacy of temporary connections and supports, alignment, and removal of paint on surfaces adjacent to field welds shall be as specified in AISC S303.

Welding for re-drilling will not be permitted. Holes shall not be enlarged more than 1.6 millimeter larger than the specified hole size without approval of the Contracting Officer.

3.6 GAS CUTTING

Use of a gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.7 TOUCHUP PAINTING

After erection of structural steel, the Contractor shall touch up bolt heads and nuts, field welds, and abrasions in the shop coat. Touchup and repair shall be accomplished as soon as possible after the damage or installation has occurred.

Surfaces shall be degreased, as required, prior to subsequent surface preparation. Degreasing shall be accomplished by steam cleaning or washing with a solution of trisodium phosphate in water, followed by a fresh water rinse. Cuts, welds, and large damaged areas shall be abrasive blasted to near white SSPC SP 10. Blasting abrasive shall be per linear 25 millimeter. When abrasive blasting is prohibited or impractical, mechanical cleaning by needle gun or abrasive disks or wheels shall be used. Minor abrasions and scars where extensive rusting has not occurred shall be rendered clean and dry and touched up without further surface preparation. Repair coating shall be applied within 6 hours after surface preparation or before rusting or re-contamination occurs. Touchup and repair material shall be the same inorganic zinc coating as applied in the shop. Application shall be by airless or conventional spray. Compressed air used for blasting and coating application shall be free of moisture and oil. Manufacturer's

recommended procedures shall be followed.

3.8 INSPECTION AND ACCEPTANCE PROVISIONS

3.8.1 Inspection and Tests

Inspection by the Contractor shall include proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of wrenches for high-strength bolts.

3.8.2 Inspection of Welding

Inspection of welding shall be performed in accordance with AWS D1.1, Section 6, "Inspection," and as follows:

Ultrasonic inspection of the welds shall conform to ASTM E 164.

3.8.3 Inspection of High-Strength Bolted Connections

Inspection of high-strength bolted connections shall be performed in accordance with AISC M017.

-- End of Section --

SECTION 05210

STEEL JOISTS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 325M	(1993) Standard Specification for High Strength Bolts for Structural Steel Joints (Metric)
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 370	(1995) Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 568/A 568M	(1996) Standard Specifications for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A 570/A 570M	(1996) Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM A 6/A 6M	(1995) Standard Specification for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use
ASTM C 1107	(1991; Rev A) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
ASTM C 150	(1995) Standard Specification for Portland Cement
ASTM C 404	(1994) Standard Specification for Aggregates for Masonry Grouts
ASTM F 568	(1995) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.22M (1981; Rev 1990) Metric Plain Washers

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4 (1993) Standard Symbols for Welding, Brazing and Nondestructive Examination

AWS A5.1 (1991) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding

AWS D1.1 (1994) Structural Welding Code - Steel

STEEL JOIST INSTITUTE (SJI)

SJI-01 (1994) Load Tables and Weight Tables for Steel Joists and Joist Girders

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC PS 14.01 (1991) Steel Joist Shop Painting System

SSPC Paint 15 (1991) Steel Joist Shop Paint

1.2 DESIGN REQUIREMENTS

1.2.1 Allowable Design Stress

Design stress for tension in steel joist chord and web members shall conform to the requirements of the SJI-01 specifications for steel joists.

1.2.2 Deflection

Deflection shall not exceed 1/360 of the clear span under the indicated uniform live load.

1.2.3 Allowable Loads

Total uniform dead and live load, uniform live load, and concentrated dead loads for design purposes shall be as indicated.

1.2.4 Bridging

Bridging for open web steel joists shall be horizontal type as specified in the SJI-01 specification and as indicated on the approved shop drawings.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication and Installation Drawings for Steel Joists shall be in

accordance with paragraph entitled, "Fabrication," of this section.

SD-03 Product Data

Manufacturer's catalog data shall include type, voltage and amperage for Welding Equipment.

SD-05 Design Data

Design Analysis and Calculations shall be submitted in accordance with paragraph entitled, "Fabrication," of this section.

Mix designs shall be submitted for Portland Cement.

SD-07 Certificates

Welding Procedures shall be in accordance with AWS D1.1.

Factory Test Reports for the following shall be in accordance with paragraph entitled, "Manufacturer's Information," of this section.

Ladle Analysis of Steel
Tensile Properties and Bend Tests
Mechanical Tests
Chemical Composition and Mechanical Usability
Soundness Tests

Certificates for Steel Joists shall show conformance to SJI-01.

Welders Certificates

SD-08 Manufacturer's Instructions

Installation instructions shall indicate the manufacturer's recommended method and sequence of installation for the following items:

Steel Joists

1.4 QUALIFICATIONS FOR WELDING WORK

Manufacturer's catalog data for Welding Equipment shall include type, voltage and amperage.

Welding Procedures shall be in accordance with AWS D1.1.

Welder's Certificates shall be submitted to verify welders qualifications.

1.5 DELIVERY, STORAGE, AND HANDLING

Joists stored at the site before erection shall be stored off the ground on platforms or other supports and covered to provide an enclosure, while affording proper air circulation.

Packaged materials shall be stored in their original, unbroken packages in a dry area until ready for installation.

1.6 MANUFACTURER'S INFORMATION

Factory test reports shall be submitted indicating all specification requirements with reference to the contract design.

1.6.1 Tensile Properties and Bend Tests

Tensile properties and bend test as specified in the particular referenced specification for the material and in ASTM A 6/A 6M for rolled steel plates, shapes and bars.

Tensile properties and bend test as specified in the particular referenced specification for the material in ASTM A 568/A 568M for rolled steel sheets and strip.

1.6.2 Mechanical Tests

Mechanical tests as specified in the referenced specifications for the material and in ASTM A 370 for high strength bolts.

1.6.3 Chemical Composition and Mechanical Usability

Chemical composition and mechanical usability as specified in AWS A5.1 for electrodes for manual shielded arc welding.

1.6.4 Soundness Tests

Soundness tests as specified in AWS A5.1 for electrodes for manual shielded arc welding.

PART 2 PRODUCTS

2.1 ROLLED STEEL PLATES, SHAPES, AND BARS

Plates, shapes, and bars are defined in ASTM A 6/A 6M and shall conform to the following:

Structural quality carbon steel conforming to ASTM A 36/A 36M.

2.2 STEEL SHEETS AND STRIP

Sheets and strip shall be carbon steel of structural quality having minimum yield point of 275 Megapascal conforming to ASTM A 570/A 570M.

2.3 UNFINISHED THREADED FASTENERS

Unfinished bolts and nuts shall be regular hexagon type conforming to ASTM F 568, Class 4.8 or lower.

Washers shall conform to ASME B18.22M, Type B.

2.4 HIGH-STRENGTH THREADED FASTENERS

Fasteners shall consist of heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers.

High-strength bolts, including nuts and hardened washers, shall conform to ASTM A 325M.

2.5 BEDDING MORTAR MATERIALS

Shrinkage-resistant grout shall be a premixed and packaged ferrous-aggregate-mortar grouting compound conforming to ASTM C 1107, expansive cement type.

Portland Cement shall conform to ASTM C 150, Type I.

Aggregate for cement grout shall be clean, sharp, uniformly graded natural sand conforming to ASTM C 404, Size No. 2.

Mixing water for bedding mortar shall be potable.

2.6 FABRICATION

Design Analysis and Calculations shall be submitted to establish conformance with joist strength requirements of SJI-01 specifications for Steel Joists. Certificates to verify this compliance shall be submitted by the Contractor.

Installation Drawings for steel joists shall include details and layouts indicating wall, structural framing, and other supports; location, lengths, and marking of steel joists corresponding to sequence and procedure to be followed in placing and fastening, location and type of fasteners, and sequence of welded connections. Welds shall be indicated in accordance with AWS A2.4. Drawings shall also indicate accessories and methods of installation, details of longspan and deep longspan steel joists with sloped top chords, if required.

2.6.1 Open-Web Steel Joists

Open-web steel joists shall be shop fabricated of the specified rolled steel plates, shapes, and bars, or the specified steel sheets and strip, or a combination thereof, in accordance with the SJI-01 specifications.

2.6.2 Holes in Chords

Holes shall be provided in chords for securing other work to steel joists; the area of a hole shall be deducted from the area of a chord when computing strength of member.

Holes shall not be made or enlarged by burning, nor will the burning of unfair holes in the shop or field be acceptable.

2.6.3 Loose Bearing Plates

Plates shall be provided for steel joists bearing on masonry or concrete construction. Plates shall be flat, free from warps or twists, of the proper thickness and bearing area, and drilled to receive anchor bolts.

2.6.4 Joist Extended Ends

Extended ends shall conform to the manufacturer's standard for steel joists indicated on the approved shop drawings and descriptive data and shall conform to requirements of the applicable SJI-01 specification.

2.6.5 Ceiling Extensions

Ceiling extensions shall be provided for steel joists to support ceilings that are to be attached to the bottom of the joists. Extensions shall be either an extended bottom chord element or a loose unit, whichever is the standard with the steel joist manufacturer. Extensions shall be of sufficient strength to support ceiling construction and shall extend within 13 millimeter of wall surface.

2.6.6 Header Members

Rolled steel header members shall be provided for support of steel joists at openings where indicated. Headers shall be in accordance with the manufacturer's standard for steel joists indicated on the approved shop drawings and descriptive data.

2.6.7 Shop Painting

Steel joists and accessories shall be given one coat of the specified paint in accordance with SSPC PS 14.01.

Paint shall be shop paint primer conforming to SSPC Paint 15, Type I, (red oxide).

PART 3 EXECUTION

3.1 GENERAL

Steel joists and accessories shall be installed in accordance with the approved shop drawings and descriptive data, and as specified.

Care shall be exercised in handling and placing joists. Joists shall be fastened in place and bridging installed prior to receiving construction loads. Contractor shall coordinate joist location with access space and fixture-placing requirements of other trades.

Special fittings for openings, overhangs, and ceiling extenders shall be furnished where required and not otherwise detailed or specified.

3.2 WELDING

Welding and weldments shall conform to the applicable requirements of AWS D1.1.

3.3 ANCHORS

Anchor bolts and other anchors required for connection of steel joists supported on, attached to, or built into masonry or concrete construction shall be correctly located. Anchors shall be set by use of templates or other methods required to locate the anchors accurately.

3.4 SETTING LOOSE BEARING PLATES

3.4.1 Cement and Shrink-Resistant Grout

Plates for steel joists supported on masonry or concrete construction shall be fully bedded on wedges or shims and damp-pack bedding mortar. Installation of plates shall be as follows:

Masonry and concrete bearing surfaces shall be clean. Concrete surfaces shall be roughened. Bottom surface of plates shall be clean.

Space between top of bearing surface and bottom of plate shall be approximately 1/24 of the width of plate but not less than 13 millimeter for plates that are less than 300 millimeter wide. Bearing plate shall be supported and aligned on steel wedges or shims.

Bedding mortar shall be a mix composed of the specified shrinkage-resistant grout and enough water to provide a flowable mixture without segregation or bleeding, with a water/cement ratio of 0.50 to 1.00 by weight.

Forms shall be provided to retain mortar until it is sufficiently hard to be self-supporting.

After supporting members have been positioned and the anchor bolts tightened, space between top of bearing surface and bottom of bearing plate shall be packed with mortar mix by tamping or ramming with a bar or rod until voids are filled.

Wedges or shims shall not be removed, but, when protruding, shall be cut off flush with the edge of the bearing plate prior to packing with mortar.

Mortar, after receiving its initial set, shall be kept damp for a minimum of 24 hours.

3.5 PLACING STEEL JOISTS

Supporting members shall be in place before placing of joists is started. Joists shall be placed on the supporting framework and adjusted and aligned accurately, with ends bearing on supporting members, before being permanently fastened. End supports shall be as specified. Placing and aligning joists shall be done to attain the number and spacing indicated on the approved shop drawings.

End support for short-span steel joists shall be as specified in accordance

with the SJI-01 specifications.

3.6 BRIDGING

As soon as steel joists are placed, bridging shall be completely installed. Size of bridging members shall be as indicated on the approved shop drawings.

Bridging shall conform to requirements of the SJI-01 specification. Each line of bridging shall be securely anchored to walls or supports at the ends of the line and to each joist by welding or bolting.

3.7 FASTENING STEEL JOISTS

Steel joists resting on steel supporting members shall be connected by welding. Welds shall be as specified in the SJI-01 specification for type of joists used and as indicated on the approved shop drawings. Welding sequence shall be coordinated with placing of joists.

Joists resting on masonry or concrete bearing surfaces shall be bedded in mortar and anchored to masonry or concrete construction as specified in the SJI-01 specification.

3.8 TOUCHUP PAINTING

After joist installation, field welds, bolt heads and nuts, and scarred surfaces on joists and steel supporting members shall be touchup painted. Before touchup painting, weld scars, bruises, abrasions, and rust spots shall be wire-brushed and solvent-cleaned. Paint for touchup painting shall be the same as that used for shop painting.

3.9 INSPECTION AND ACCEPTANCE PROVISIONS

3.9.1 Inspection and Tests

Inspection by the Contracting Officer will include proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of wrenches for high-strength bolts.

Repair of damaged joists will be allowed only if approved. Method of repairs shall be in accordance with the manufacturer's recommendation.

3.9.2 Inspection of Welds

Inspection of welded joints shall be performed in accordance with AWS D1.1.

-- End of Section --

SECTION 05312

STEEL ROOF DECK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG-911	(1991) LRFD Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1992; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 446/A 446M	(1993) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A 525M	(1991; Rev A) Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process (Metric)
ASTM A 526/A 526M	(1990) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality
ASTM A 780	(1993) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D 1056	(1992) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1149	(1991) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D 746	(1979; R 1987) Standard Test Method for Brittleness Temperature of Plastics and

	Elastomers by Impact
ASTM E 84	(1995) Standard Test Method for Surface Burning Characteristics of Building Materials

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A5.1	(1991) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.3	(1989) Structural Welding Code - Sheet Steel

1.2 DESIGN REQUIREMENTS

1.2.1 Properties of Sections

Properties of metal roof deck sections shall be computed on the basis of the effective design width as limited by the provisions of AISI SG-911.

Roof deck section properties, including section modulus and moment of inertia per meter of width, shall equal or exceed the required values of section properties indicated.

1.2.2 Allowable Loads

Total uniform dead and live load for detailing purposes shall be as indicated.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication drawings for the following items shall be in accordance with the paragraph entitled, "Fabrication," of this section.

Roof Deck Units
Roof Sump Pans
Cant Strips
Ridge and Valley Plates
Metal Closure Strips

Installation drawings for Metal Deck Units shall be in accordance with the paragraph entitled, "Installation Information," of this section.

SD-03 Product Data

Manufacturer's catalog data shall include type, voltage and amperage for the following items:

Welding Equipment
Welding Rods and Accessories

SD-04 Samples

Samples of the following shall be submitted in accordance with paragraph entitled, "Fabrication," of this section.

Metal Roof Deck Unit
Flexible Closure Strip

SD-07 Certificates

Welding Procedures shall be in accordance with AWS D1.3.

Certificates for Metal Roof Deck Unit shall show compliance with UL listing. Certificates for Welder Qualifications shall be in accordance with the paragraph entitled, "Qualifications for Welding Work," of this section.

Certificates shall also be provided for the following items:

Joint Sealing Material
Galvanizing Repair Paint
Flexible Closure Strips

SD-08 Manufacturer's Instructions

Installation Instructions metal floor deck units shall be submitted in accordance with paragraph entitled, "Installation Information," of this section.

1.4 QUALIFICATIONS FOR WELDING WORK

Manufacturer's catalog data for Welding Equipment and Welding Rods and Accessories shall include type, voltage and amerpage.

Welder Qualifications shall also be submitted to the Contractor for review.

Welders shall have been qualified by tests in accordance with AWS D1.3.

Welding Procedures shall be in accordance with AWS D1.3.

1.5 DELIVERY, STORAGE, AND HANDLING

Decking stored at the site before erection shall be stacked on platforms or pallets and covered to provide an enclosure, while affording proper air circulation.

Packaged materials shall be stored in their original, unbroken package in a dry area until needed for installation.

Decking shall not be used for storage or as a working platform until the roof deck units have been permanently fastened in position. Roof decking shall not be damaged or overloaded during construction.

1.6 INSTALLATION INFORMATION

Installation Instructions shall indicate the manufacturer's recommended method and sequence of installation for Metal Deck Units.

Field measurements shall be taken prior to preparation of drawings and fabrication.

Details and layouts indicating the structural framing, location, length, and markings of metal deck units corresponding with the sequence and procedure to be followed in placing and fastening deck units, and the location, type, and sequence of welded connections.

Welds shall be indicated in accordance with AWS A2.4.

Deck unit cross section with dimensions; and complete computations of deck unit section properties.

Accessories and methods of installation, including reinforcement at openings.

Size and number of openings to be cut in metal decking.

When required, the location of metal deck cells to be used for air ducts.

When required, the location of metal deck cells to be used for electrical raceways.

When both fire resistance rated and nonrated construction are required, the location of fire resistance rated construction.

Installation Instructions shall indicate the manufacturer's recommended method and sequence of installation for.

PART 2 PRODUCTS

2.1 STRUCTURAL QUALITY STEEL SHEETS

Sheets shall be hot-dip galvanized carbon steel having minimum yield point of 230 Megapascal, conforming to ASTM A 446/A 446M, Grade A, with zinc coating conforming to ASTM A 525M, G90.

2.2 COMMERCIAL QUALITY STEEL SHEETS

Sheets shall be hot-dip galvanized carbon steel conforming to ASTM A 526/A 526M, with zinc coating conforming to ASTM A 525M, G90.

2.3 GALVANIZED STEEL ANGLES

Angles shall be hot-rolled carbon steel conforming to ASTM A 36/A 36M, merchant quality, Grade Designation SAE/AISI 1023 or SAE/AISI 1025, and hot-dip galvanized in accordance with ASTM A 123.

2.4 ELECTRODES FOR MANUAL SHIELDED METAL ARC WELDING

Electrodes shall be E60 series, covered mild electrodes, conforming to requirements of AWS A5.1.

2.5 JOINT SEALING MATERIAL

Material shall be a nonskinning, gun-grade, bulk compound as recommended by the manufacturer.

2.6 GALVANIZING REPAIR PAINT

Paint shall be high zinc-dust content paint for regalvanizing welds in galvanized steel and shall conform to ASTM A 780.

2.7 FLEXIBLE CLOSURE STRIPS

Strips shall be made of the elastomeric material specified and shall be premolded to the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

Elastomeric material shall be a vulcanized, closed-cell, expanded chloroprene elastomer having approximately 25 kilopascal compressive-deflection at 25 percent deflection (limits), conforming to ASTM D 1056, Grade No. SCE 41, with the following additional properties:

Brittleness temperature shall be minus 40 degrees C when tested in accordance with ASTM D 746.

Flammability resistance shall have a flame spread rating of less than 25 when tested in accordance with ASTM E 84.

Resistance to ozone shall be "no cracks" after exposure of a sample kept under a surface tensile strain of 25 percent to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 40 degrees C and tested in accordance with ASTM D 1149.

Adhesive shall be elastomeric type with a chloroprene base as recommended by the manufacturer of the flexible closure strips.

2.8 FABRICATION

One sample of Metal Roof Deck Unit used shall be furnished to illustrate actual cross section dimensions and configurations.

One sample of each type Flexible Closure Strip, 300 millimeter long, shall also be furnished.

2.8.1 Roof Deck Units

Units shall be fabricated from 20 ga. thick structural-quality steel sheets before galvanizing.

Units shall be wide rib, Type B, having depth of not less than 38 millimeter, longitudinal ribs spaced not more than 150 millimeter on center, telescoped or nested endlaps, and nested or overlapping type sidelaps.

Ribs of short-span deck units that are welded from the top shall have not less than 13 millimeter nominal width on the bottom surface.

Units shall be of sufficient length to span three or more spacings where possible.

2.8.2 Roof Sump Pans

Pans shall be fabricated from a single piece of the specified structural-quality steel sheet not less than nominal 1.9 millimeter thick before galvanizing. Pans shall be of adequate size to receive roof drains and shall be recessed not less than 38 millimeter below roof deck surface with level bottoms and sloping sides to direct water flow to roof drain, and bearing flanges not less than 75 millimeter wide.

2.8.3 Cant Strips

Strips shall be fabricated from the specified commercial-quality steel sheets not less than nominal 0.91 millimeter thick before galvanizing. Strips shall be bent to form a 45-degree cant not less than 125 millimeter wide; top and bottom flanges shall be not less than 75 millimeter wide. Length of strips shall be 3000 millimeter where possible.

2.8.4 Ridge and Valley Plates

Plates shall be fabricated from the specified structural-quality steel sheets, not less than nominal 0.91 millimeter thick before galvanizing. Plates shall be not less than 120 millimeter wide and bent to provide tight fitting closures at ridges and valleys. Minimu length of ridge and valley plates shall be 3000 millimeter where possible.

2.8.5 Metal Closure Strips

Strips shall be fabricated from the specified commercial-quality steel sheets not less than nominal 0.91 millimeter thick before galvanizing. Strips shall be of the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

PART 3 EXECUTION

3.1 GENERAL

Metal roof deck units and accessories shall be installed in accordance with the approved shop drawings and descriptive data and as specified.

3.2 WELDING

Procedures for welding, appearance and quality of welds made, and methods used for correcting welding work shall conform to AWS D1.3.

Metal sheets shall be attached to structural members by plug welding through special welding washers supplied by the manufacturer.

3.3 PLACING ROOF DECK UNITS

Supporting members shall be completely in place before placing of units is started. Units shall be placed on supporting steel framework; adjusted to final position with ends bearing on the supporting members; and accurately aligned, end to end, before being permanently fastened. Endlaps shall be not less than 50 millimeter. Placing and aligning of units shall be done to maintain the required number of units indicated on the approved shop drawings and to prevent stretching or contracting of the sidelap interlocks.

A vent clip of suitable design as recommended by the manufacturer of the metal sheet shall be provided at the sidelaps of each sheet after sheets are fastened in place. For beam spacing of 1200 millimeter and less, one vent clip shall be installed at midspan; for beam spacing over 1200 millimeter, two vent clips shall be placed at the third points.

3.4 FASTENING ROOF DECK UNITS

Units shall be fastened to steel supporting members by welding, unless otherwise specified. Spacing of welds shall not exceed 150 millimeter on center at endlaps and 300 millimeter on center at all intermediate supports, both parallel and perpendicular to deck span. Welds shall be 13 millimeter minimum diameter fusion welds. Welding sequence and procedure shall be coordinated with placing of units.

For spans exceeding 900 millimeter center-to-center of the supporting member, sidelaps between adjacent units shall be locked together at intervals not exceeding 750 millimeter on center by welding or button punching.

3.5 JOINT SEALING

Sidelaps and endlaps shall be sealed with manufacturer's recommended joint sealing material. Material shall be shop or field applied. Before applying the sealing material, dust, dirt, moisture, and other foreign material shall be completely removed from the surfaces to which the sealing material is to be applied. Sealing material shall be applied in strict accordance with the sealing material manufacturer's printed instructions.

3.6 CUTTING AND FITTING

Cutting and fitting of roof deck units and accessories shall be performed where indicated and as required for passage of other work projecting through, or adjacent to, roof decking.

Additional metal reinforcement and closure pieces shall be provided as required for strength, continuity of roof decking, or support of other work.

3.7 REINFORCEMENT AT OPENINGS

Roof decking around openings 380 millimeter and under in size shall be reinforced by means of a flat, galvanized structural-quality steel sheet placed over the opening and fusion welded to top surface of roof decking. Steel sheet shall be not less than nominal thickness of 0.91 millimeter before galvanizing and at least 300 millimeter wider and longer in size than the opening. Spacing of welds shall not exceed 300 millimeter on center, with not less than one weld at each corner.

Ends of roof deck units at openings over 380 to 750 millimeter in size that are not framed with steel supporting members shall be reinforced by welding a galvanized steel angle to the underside of roof decking at right angles to roof deck ribs and extending at least three ribs beyond each side of the opening. Steel angle shall be not less than 25 by 25 by 7 millimeter and shall be fillet welded to bottom surface of each rib. Opening sides parallel to roof deck ribs shall be reinforced with a flat, galvanized steel sheet welded to top surface of roof decking as specified for openings 380 millimeter and under in size, except when a roof sump pan is to be placed over the opening.

3.8 ROOF SUMP PANS

Pans shall be placed over openings in roof decking and fusion welded to top surface of roof decking. Spacing of welds shall not exceed 300 millimeter with not less than one weld at each corner. Opening in the bottom of each roof sump pan to receive the roof drain shall be field cut as part of the work of this section.

3.9 CANT STRIPS

Strips shall be fusion welded to surface of roof decking, secured to wood nailers by galvanized screws or to steel framing by galvanized self-tapping screws or welds. Spacing of welds and fasteners shall not exceed 300 millimeter. End joints shall be lapped not less than 75 millimeter and shall be secured with galvanized sheet metal screws spaced not more than 100 millimeter on center.

3.10 RIDGE AND VALLEY PLATES

Plates shall be fusion welded to top surface of roof decking. End joints shall be lapped not less than 75 millimeter. For valley plates, endlaps shall be in the direction of water flow.

3.11 CLOSURE STRIPS

Closure strips shall be provided at open, uncovered ends and edges of the roof decking and in voids between roof decking and top of walls and partitions where indicated. Closure strips shall be installed in position in a manner to provide a weathertight installation.

3.12 ROOF INSULATION SUPPORT

Metal closure strips shall be provided for support of roof insulation where rib openings in top surface of metal roof decking occur adjacent to edges and openings. Metal closure strips shall be welded in position.

3.13 TOUCHUP PAINTING

After roof decking installation, scarred areas on top and bottom surfaces of metal roof decking shall be wirebrushed, cleaned, and touchup painted. Scarred areas shall include welds, weld scars, bruises, and rust spots. Galvanized surfaces shall be touched up with galvanizing repair paint. Painted surfaces shall be touched up with repair paint of painted surfaces.

3.14 CLEANING AND PROTECTION

Upon completion of the deck, surfaces shall be swept clean and left ready for installation of the roofing.

-- End of Section --

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC M017	(1992) Manual of Steel Construction, Volume II, Connections

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B18.22M	(1981; R 1990) Metric Plain Washers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.3.8M	(1981; R 1991) Metric Hex Lag Screws
ASME B18.21.2M	(1990) Lock Washers (Metric Series)
ASME B18.6.7M	(1985; R 1993) Metric Machine Screws

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1992; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1995) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 27/A 27M	(1993) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A 283/A 283M	(1993; Rev A) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 366/A 366M	(1996) Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality

ASTM A 47M	(1990) Standard Specification for Ferritic Malleable Iron Castings (Metric)
ASTM A 48M	(1994; Rev A) Standard Specification for Gray Iron Castings (Metric)
ASTM A 500	(1993) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	(1993) Standard Specification for Hot-Formed Welded and Seamless Carbon-Steel Structural Tubing
ASTM A 525M	(1991; Rev A) Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process (Metric)
ASTM A 526/A 526M	(1990) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality
ASTM A 563M	(1996) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A 569/A 569M	(1991; Rev A) Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip Commercial Quality
ASTM A 575	(1989) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM C 514	(1994) Standard Specification for Nails for the Application of Gypsumboard
ASTM E 621	(1994) Standard Practice for Use of Metric (SI) in Building Design and Construction
ASTM F 568	(1995) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1	(1991) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1	(1994) Structural Welding Code - Steel

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910	(1996) Occupational Safety and Health Standards

FEDERAL SPECIFICATIONS (FS)

FS FF-B-588	(Rev D) Bolt, Toggle; and Expansion Sleeve, Screw
FS FF-S-325	(Int Amd 3) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(1988; MBG 531S-89) Metal Bar Grating Manual

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC SP 10	(1994) Joint Surface Preparation, Near-White Blast Cleaning (Nace No. 2)

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Structural Steel Plates, Shapes, and Bars
Galvanized Carbon Steel Sheets
Steel Pipe Railing
Wheel Guards
Anchorage Materials
Paint Materials
Fastening Materials
Miscellaneous Metal Items

SD-02 Shop Drawings

Installation drawings for Miscellaneous Metal Items shall include location, dimensions, size, and weight or thickness as applicable to the members, type and location of welded connections, location and details of anchorage devices that are to be embedded in cast-in-place concrete and masonry construction, and any other pertinent construction and erection details.

SD-08 Manufacturer's Instructions

Manufacturers instructions covering installation of Miscellaneous

Metal Items shall be submitted.

SD-07 Certificates

Welding Procedures shall be in accordance with AWS D1.1.

Certificates for Welder Qualifications shall be in accordance with the paragraph entitled, "Qualifications for Welding Work," of this section.

Certificates shall be provided for Miscellaneous Metal Items showing conformance with the referenced standards contained in this section.

SD-04 Samples

Contractor shall submit one full-size sample, each type, for the following. After approval, full-size samples may be used in the construction, provided each sample is clearly identified and its location recorded.

Cast Abrasive Thresholds
Metal Safety Nosing for Concrete Treads
Anchorage Materials
Fastening Materials
Lock Cylinder

1.3 METALWORK REQUIREMENTS

For items not specifically described in these specifications, materials and workmanship shall conform to the accepted standard practices of the trades. Supplementary parts necessary to complete each item shall be furnished and installed. Anchors, sockets, or fastenings required for securing metal work to other structures shall be furnished to the appropriate trades promptly. Details and specifications of items for which standard products are available are representative guides of minimum requirements for such items. Standard products, generally meeting such requirements, will be accepted subject to approval. Welding shall be continuous along entire area of contact except where tack welding is noted. Tack welding will not be permitted on exposed surfaces. Items specified to be galvanized shall be hot-dip galvanized after fabrication. Weight of coating shall be not less than 0.38 kilogram per square meter of surface.

Templates and patterns for proper fitting of hardware and other accessories shall be used wherever practical.

Substitutions of materials or modification of details, or both, shall be made only when warranted and approved.

1.4 QUALIFICATIONS FOR WELDING WORK

Section 05095, "Welding Steel Construction," applies to work specified in this section.

Welding Procedures shall be in accordance with AWS D1.1. Test specimens shall be made in the presence of Contracting Officer and shall be tested by an approved testing laboratory at the Contractor's expense.

Certification of Welder Qualifications by tests in accordance with AWS D1.1, or under an equivalent approved qualification test shall be submitted. In addition, tests shall be performed on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, an immediate retest of two test welds shall be made and each test weld shall pass. Failure in the immediate retest will require that the welder be retested after further practice or training and a complete set of test welds shall be made.

1.5 DRAINAGE HOLES

Drainage holes shall be drilled to eliminate water traps. Hole locations and diameter of holes shall be 13 millimeter and shown on detail drawings for Contracting Officer's approval. Hole size and locations shall not affect structural integrity.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL PLATES, SHAPES, AND BARS

Plates, shapes, and bars shall conform to ASTM A 36/A 36M.

Plates to be bent or cold formed shall conform to ASTM A 283/A 283M, Grade C.

2.2 STRUCTURAL STEEL TUBING

Square or rectangular tubing shall be hot formed, welded or seamless, conforming to ASTM A 501.

2.3 HOT-ROLLED CARBON STEEL BARS AND BAR SIZE SHAPES

Bars and bar sizes shall conform to ASTM A 575, Grade M1020.

2.4 HOT-ROLLED CARBON STEEL SHEETS AND STRIPS

Sheets and strip shall be uncoated and shall conform to ASTM A 569/A 569M.

2.5 COLD-ROLLED CARBON STEEL SHEETS

Sheets shall be uncoated and shall conform to ASTM A 366/A 366M.

2.6 GALVANIZED CARBON STEEL SHEETS

Sheets shall conform to ASTM A 526/A 526M; galvanizing shall conform to ASTM A 525M, G90.

2.7 GRAY IRON CASTINGS

Castings shall conform to ASTM A 48M, Class 30.

2.8 MALLEABLE IRON CASTINGS

Castings shall conform to ASTM A 47M, Grade 32510 or Grade 35018.

2.9 ANCHORAGE MATERIALS

Threaded-type concrete inserts shall be galvanized ferrous castings having an enlarged base with not less than two nailing lugs, length not more than thickness of concrete section less 19 millimeter, and internally threaded to receive diameter M20 machine bolt. Ferrous castings shall be ferritic malleable iron conforming to ASTM A 47M, Grade 32510 or Grade 35018, or may be medium-strength cast steel conforming to ASTM A 27/A 27M, Grade U-60-30. Inserts shall be galvanized after fabrication in accordance with ASTM A 153/A 153M.

Threaded inserts shall not be removable when embedded in 20 Megapascal concrete and subjected to a 44.5 kilonewton tension load test in an axial direction.

Carbon steel bolts having special wedge-shape heads, nuts, washers, and shims shall be provided. Such hardware items shall be galvanized in accordance with ASTM A 153/A 153M.

Slotted-type concrete inserts shall be galvanized, pressed steel plate, welded construction, box type with slot designed to receive diameter M20 square head bolt and to provide lateral adjustment of the bolt. Length of insert body less anchorage lugs shall be not less than 115 millimeter. Inserts shall be provided with knockout cover. Steel plate shall be not less than 3 millimeter thick and shall conform to ASTM A 283/A 283M, Grade C. Inserts shall be galvanized after fabrication in accordance with ASTM A 153/A 153M.

Slotted inserts shall not be removable when embedded in 20 Megapascal concrete and subjected to a 27 kilonewton tension load test in an axial direction.

Masonry anchorage devices shall be expansion shields conforming to FS FF-S-325 and ASTM C 514, Group, Type, and Class as follows:

Toggle bolts shall be tumble-wing type of the class and style best suited for the work, and shall conform to FS FF-B-588, Type II.

2.10 FASTENING MATERIALS

Standard bolts shall be regular hexagon head type, low-carbon steel, coarse thread series, conforming to ASTM F 568.

Nuts shall be plain hexagon, regular style, carbon steel, conforming to ASTM A 563M, Grade A.

Lag bolts shall be square head, gimlet point or cone point, carbon steel, conforming to ASME B18.2.3.8M.

Machine screws shall be carbon steel, cross-recess drive, flat-head, conforming to ASME B18.6.7M.

Wood screws shall be carbon steel, single thread, flat countersunk head, cross-recess drive, conforming to ASME B18.2.3.8M.

Plain washers shall be round, general-assembly-grade, carbon steel class, conforming to ANSI B18.22M.

Lockwashers shall be helical spring, carbon steel class, of the style best suited for the work, conforming to ASME B18.21.2M.

Electrodes for manual shielded metal arc welding shall meet the requirements of AWS D1.1, and shall be mild steel electrodes conforming to AWS A5.1, E60 series.

2.11 PAINT MATERIALS

Paint for carbon steel shall be as specified in Section 09970, "Coatings for Steel."

Primer for carbon steel shall be as specified in Section 09970, "Coatings for Steel."

2.12 GENERAL FABRICATION

2.12.1 Workmanship

Fabricated Structural Steel shall be in accordance with ASTM E 621 and AISC M017.

Joints shall be milled to a close fit. Corner joints shall be coped or mitered, well-formed, and in true alignment. Joints exposed to the weather shall be formed and fabricated to exclude water.

Castings shall be sound and free from warp or defects that impair strength and appearance. Exposed surfaces shall have a smooth finish and sharp, well-defined lines and arrises. Joints shall be milled to a close fit.

2.12.2 Holes for Other Work

Holes shall be provided as indicated for securing items to metal work.

2.12.3 Galvanizing

Fabricated metal items specified to be galvanized shall be covered with a zinc coating applied by the hot-dip process after fabrication.

Galvanizing of iron and steel hardware shall be in accordance with ASTM A 153/A 153M.

Galvanizing of rolled, pressed, and forged steel shapes, plates, bars, and strip, 6 millimeter thick and heavier, shall be in accordance with ASTM A 123.

Galvanizing of assembled steel products shall be in accordance with ASTM A 123.

2.12.4 Shop Painting

Fabricated metal work, except metal surfaces embedded in concrete or masonry, surfaces and edges to be field welded, and galvanized surfaces shall be primed in accordance with Section 09970, "Coatings for Steel."

2.13 MISCELLANEOUS METAL ITEMS

2.13.1 Ladders

Ladders shall be fixed-rail type, located and detailed as indicated and specified. Rungs shall be 75 millimeter, solid-section structural steel rods, spaced 300 millimeter on center. Side rails shall be structural steel flat bars with rounded edges 64 by 13 millimeter spaced 400 millimeter apart, and conforming to 29 CFR 1910, Section 27. Rungs shall be fitted into punched holes in the side rails, welded, and ground smooth. Splices and connections shall have a smooth transition with original members without projections that are sharp or more extensive than required for joint strength. Ladders shall be provided with structural steel brackets, drilled to receive anchor bolts, and welded to side rails. Bracket spacing shall not exceed 3.1 meter on center.

Exterior and interior ladders, including brackets and fasteners, shall be galvanized where indicated.

2.13.2 Ladder Safety Cages

Cages shall be basket guard hoop type, located and detailed as indicated and specified. Cages shall be fabricated from structural steel flat bars and assembled by bolting or welding. Top and bottom hoops and intermediate hoops at intervals of not more than 6.1 meter between top and bottom hoops, shall be 100 by 8 millimeter. Hoops between 100 millimeter wide hoops shall be 50 by 8 millimeter and spaced not more than 1.2 meter on center. Vertical bars shall be 50 by 8 millimeter and spaced not more than 230 millimeter or 40 degrees on center. Hoops shall be fastened to the steel ladder side rails with M15 steel bolts or be shop welded.

Exterior ladder safety cages, including fasteners, shall be galvanized.

2.13.3 Loose Steel Lintels

Lintels shall be provided for openings and recesses in masonry walls and partitions as indicated.

Lintels shall be structural steel shapes as indicated. Lintels consisting of more than one member shall be welded together to form one unit. Bearing at each side of openings shall be not less than 150 millimeter.

Lintels installed in exterior walls shall be galvanized.

2.13.4 Steel Pipe Railings

Steel pipe railings shall include guarding at open-sided areas consisting of top rail, intermediate rail and posts, and handrails at walls, as indicated.

Minimum railings shall be 38 millimeter nominal size and standard weight, conforming to ASTM A 500, Grade B, ASTM A 501; or may be 38 millimeter nominal size, 4.1 kilogram per meter round structural-steel tubing.

Joining of post, rails, and corners shall be made by one of the following methods:

Flush-type steel railing fittings, welded and ground smooth, with railing splice locks secured with M10 hexagonal recessed-head setscrews.

Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Railing splices shall be butted and reinforced by a tight-fitting interior sleeve not less than 150 millimeter long.

Railings may be bent at corners instead of joining, provided the bends are made in suitable jigs and that the cylindrical cross section of the pipe is maintained throughout the entire bend.

Removable railing sections shall be provided as indicated.

Kickplates shall be provided between railing posts where indicated. Kickplates shall be steel flat bars 7 millimeter thick by not less than 150 millimeter high. Kickplates shall be secured as indicated.

Exterior and interior railings, including pipe, fittings, brackets, fasteners and other ferrous metal components where indicated shall be galvanized; interior railings not indicated galvanized shall be black.

2.13.5 Floor Grating Treads and Platforms

Floor grating shall be carbon steel, all-welded, parallel bearing bars with right-angle cross members, conforming to NAAMM MBG 531.

Grating treads shall be open riser type, fabricated from floor grating having the bearing bar size indicated, with steel floor plate nosing on front edge and with steel angle or steel plate carrier at each end for string connections. Treads shall be secured to stringers with bolts.

Platforms shall be fabricated from floor grating having the bearing bar size indicated. Nosing matching that on grating treads shall be provided at all landings. Open-sided edges of floor grating platforms shall be provided with toe plates, and all other edges shall be provided with end-banding bars. Grating shall be secured to platform framing members as indicated.

2.13.6 Workmanship

Welding shall be used for joining pieces together. Bolts or similar fastenings shall not appear on finish surfaces. Joints shall be true and tight and connections between parts lightproof tight. Welds shall be continuous and ground smooth.

Stair work shall be erected to line, plumb, square, true, and level. Runs shall register level with floor and platform levels.

PART 3 EXECUTION

3.1 GENERAL

Fabricated metal work shall be installed in accordance with the approved detail drawings and descriptive data for each item of fabricated metal, and as specified.

Fabricated metal items shall be securely fastened plumb and true to lines and levels.

3.2 ANCHORAGE DEVICES EMBEDDED IN OTHER CONSTRUCTION

Anchorage devices, such as concrete inserts, anchor bolts, and fabricated metal items having integral anchors, which are to be embedded in cast-in-place concrete and masonry construction, shall be delivered in time to be installed before the start of cast-in-place concrete operations and masonry work.

Setting drawings, templates, instructions, and directions shall be provided for the installation of the anchorage devices.

3.3 FASTENING TO CONSTRUCTION-IN-PLACE

Anchorage devices and fasteners shall be provided where necessary for fastening fabricated metal items to construction-in-place. Fastening shall include threaded fasteners for concrete inserts embedded in cast-in-place concrete; masonry anchorage devices and threaded fasteners for solid masonry and concrete-in-place; toggle bolts for hollow masonry and stud partitions; through bolting for masonry and wood construction; lag bolts and wood screws for wood construction; and connections for structural steel. Fastening shall be provided as indicated and as specified. Fastening to wood plugs in masonry or concrete-in-place will not be permitted.

3.4 CUTTING AND FITTING

Cutting, drilling, and fitting required shall be performed for the installation of fabricated metal work. Cutting, drilling, and fitting shall be executed carefully; when required, work shall be fitted in place before fastening.

3.5 SETTING MASONRY ANCHORAGE DEVICES

Masonry anchorage devices shall be set in masonry or concrete-in-place construction in accordance with the anchorage device manufacturer's printed

instructions. Holes shall be of the recommended depth and diameter and shall be drilled as recommended by the manufacturer of the particular anchorage device used. Drilled holes shall be left rough, not reamed, and free of drill dust.

3.6 FIELD WELDING

Procedures for manual shielded metal arc welding, the appearance and quality of welds made, and the methods used in correcting welding work shall conform to AWS D1.1, "Workmanship" and "Technique."

Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed welds shall be ground smooth.

3.7 THREADED CONNECTIONS

Where exposed to view, bolt and screw heads shall be flat and countersunk, unless otherwise specified. Threaded connections shall be made up tightly so that the threads will be entirely concealed by fitting.

3.8 STEEL PIPE RAILINGS

Railings shall be adjusted prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length. Posts shall be spaced not more than 1.8 meter on center and shall be plumb in each direction. Posts and rail ends shall be secured to building construction as follows:

Concrete anchorage for posts shall be by means of pipe sleeves set and anchored into the concrete. Sleeves shall be galvanized, standard weight steel pipe not less than 150 millimeter long and have an inside diameter not less than 13 millimeter greater than the outside diameter of the inserted pipe post. Steel plate closure shall be provided, secured to the bottom of the sleeve, and shall be of width and length not less than 25 millimeter greater than the outside diameter of the sleeve. After posts have been inserted into sleeves, the annular space between post and sleeve shall be filled solid with molten lead, sulfur, or a quick-setting hydraulic cement. Anchorage joint shall be covered with a steel round flange welded to the post.

Steel anchorage for posts shall be made by means of steel oval flanges, angle or floor type required by conditions, welded to posts and bolted to the structural steel supporting members.

Concrete and masonry anchorage for rail ends shall be by means of steel round flanges welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.

Steel anchorage for rail ends shall be by means of steel oval or round flanges welded to rail ends and bolted to the structural steel members.

Handrails shall be secured to walls by means of wall brackets and wall return fitting at handrail ends. Brackets shall be malleable iron castings with not less than an 75 millimeter projection from the finished wall

surface to the center of the pipe handrail and with the wall plate portion of the bracket drilled to receive one M10 bolt. Brackets shall be located not more than 1525 millimeter on center. Wall return fittings shall be cast-iron castings, flush-type, with the same projection as that specified for wall brackets. Wall brackets and wall return fittings shall be secured to building construction as follows:

Concrete and solid masonry anchorage shall be by means of bolt anchor expansion shields and lag bolts.

Hollow masonry and stud partition anchorage shall be by means of toggle bolts having square heads.

3.9 TOUCHUP PAINTING

After installation of fabricated metal work, the Contractor shall touch up field welds, field bolt heads and nuts, screw heads, damaged galvanized steel, and scarred surfaces on fabricated metal work and on adjacent ferrous metal surfaces. Touchup and repair shall be accomplished as soon as possible after the damage or installation has occurred. Surfaces shall be degreased, as required, prior to subsequent surface preparation. Degreasing shall be accomplished by steam cleaning or washing with a solution of trisodium phosphate in water followed by a fresh water rinse. Cuts, welds, and large damaged areas shall be sandblasted to near white SSPC SP 10. Blasting abrasive shall be sharp silica sand, size 16 to 35 mesh. When sandblasting is prohibited or impractical, mechanical cleaning by needle gun or abrasive disks or wheels shall be used. Minor abrasions and scars where extensive rusting has not occurred shall be rendered clean and dry and touched up without further surface preparation. Repair coating shall be applied within 6 hours after surface preparation or before rusting or re-contamination occurs. Touchup and repair material shall be the same inorganic zinc coating as applied in the shop. Application shall be by airless or conventional spray. Compressed air used for blasting and coating shall be free of moisture and oil. Manufacturer's recommended procedures shall be followed and the requirements of Section 09970, "Coatings for Steel," shall apply.

-- End of Section --

SECTION 06100

ROUGH CARPENTRY

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B18.22M	(1981; R 1990) Metric Plain Washers

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 525M	(1991; Rev A) Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process (Metric)
ASTM E 84	(1995) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F 568	(1995) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.3.8M	(1981; R 1991) Metric Hex Lag Screws

AMERICAN WOOD PRESERVERS BUREAU (AWPB)

AWPB LP 2	(1988) Softwood Lumber, Timber and Plywood Pressure Treated with Water-Borne Preservatives for Aboveground Use

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA A3	(1991) Determining Penetration of Preservatives and Fire Retardants
AWPA C1	(1995) All Timber Products - Preservative Treatment by Pressure Processes
AWPA C20	(1993) Structural Lumber - Fire-Retardant

	Treatment by Pressure Processes
AWPA C27	(1993) Plywood - Fire-Retardant Treatment by Pressure Processes
AWPA P5	(1994) Standards for Waterborne Preservatives
AWPA P8	(1991) Oil-Borne Preservatives

FEDERAL SPECIFICATIONS (FS)

FS FF-B-588	(Rev D) Bolt, Toggle; and Expansion Sleeve, Screw
FS FF-N-105	(Rev B; Int Am 4) Nails, Brads, Staples, and Spikes: Wire, Cut, and Wrought
FS FF-S-325	(Int Amd 3) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
FS TT-W-571	(Rev J) Wood Preservation: Treating Practices

INDUSTRIAL FASTENER INSTITUTE (IFI)

IFI 502	(1982) Metric Tapping Screws

NATIONAL INSTITUTE FOR STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1	(1983) Construction and Industrial Plywood
NIST PS 20	(1970; Rev 1986) American Softwood Lumber Standards

SOUTHERN PINE INSPECTION BUREAU (SPIB)

SPIB 1001	(1994) Grading Rules

WEST COAST LUMBER INSPECTION BUREAU (WCLIB)

WCLIB Std 17	(1991) Standard Grading Rules for West Coast Lumber

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

WWPA-01	(1991) Western Lumber Grading Rules 91

1.2 SUBMITTALS (Not Applicable)

1.3 DELIVERY, HANDLING, AND STORAGE

Wood materials shall be securely bundled and shipped with adequate

moisture-resistant covers to preclude damage by weather or handling during delivery, when stored, and during construction.

Wood materials that must be stored outdoors before immediate use shall be placed in orderly piles and stored on blocks above ground. Lumber shall be stored in stacks with provision for air circulation within stacks. Material shall be protected from the elements with moisture-resistant covers.

PART 2 PRODUCTS

2.1 WOOD MATERIALS

2.1.1 General Requirements

Each piece of framing lumber, board lumber, and plywood shall bear the trademark and grade identification of the manufacturer's association or the authorized inspection bureau under rules of which the lumber is manufactured and graded.

Softwood lumber shall be seasoned S4S and kiln-dried or air-dried to the specified Moisture Content. Dressed sizes shall conform to NIST PS 20.

Structural framing lumber shall be stress graded, with each piece being rated for strength and stamped to indicate the grade and fiber stress in bending; or it shall be certified with manufacturer's certificate of inspection.

Moisture content shall conform to the rules of the lumber association or the inspection bureau under which the lumber is graded but shall not exceed 15 percent for boards and dimensional lumber 50 millimeter or less in thickness.

2.1.2 Board Materials

Board materials shall be one of the following species:

Southern yellow pine	No. 2 boards SPIB 1001
Western red cedar, west coast hemlock, Douglas fir, larch	Utility Grade boards, WCLIB Std 17
White fir, ponderosa pine, western cedar, incense cedar, Idaho white pine, sugar pine	Utility Grade, WWPA-01 Grading Rules

2.1.3 Plywood Sheathing

Plywood sheathing shall be fire-retardant treated, tongue-and-groove exterior grade sheathing, 16 millimeter minimum thickness, grade stamped "C-C Ext-DFPA," and manufactured in accordance with NIST PS 1, Group 1. After manufacture, plywood shall be fire-retardant treated as specified under "Fire-Retardant-Treated Lumber."

2.1.4 Fire-Retardant-Treated Lumber

Lumber for wood framed partitions and solid-wood sheathing or plywood sheathing shall be fire-retardant treated by means of an approved pressure impregnating process in accordance with AWPA C1, AWPA C20 (solid wood), and AWPA C27 (plywood).

Contractor shall submit reports of the results of retention-penetration test boring cores, weight test of plywood panels, and performance ratings. Treatment and performance inspection shall be performed by an independent, qualified test agency that establishes the performance rating.

After treatment, wood materials shall have a flame-spread rating not greater than 25, with no evidence of significant progressive combustion when tested for 30 minutes duration in accordance with ASTM E 84. Fuel contributed shall not exceed 15; smoke developed shall not exceed 5.

After treatment, solid lumber materials shall have a minimum penetration of 13 millimeter of fire retardant material when tested by a borer core in accordance with AWPA A3. Plywood materials shall have a minimum retention of 400 kilogram per cubic meter when tested by weighing before and after treatment.

Approved fire-retardant materials shall bear identification showing the fire performance rating thereof issued by an approved testing agency.

After treatment, solid lumber shall be kiln-dried to reduce moisture to not more than 19 percent. Plywood shall be kiln-dried to reduce moisture to not more than 15 percent.

2.1.5 Preservative Treated Lumber

The following wood members shall be pressure-preservative treated in accordance with FS TT-W-571 or AWPB LP 2. Each piece shall bear the AWPB stamp, indicating point of treatment, preservative symbol, symbol of standard, date of treatment, and moisture content after treatment:

Wood sills, plates, rough bucks, and frames in exterior masonry wall openings

Wall plates and furring in contact with exterior masonry or concrete

Nailers that are set into, or are in contact with, concrete or masonry

Blocking and nailers for roof deck, sub fascia members, roof cants and saddles

Preservative shall be either water-borne, conforming to AWPA P5, or oil-borne conforming, to AWPA P8.

Nailers to receive membrane waterproofing and wood members to receive finish materials shall be treated with a water-borne preservative to eliminate preservative bleed-through at nails.

Wood treated with oil-borne preservatives shall be clean, free from surface oil, and properly seasoned for use.

Wood treated with water-borne preservatives shall be air-dried or kiln-dried to reduce maximum moisture content to 15 percent.

Cut surfaces of preservative-treated materials shall be brush coated with at least two coats of copper naphthenate as specified in AWPA P8.

Treated wood exposed in the final structure shall be free from objectionable odors and shall not be harmful or corrosive to adjacent materials or anchorages.

2.2 ANCHORAGE AND FASTENER MATERIALS

2.2.1 Nails and Staples

Nails, staples, and tacks shall conform to FS FF-N-105.

Nails for fastening interior wood partitions or rough framing shall be steel wire nails.

Nails for roof blocking, cants, and nailers shall be galvanized.

Nails used to fasten exposed wood fascias or finished wood members exposed to the weather shall be aluminum alloy or galvanized finishing nails.

Power-driven staples shall be galvanized Type III, Style 3.

2.2.2 Bolts, Nuts and Screws

Bolts and nuts shall be carbon steel, galvanized, conforming to ASTM F 568, Class 4,8 or less.

Wood screws shall be carbon steel, galvanized, conforming to IFI 502.

Lag screws or lag bolts shall be commercial steel, galvanized, conforming to ASME B18.2.3.8M.

Expansion shields, expansion nails, and drive screw devices shall conform to FS FF-S-325.

Toggle bolts shall conform to FS FF-B-588.

Washers shall be carbon steel, galvanized, general assembly purpose type, conforming to ANSI B18.22M.

2.2.3 Bar or Strap Anchors

Bar or strap anchors shall be steel conforming to ASTM A 36/A 36M. Hot-dip galvanized coating shall be in accordance with ASTM A 525M, Z275.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

Members shall be framed for the passage of ducts and pipes and shall not be cut, notched, or bored more than one quarter of their depth without approved reinforcement.

Washers shall be provided under bolt heads or nuts in contact with wood. Lumber shall be bored to receive bolts.

Nailers, blocking, and furring shall be furnished in lengths that minimize joints.

3.1.2 Blocking and Nailers

Nailing strips, blocking and sub fascia wood members shall be continuous, cut with square ends and in maximum practical lengths.

For bolted connections, sub fascia members shall be fastened to structural steel members or concrete with 13 millimeter (1/2-inch) bolts at a maximum spacing of 1200 millimeter on center, one bolt near each end of the member. Bolt heads shall be countersunk flush with the surface of the wood. Sub fascia members shall be held to a tolerance of 3 in 3000 millimeter.

Perimeter roof blocking, nailers, and cants shall be groove-cut to provide ventilation for insulation. Groove cuts shall be matched for continuity or new vent grooves cut when wide vents are built of more than one width of wood.

Bottom half of nailers shall be cut to provide a net open area equivalent to 10 percent of the edge face.

Wood vents for parapet walls and other vertical surfaces shall be 25 millimeter nominal thickness, treated boards, installed continuously. Wall side of vent shall be cut to provide a net open area equivalent to 20 percent of the thickness edge.

-- End of Section --

SECTION 06200

FINISH CARPENTRY

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI-01	(1986) Architectural Casework - General

FEDERAL SPECIFICATIONS (FS)

FS MMM-A-130	(Rev B; Int Am 3) Adhesive, Contact
FS MMM-A-181	(Rev D) Adhesives, Phenol, Resorcinol, or Melamine Base

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA LD 3	(1991) High-Pressure Decorative Laminate

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

Installation drawings shall be submitted for the following items in accordance with paragraph entitled, "Installation Paneling," of this section.

Wood Trim

1.3 DELIVERY, HANDLING, AND STORAGE

Contractor shall protect materials from damage during delivery, when stored, and during construction. Damaged and defective materials shall be removed and replaced with new.

Trim, paneling, cabinet work, and other finish millwork items shall be delivered and brought into the building only after the building has dried out, following the installation of wet materials, and when there is no

danger of damage to materials due to excessive moisture.

Hardboard, plywood paneling and particleboard shall be stored in accordance with manufacturer's directions for at least 48 hours in the room in which they are to be installed. Plywood paneling shall be removed from cartons and stacked flat, with 25 millimeter stripping under and between each pair of face-to-face panel. Face panels shall be separated by a slipsheet.

1.4 SITE CONDITIONS

Field measurements shall be taken before fabrication and installation of materials to verify and supplement the indicated dimensions.

1.5 DRAWINGS

Fabrication Drawings shall be submitted for finish carpentry materials consisting of fabrication and assembly details to be performed in the factory.

1.6 SAMPLES

The following samples shall be submitted:

Plastic Laminate 80 by 150 millimeter.

Manufacturer's Standard Color Charts showing recommended colors and finishes for finish carpentry materials.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Plywood Paneling

2.1.2 Solid Wood

2.1.2.1 Quality and Appearance

Solid wood finish materials shall be Premium Grade in accordance with the AWI-01 Standards.

2.1.2.2 Millwork

Solid Wood Trim shall be 300-S-4, Premium Grade, and milled to the indicated profile. Moldings, joint tolerances, miters, construction quality, and surface finish shall conform to AWI-01requirements for "Standing and Running Trim & Rails."

Material shall be furnished in the maximum practical length for the end use.

Material shall be kiln-dried. Moisture content shall not exceed 12 percent at the time of delivery to the building site.

Corners shall be mitered, tightly butted, and secured.

Wood trim shall be carefully selected to match hardwood plywood paneling.

Exposed nailing shall be countersunk finishing nails. Countersunk holes shall be filled with matching wood filler or putty.

Wood trim shall be hand sanded at the jobsite to a smooth clean finish, free of machine or tool marks, abrasions, raised grain, or similar imperfections.

2.2 MANUFACTURED UNITS

2.2.1 Plastic Laminate

2.2.1.1 Sills and Trim

Sills and trim surface shall be 1.0 millimeter thick, high-pressure laminated, melamine plastic, post-forming type, conforming to NEMA LD 3, Style D-decorative, Type II, Class 1.

Color, pattern, and finish shall be as selected by the Contracting Officer from samples of the approved manufacturer(s).

2.2.1.2 Adhesive

Adhesives for plastic-laminate panels shall be phenol-resorcinol and melamine conforming to FS MMM-A-181 or contact adhesive conforming to FS MMM-A-130.

2.3 FINISHING

2.3.1 Priming and Sealing

2.3.1.1 Trim

Mill-fabricated solid wood trim shall be delivered to the project unsealed and ready to receive the specified finish.

PART 3 EXECUTION

3.1 PREPARATION

Paneling and finished millwork items shall be installed only when temperature and humidity conditions approximate the interior conditions that will exist when the building is occupied. Relative humidity in the building at the time of installation of materials shall be within the limits recommended by the manufacturer.

3.2 INSTALLATION

3.2.1 Wood Trim

Wood trim shall be set straight, plumb and level, closely fitted, and rigidly fastened. Nail heads of exposed work shall be countersunk and the

holes filled with matching wood filler.

Joints shall be tight and formed to conceal shrinkage. Shop miters over 100 millimeter shall be glued and splined.

Furring and framing to receive paneling shall be checked for plumb and true plane surface. Adjustments shall be made before proceeding with the work.

3.2.2 Plastic Laminate Sills and Trim

Plastic laminate shall be bonded to substrate as specified in paragraph entitled, "Particleboard Core Materials," or to close-grained hardwood plywood, Graded DFPA "B-D," or better.

Core shall be at least 20 millimeter thick for horizontal applications and at least 15 millimeter thick for vertical application.

Plastic laminate shall be bonded to the approved core material with adhesives as recommended by the laminate manufacturer.

-- End of Section --

SECTION 07210

BUILDING INSULATION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 479	(1995) Standard Specification for Annealed Aluminum and Aluminum-Alloy Foil for Flexible Barrier Applications
ASTM C 1289	(1995) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C 208	(1995) Standard Specification for Insulation Boards (Cellulosic Fiber) Structural and Decorative
ASTM C 665	(1994) Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM E 154	(1988; R 1983) Water Vapor Retarders Used in Contact with Earth Under Concrete Slab, on Walls, or as Ground Cover
ASTM E 84	(1995) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Standard Test Methods for Water Vapor Transmission of Materials

FEDERAL SPECIFICATIONS (FS)

FS FF-N-105	(Rev B; Int Am 4) Nails, Brads, Staples, and Spikes: Wire, Cut, and Wrought
FS UU-B-790	(Rev A; Int Am 1) Building Paper, Vegetable Fiber: Kraft, Waterproofed, Water Repellent and Fire Resistant

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330,

"Submittals," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Glass Fiber Insulation Board
Batts and Rolls
Rigid Polyurethane Board
Vapor Barrier
Vapor Barrier Tape
Fasteners
Adhesive
Nails
Staples
Wire Netting
Vapor-Barrier Adhesive
Sand

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for installation of the following items:

Fasteners
Vapor-Barrier Adhesive

SD-06 Test Reports

Test Reports shall be submitted in accordance with paragraph entitled, "Tests," of this section.

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with referenced standards contained in this section.

Glass Fiber Insulation Board
Batts and Rolls
Rigid Polyurethane Board
Vapor Barrier
Vapor Barrier Tape
Staples

SD-04 Samples

Contractor shall submit the following samples:

Three Glass-Fiber Insulation Board samples, full thickness by 300 millimeter wide by 300 millimeter long.

Three Vapor-Barrier samples, 300 millimeter.

Vapor Barrier Tape
Water-Vapor Barrier Subgrade Covers
Rigid Polyurethane Board
Fasteners
Adhesive

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered to the project site in their original, unopened packages or containers bearing labels identifying the manufacturer's name, brand name, material, and other information.

Materials shall be stored in their original unbroken packages or containers in a weathertight and dry area, and protected from damage until ready for use.

PART 2 PRODUCTS

2.1 THERMAL-INSULATION MATERIALS

2.1.1 Glass-Fiber Insulation Board

For informational purposes, a list of known sources for recycled building insulation is provided below. Note that the Contractor is not limited to these sources. An approved product from other sources may be submitted for the Government's approval during construction.

Acceptable manufacturer's include, but are not limited to:

Certain Teed Corporation
Guardian Fiberglass, Inc.
Manville Building Products Corp.
Owens-Corning Fiberglass Corp.
Western Fiberglass, Inc.

2.1.1.1 Board

Glass-fiber insulation board shall have a minimum thermal resistance of R-8, width and length as required to suit construction conditions. Insulation shall have a 0.254 millimeter thick, white, puncture-resistant woven-glass cloth with vinyl facing on one side. Insulation shall conform to ASTM C 208, non-load bearing for use at temperatures up to and including 205 degrees C; the composite insulation shall have a UL rating of 25/50 when tested in accordance with ASTM E 84.

Glass-fiber insulation board shall contain a minimum content of 6 percent recovered materials.

2.1.1.2 Batts and Rolls

Glass-fiber insulation batts and rolls shall be of nominal thickness and width indicated. Insulation shall conform to ASTM C 665 for the following:

Type I, unfaced insulation

Type II, Kraft faced insulation

Type III, foil faced insulation having a UL rating of 25/50 when tested in accordance with ASTM E 84.

Glass-fiber insulation batts and rolls shall contain a minimum content of 6 percent recovered materials.

2.1.2 Rigid Polyurethane Board

Rigid polyurethane board shall be of thickness indicated and shall conform to ASTM C 1289.

2.1.3 Vapor Barrier

Vapor barrier shall be fire-retardant, high-vapor transmission and aluminum-foil-laminated-to-creped-paper type, conforming to ASTM B 479.

2.1.4 Vapor-Barrier Tape

Vapor-barrier tape shall be not less than 50 millimeter wide with a fire-retardant pressure-sensitive adhesive coating on one face. Vapor-barrier material shall be fire-retardant, high-vapor transmission and aluminum-foil-laminated-to-creped-paper type, conforming to ASTM B 479.

2.1.5 Water-Vapor Barrier Subgrade Covers

Water-vapor barrier subgrade covers shall be resistant to decay when tested in accordance with ASTM E 154, shall have a water-vapor permeance after exposure in the resistance-to-decay test not exceeding 29 nanogram per pascal-second-square meter when tested in accordance with ASTM E 96, Water Method, and shall be one of the following materials:

Clear polyethylene sheeting, 0.203 millimeter thick

Polyethylene-coated barrier paper consisting of 0.051 millimeter thick polyethylene film laminated to one surface of rot-resistant, water-resistant, uncreped and reinforced barrier paper; paper shall conform to FS UU-B-790, Type I, Grade A, Style 4.

Asphalt-core board, surfaced both sides with asphalt-saturated and asphalt-coated felt, weighing not less than 3 kilogram per square meter, and not less than 3 millimeter thick

2.2 FASTENING MATERIALS

2.2.1 Fasteners

Fasteners shall have a 50 by 50 millimeter perforated plate, minimum 20 millimeter wide prong, of sufficient length to bend to the bottom of the notch. Fasteners shall be cold-rolled carbon steel, zinc coated. Washers shall be 40 millimeter diameter, slotted type, zinc coated.

2.2.2 Adhesive

Adhesive shall have a bonding strength of 310 newton per clip after a 3-day drying time at 21 degrees C and shall have a temperature range of minus 29 degrees to plus 107 degrees C.

2.2.3 Staples

Staples shall be galvanized steel, flat top crown, of the size required to suit the application, conforming to FS FF-N-105, Type II, Style 3.

2.2.4 Vapor-Barrier Adhesive

Vapor-barrier adhesive shall be fire resistant, suitable for bonding laps in the vapor-barrier material, and as recommended by the manufacturer of each type of vapor-barrier material used in the work.

2.2.5 Sand

Sand for ballast over water-vapor barrier subgrade covers in crawlspaces shall be natural sand.

PART 3 EXECUTION

3.1 GENERAL

Building insulation shall be installed in accordance with approved descriptive data and as specified.

Insulation material shall be cut and fit as necessary to fully insulate small areas between closely spaced framing members and to accommodate piping, conduit, outlet boxes, and other construction penetrating the insulation material.

Vapor barriers, both those affixed to the principal face of the insulation material and those separately attached, shall be installed to provide a continuous vapor-barrier seal. Tears, breaks, or ruptures that might interfere with the effectiveness of the vapor barrier shall be prevented.

3.2 CONDITIONS AT BUILDING

Insulation shall be installed only after building construction has progressed to the point that inclement weather will not damage or wet the insulation material.

Electrical wiring, plumbing, and other concealed work shall be completed and approved prior to the start of building insulation work.

3.3 PREPARATION OF SURFACES

Surfaces on which thermal-insulation materials are to be applied shall be clean, smooth, dry, and free from projections that might puncture the vapor barriers. Condition of surfaces shall be inspected and approved prior to

the start of building insulation work.

Construction shall be supplemented with nailers, furring strips, or other supporting members to support the insulation in its proper location.

3.4 PERIMETER INSULATION SYSTEM

Perimeter insulation applied to foundation walls shall be installed before the start of drainage-fill placing operations. Cellular plastic boards shall be applied to the interior side of outside foundation walls where indicated and shall extend the indicated dimension from the top of the foundation wall. Cellular plastic boards shall be secured to the foundation wall surface by means of spot-applied bonding adhesive for cellular plastic boards; the bonding adhesive shall be applied in accordance with the adhesive manufacturer's printed directions. Cellular plastic boards shall be applied in a horizontal position with ends and sides closely butted together and with vertical joints broken.

Perimeter insulation applied on horizontal surfaces shall be installed after the completion of drainage fill-placing operations. Cellular plastic boards shall be applied horizontally under concrete slabs on the ground where indicated and shall extend the indicated dimension in from the exterior wall. Cellular plastic boards shall be installed with ends and sides closely butted together and the surface leveled to finish flush with the drainage-fill surface. Cellular plastic boards shall be protected by covering horizontal surfaces with water-vapor barrier subgrade covers. Subgrade cover sheets shall be laid with not less than 150 millimeter laps at edges and ends. Lapped joints shall be sealed with adhesive.

3.5 WALL AND CEILING INSULATION SYSTEM

Glass-fiber insulation batts and rolls shall be placed between wall and ceiling framing members, fitting snugly against framing members. Insulation shall be cut to required length for each space to be insulated.

Batts without membrane facing shall be secured in place between framing members by means of wood nailing strips or an approved adhesive, standard with the insulation materials manufacturer.

3.6 INSPECTION AND ACCEPTANCE PROVISIONS

3.6.1 Finished-Building Insulation Requirements

Building insulation work will be rejected for, but not limited to, any of the following deficiencies:

Thermal insulation material not conforming to the type and nominal thickness indicated for the kind of construction

Insulated construction not having small areas between closely spaced framing members fully insulated

Installed thermal-insulation material damaged or wetted by exposure to inclement weather

Installed vapor barriers having tears, breaks, or ruptures that cannot be sealed with vapor-barrier tape or other approved method

3.6.2 Repair of Defective Work

Defective work shall be removed and replaced, at no expense to the Government, with building insulation materials that meet the requirements of this section.

3.7 TESTS

Test Reports shall be submitted for water-vapor barrier subgrade Covers for resistance to decay and permeance.

-- End of Section --

SECTION 07400

ROOFING AND SIDING PANELS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S335	(1989) Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design with Commentary

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG-671	(1986; Addendum 1989) Specification for the Design of Cold-Formed Steel Structural Members

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1992; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 366/A 366M	(1996) Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 446/A 446M	(1993) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A 525M	(1991; Rev A) Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process (Metric)
ASTM C 553	(1992) Standard Specification for Mineral Fiber Blanket and Felt Insulation (Industrial Type)
ASTM C 920	(1995) Standard Specification for Elastomeric Joint Sealants

ASTM D 1056	(1992) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM E 621	(1994) Standard Practice for Use of Metric (SI) in Building Design and Construction

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1	(1991) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1	(1994) Structural Welding Code - Steel

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Paint 12	(1982) Paint Specification No. 12 Cold-Applied Asphalt Mastic (Extra Thick Film

1.2 PERFORMANCE REQUIREMENTS

1.2.1 Properties of Sections

Properties of steel roofing and siding sections shall be in accordance with ASTM E 621 and AISI SG-671.

Section properties, including yield point, section modulus, and moment of inertia per millimeter of width, shall equal or exceed the required values of section properties.

1.2.2 Allowable Design Stress, Deflection, and Loads

Allowable design stress, deflection, and loads for the metal roofing and siding shall be as follows:

Deflection of metal roofing and siding shall not exceed 1/180 under the indicated total dead and live load.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings for metal roofing and siding units shall be in accordance with paragraph entitled, "General Information," of this section.

Installation drawings for the following items shall indicate completely dimensioned structural frame and erection layouts,

openings in roof and walls, special framing details, construction details at corners, ridges, eaves, building intersections, curbs and flashing, location and type of mastic and metal filler strips, location and erection of subgirts, sandwich walls, and fire-rated walls.

Aluminum Roofing and Siding
Steel Roofing, Siding Sheets and Panels
Flashing and Accessories

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Steel Sheet Materials
Subgirts and Formed Shapes
Closure Materials
Insulation
Enamel Repair Paint

SD-04 Samples

Contractor shall submit three pieces each of the following samples:

Steel Roofing, Siding Sheets and Panels
Fasteners
Metal Closure Strips, 250 millimeter long of each type
Insulation, approximately 200 by 280 millimeter

Contractor shall submit three pieces each of the different color panels used in design for this contract, approximately 100 by 100 millimeter. Color shall be selected in accordance with the various applications for steel roofing, siding, flashing, fasteners, calk and sealants, and repair paint as specified in the design.

SD-06 Test Reports

Test reports for the following shall be submitted in accordance with the referenced articles in this section.

Leakage Tests

Coatings and base metals of metal roofing and siding type of test as specified in paragraphs entitled, "Aluminum Materials" and Steel Sheet Materials," and in various referenced standards in this section.

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with referenced standards contained in this section.

Fasteners
Enamel Repair Paint

1.4 QUALIFICATIONS FOR WELDING WORK

Welding procedures shall be in accordance with AWS D1.1.

Operators shall be permitted to make only those types of weldments for which each is specifically qualified.

1.5 DELIVERY, HANDLING, AND STORAGE

Metal roofing and siding shall be carefully handled at all times to prevent damage to the surfaces, edges, and ends. Contractor shall be responsible for arrangement with the manufacturer for adequate packaging and protection during shipment and offsite storage. Upon arrival at the job site, the sheets shall be checked for damage, dampness, and wet storage stain.

Moisture shall be removed from dampened or wetted sheets. Sheets not immediately used in the work shall be stored and protected in a covered, dry location that provides good air circulation free from effects of moisture and other corrosive environments. Sheets found with damage or stain shall not be used in the work.

1.6 FIELD MEASUREMENTS

Field measurements shall be taken prior to preparation of drawings and fabrication.

1.7 GENERAL INFORMATION

Fabrication Drawings for metal roofing and siding units shall indicate material, thickness, width and length, and any special miter or bevel cuts.

PART 2 PRODUCTS

2.1 STEEL SHEET MATERIALS

2.1.1 Steel Roofing

Roofing shall be roll formed to the specified profile, thickness and depth as indicated. Material shall be plumb and true, and within the tolerances listed in ASTM A 525M.

Flashings, dormers, closers, fillers, metal expansion joints, ridge rolls, and other sheet metal accessories shall be factory-formed material of the same type and quality finish as specified for roofing and siding sheets, and shall be not less than 0.61 millimeter thick.

Roofing sheets shall be of sufficient length to bridge at least three spans plus the required end lap.

Roofing material, before coating, shall be not less than 0.76 millimeter thick.

2.1.2 Profile of Sheet

Profile shall be vertical architectural pattern.

2.1.3 Baked-Enamel-Coated Steel

Roofing and siding sheets shall be enamel-coated, hot-dip galvanized steel conforming to ASTM A 446/A 446M, Grade A. Corrugation dimensions and profile shall be as specified. Sheets shall have a coating in accordance with ASTM A 525M, G90.

Pretreated steel shall be given a two-coat, baked-on, thermo-setting acrylic enamel, alkyd melamine, or vinyl-solution finish with a minimum dry-film thickness of 0.025 millimeter.

Roofing sheets exposed on one side only, shall have finish coat one side and standard wash coat on the reverse side. Color of sheets shall be as selected from manufacturer's standard colors.

2.2 SUBGIRTS AND FORMED SHAPES

Panel subgirts, T-bars, Z-bars, and angle closers shall be die-formed shapes fabricated from steel conforming to ASTM A 36/A 36M, hot-dip galvanized in accordance with ASTM A 525M, G90.

Die-formed subgirts shall have a minimum uncoated thickness of 1.2 millimeter and bar shapes shall be at least 6.4 by 25 millimeter. T-bars shall have a minimum uncoated thickness of 0.76 millimeter and Z-bars shall have a minimum uncoated thickness of 1.9 millimeter.

Concealed clips shall be fabricated from hot-dip-galvanized steel conforming to ASTM A 366/A 366M, coating designation ASTM A 525M, G90.

2.2.1 Galvanized Steel Angles

Galvanized steel angles shall be hot-rolled carbon steel conforming to ASTM A 36/A 36M, and hot-dip galvanized in accordance with ASTM A 123.

2.2.2 Electrodes for Manual, Shielded Metal Arc Welding

Electrodes for manual, shielded metal arc welding shall meet the requirements of AWS D1.1, and shall be covered, mild-steel electrodes conforming to AWS A5.1.

2.3 FASTENERS

Exposed fasteners for securing sheets to structural steel framing or to subgirts shall be M6 by 0.75 self-tapping, Type B, recessed hexagon-head, Type 305 corrosion-resistant steel screws with cadmium-plate finish; length as required for the application. Fastener assembly shall include a corrosion-resistant steel washer and a neoprene washer, or an integral corrosion-resistant steel and neoprene washer. Exposed head of fastener shall match Color of roofing sheets by means of plastic caps or

factory-coated heads.

2.4 CLOSURE MATERIALS

2.4.1 Mastic Closure Strips

Mastic closure strips shall be closed-cell, expanded cellular rubber conforming to ASTM D 1056, Type S, Class SCE-41 CMP. Closure strips shall be cut or premolded to the exact configuration of the specified roofing.

Closure strips shall be uniform in appearance, free of weak sections, bubbles, cracks, and defects.

2.4.2 Adhesives for Closure Strips

Adhesive for use with closure strips shall be the type recommended and furnished by the closure strip manufacturer.

2.4.3 Metal Closure Strips

Metal closure strips shall be factory fabricated accessories matching the type, thickness, and corrugation profile of the specified roofing. Steel closure strips shall be the same thickness and finish as the exterior roofing and siding panels.

2.4.4 Joint Sealants

2.4.4.1 Sealants

Sealants shall be an approved gunnable type for use in hand- or air-pressure calking guns at temperatures above 4 degrees C (or frost-free application at temperatures above minus 12 degrees C). They shall be used around doors, windows, masonry, and other construction material. Solids content shall be a minimum of 85 percent of the total volume. Sealant shall dry with a tough, durable surface skin which permits it to remain soft and pliable underneath, providing a weathertight joint. No migratory staining shall be permitted on painted or unpainted metal, stone, glass, vinyl, or wood.

Joints shall be primed with a compatible one-component or two-component primer as recommended by the sealant manufacturer.

2.4.4.2 Shop Applied

Sealant for shop-applied calking shall be an approved gun grade, nonsag one-component polysulfide or silicone conforming to ASTM C 920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

2.4.4.3 Field Applied

Sealant for field-applied calking shall be an approved gun grade, nonsag one-component polysulfide or two-component polyurethane with an initial maximum Shore A durometer hardness of 25, and shall conform to ASTM C 920,

Type II. Color shall match panel colors.

2.5 INSULATION

Insulation shall be rigid glass-fiber insulation conforming to ASTM C 553, Form A, Class 1, Class A fire-hazard classification with a minimum density of 96 kilogram per cubic meter, and 25 millimeter thick. Thermal conductivity (K) shall be not more than 0.38 watt per meter per degree K. Insulation shall have a factory-painted, glass-mat surface on the exposed side.

2.6 FABRICATION OF METAL PANELS

Manufacturer's standard product fabrication and details shall be provided. Flat and curved panels shall be provided as required.

System components shall be factory fabricated ready for field installation.

2.7 REPAIR OF FINISH-PROTECTED MATERIALS

2.7.1 Enamel Repair Paint

Repair paint for color finish enameled roofing shall be compatible paint of the same formula and Color as the specified finish furnished by the roofing and siding manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

Roofing shall be erected in accordance with the approved erection drawings, the printed instructions and safety precautions of the manufacturer.

Sheets shall not be subjected to overloading, abuse, or undue impact. Bent, chipped, or defective sheets shall not be applied.

Sheets shall be erected true and plumb and in exact alignment with the horizontal and vertical edges of the building, securely anchored, and with the indicated rake, eave, and curb overhang.

Work shall be installed to allow for thermal movement of the roofing movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

Exterior panels of insulated walls shall be installed to provide ventilation of the space between the exterior panel and the insulation.

Weld burns and abrasions due to assembly shall be touched up with the proper finish repair material.

Uncovered edge of the top sheet at sidelaps shall turn down for roofing.

Roofing sheets shall be laid with corrugations in the direction of the roof slope.

Separate aluminum from contacting dissimilar metals, except zinc and cadmium coatings, with heavy-bodied bituminous coating or resilient gasket.

End laps of exterior roofing sheets shall be not less than 200 millimeter.

3.2 ALIGNMENT OF STRUCTURAL FRAME

Erected structural-steel frame shall be inspected for plumb and true surfaces. Misalignment of framing and erection not in accordance with AISC S335 and ASTM E 621 shall be corrected before commencing installation of roofing and siding.

3.3 WELDING

Procedures for manual, shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting welding work shall be in accordance with AWS D1.1.

3.4 FASTENING SYSTEM

Fastening system shall consist of exposed fasteners of materials and spacing as specified, with applied plastic head caps to match color of specified roofing.

3.4.1 Single Sheet, Uninsulated Metal Roofing

Roofing shall be attached with fasteners of a length to penetrate the support member and extend at least 7 millimeter on the inside of the member.

3.5 DISSIMILAR METALS

Dissimilar metals, except corrosion-resistant steel and zinc, shall be insulated from each other by painting, or other approved system, as recommended by the roofing and siding manufacturer.

Aluminum shall be insulated from other metals by painting the other metal with one coat of bituminous paint conforming to SSPC Paint 12cold-applied asphalt mastic to a thickness of at least 1.6 millimeter.

Aluminum surface shall be backpainted where it is impractical to paint the other material.

Aluminum surfaces in contact with lime mortar, concrete, or other masonry materials shall be backpainted with a 1.6 millimeterthick coat of No. 12 asphalt mastic.

3.6 JOINT SEALANTS

Joints shall be made weathertight. Joints of metal roofing shall be sealed. End joints of metal siding, flashing at corners, ridges, eaves, rakes, curbs, and openings in walls and roofs shall be sealed with the specified joint sealant.

Sealing beads shall be continuous, not less than 13 millimeter in diameter, and applied to ensure a weathertight joint.

3.7 FLASHING AND CLOSURE INSTALLATION

3.7.1 Metal Flashing

Concealed metal flashing shall be installed at heads and sills of openings as indicated, at curbs and holders for closure and filler strips, and formed to the proper profile and thickness.

Exposed metal flashing shall be installed at building corners, jambs and sills, rakes and eaves, junctions between metal siding and roofing, valleys and changes of slope or direction in metal roofing, and building expansion joints and gutters. Flashing shall be of thickness and profile shown.

Exposed metal flashing shall be the same material, color, and finish as the specified metal roofing and siding.

Flashing shall be fastened at not more than 200 millimeteron center for roofs, and not more than 300 millimeter on center for walls, except where flashings are held in place by the same screws that secure covering sheets.

Flashing shall be furnished in at least 2.5 meter lengths. Exposed flashing shall have 25 millimeter locked and blind-soldered end joints, and expansion joints at intervals of not more than 5 meter.

Expansion joints shall be formed to the profile indicated with end joints flat-seamed, locked, and soldered, and with free-sliding, sleeve type slip joints at 5 meter intervals, designed to allow expansion and contraction and remain weathertight.

Pipe sleeves of the specified metal flashing material shall be installed for pipe and vent projections through metal roofing. Sleeves shall be fastened to roofing with the specified fasteners and flashed with stainless steel flashing.

Exposed flashing and flashing subject to rain penetration shall be bedded in the specified joint sealant.

Flashing in contact with dissimilar metal shall be insulated by means of the specified asphalt mastic material to prevent electrolytic deterioration.

Drips shall be formed to the profile indicated, with the edge folded back 13 millimeter to form a reinforced drip edge.

3.7.2 Closures

Metal closure strips shall be installed at open ends of metal ridge rolls; open ends ribbed pattern roofs, and at intersection of wall and roof unless open ends are concealed with formed eave flashing; rake of metal roof unless open end has a formed flashing member; and in other required areas.

Mastic closure strips shall be installed at intersection of ridge roll with

metal roofing.

3.8 ACCEPTANCE PROVISIONS

3.8.1 Erection Tolerances

Metal roofing shall be erected straight and true with plumb vertical lines correctly lapped and secured in accordance with the manufacturer's written instructions. Horizontal lines shall not vary more than 3 millimeter in 12 meter.

3.8.2 Leakage Tests

Finished application of metal roofing shall be subject to inspection and test for leakage by the Contracting Officer. Inspection and tests will be conducted without cost to the Contractor.

Inspection and testing will be made promptly after erection to permit correction of defects and the removal and replacement of defective materials.

3.8.3 Repairs to Finish

Scratches, abrasions, and minor surface defects of finish may be repaired with the specified repair materials. Finished repaired surfaces shall be uniform and free from variations of color and surface texture.

Repaired metal surfaces that are not acceptable to the Contracting Officer shall be immediately removed and replaced with new material.

3.8.4 Paint-Finish Metal Roofing

Paint-finish metal roofing will be tested for color stability by the Contracting Officer during the manufacturer's specified guarantee period. Tests will be performed by means of groups of 50 millimeter metal disks, fastened in exposed areas.

Panels that indicate color changes, fading, or surface degradation, determined by visual examination of the test areas after removal of the disks, shall be removed and replaced with new panels at no expense to the Government.

New panels will be subject to the specified tests for an additional year from the date of their installation.

-- End of Section --

SECTION 07511

BUILT-UP ASPHALT ROOFING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 532	(1988) Structural Insulating Formboard (Cellulosic Fiber)
ASTM D 1227	(1987) Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing
ASTM D 1863	(1993) Mineral Aggregate Used on Built-Up Roofs
ASTM D 2178	(1989) Asphalt Glass (Felt) Used in Roofing and Waterproofing
ASTM D 2277	(1987) Fiberboard Nail-Base Sheathing
ASTM D 249	(1989) Asphalt Roll Roofing (Organic Felt) Surfaced with Mineral Granules
ASTM D 312	(1995) Standard Specification for Asphalt Used in Roofing
ASTM D 371	(1989) Asphalt Roll Roofing (Organic Felt) Surfaced with Mineral Granules; Wide Selvage
ASTM D 41	(1994) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 4586	(1993) Standard Specification for Asphalt Roof Cement, Asbestos Free
ASTM D 517	(1992) Asphalt Plank

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Asphalt Primer
Base Sheets
Roofing Felts
Cap Sheets
Sheathing Paper
Bituminous Plastic Cement
Fasteners
Cants
Aggregate Surfacing
Roof Walkways
Adhesive
Asphalt Base Emulsion

SD-07 Certificates

Certificates for Adhesive shall show UL listing and flame resistance certification.

PART 2 PRODUCTS

2.1 ADHESIVE FOR APPLICATION OF INSULATION

Adhesive for application of insulation to steel decks shall be nonflammable (except for foamglass) and shall meet the requirements of the Underwriters Laboratories, Inc., for a metal roof-deck construction assembly. Asphalt adhesive shall be applied full mop prior to installation of insulation.

2.2 ASPHALT-PRIMER

Asphalt primer shall conform to ASTM D 41.

Asphalt shall conform to ASTM D 312, Type III.

2.3 BASE SHEETS

Base sheet shall be asphalt-impregnated glass-fiber felt conforming to ASTM D 2178.

2.4 ROOFING FELTS

Roofing felt shall be asphalt-impregnated glass fiber conforming to ASTM D 2178, Type IV.

2.5 CAP SHEETS

Cap sheet shall be asphalt roll roofing conforming to ASTM D 249.

Cap sheet shall be wide selvage asphalt roll roofing conforming to ASTM D 371, with a 430 millimeter selvage.

2.6 SHEATHING PAPER

Sheathing paper shall be rosin-sized weighing not less than 3 kilogram per 10 square meter or unsaturated felt weighing approximately 3.7 kilogram per 10 square meter.

2.7 BITUMINOUS PLASTIC CEMENT

Bituminous plastic cement shall conform to ASTM D 4586, Type I for asphalt-saturated felts.

2.8 FASTENERS

Roofing nails shall be nonferrous with 30 millimeter diameter heads (annular or spiral-threaded for plywood deck) of sufficient length for maximum penetration into the deck or wood nailer.

Insulation holddown clips, as recommended and approved by the insulation manufacturer, shall be used at the roof perimeter in addition to the asphalt adhesive.

2.9 CANTS

Cants shall be made from treated fiberboard and shall reduce the angle covered into two equal angles. Fiberboard shall conform to ASTM C 532 and ASTM D 2277, treated for moisture resistance by an integral treatment of wax or bituminous impregnation.

2.10 AGGREGATE SURFACING

Gravel shall conform to ASTM D 1863, size No. 7.

2.11 ROOF WALKWAYS

Asphalt planks shall be 950 by 1830 millimeter by 15 millimeter thick, consisting of a homogeneous core of asphalt, plasticizers, and fillers bonded between two saturated and coated facing sheets. Top side shall be surfaced with ceramic granules. Planks shall conform to ASTM D 517, mineral-surfaced asphalt.

2.12 ASPHALT-BASE EMULSION

Asphalt-base emulsion shall conform to ASTM D 1227, Type IV.

PART 3 EXECUTION

3.1 ROOFING SYSTEM

Contractor shall provide a roofing system with asphalt bitumen and aggregate surfacing on a precast concrete deck with insulation and metal deck with insulation.

3.2 SUMMARY OF MINIMUM MATERIAL WEIGHTS (PER 10 SQ METRE)

Asphalt assembly:

Base sheet	7.037	kg
Adhesive to receive insulation	11.4	kg
Vapor retarder	24.5	kg
Roof insulation	73	kg
Asphalt mopping to receive base sheet	11.4	kg
Asphalt-saturated roofing felts (3 piles)	9.5	kg
Asphalt moppings between felts (3 at 11.4 kg)	34	kg
Flood coat	27	kg
Gravel surfacing	227	kg
Approximate total weight	425	kg

3.3 PREPARATION

Contractor shall verify that work of other trades that penetrates the roof deck or requires men and equipment to traverse the roof deck is complete.

Contractor shall examine deck surfaces for inadequate anchorage, foreign material, moisture, and unevenness which would prevent the execution and quality of application.

Contractor shall proceed with the roofing application only after defects have been corrected.

Starting work designates acceptance of the surfaces by the Contractor.

3.4 APPLICATION

3.4.1 General

Roofing installation shall be continuous, with all operations proceeding together. Base sheet and specified plies of felt shall follow shingle-fashion as a single composite operation.

Roofing shall be applied only when the ambient temperature is above 10 degrees C.

Interval between the base sheet application and succeeding plies shall not exceed 48 hours.

Before cessation of work on each working day or when work is interrupted

due to rainfall or other causes, the roof shall be sealed against intrusion of water. Base sheet shall be brought to the edge of the insulation, dams shall be installed and exposed felts shall be effectively glazed. Insulation or unglazed felts shall not be left exposed during rainfall or overnight.

Traffic over partially or completely finished roofing shall be only on planks or on plywood not less than 15 millimeter thick and 600 millimeter wide.

Bitumen quantities specified for laminating insulation, attaching base sheets, laminating successive plies of felts, or flood coating shall be regarded as square meter by square meter minimums, not as averages for areas.

Debris shall be removed from the roof at the end of each work day.

3.4.2 Built-Up Roofing Application

Roofing shall be installed in accordance with the approved roofing manufacturer's specification and the NRCA Roofing and Waterproofing Manual applicable specification.

10-SERIES for Temporary Roofs and Vapor Retarders

20-SERIES for Insulation Attachment

30-SERIES for Nailable Roof Decks

40-SERIES for Insulated Roof Decks

50-SERIES for Concrete Roof Decks

3.4.3 Vapor Retarder Application

Vapor retarders shall be installed in accordance with the approved roofing manufacturer's specification and the NRCA Roofing and Waterproofing Manual applicable specification.

3.4.4 Flashing Applications

Flashing shall be provided in the angles formed at walls and other vertical surfaces and where required to make the work watertight. Bituminous plastic cement shall be used for the application of flashing. Flashing shall be provided and installed immediately after the top ply of the roofing is placed and shall be returned and sealed or capped and sealed to waterproof edges and ends. Flashing shall be stepped where vertical surfaces abut sloped roof surfaces. Sheetmetal reglet up to which base flashing is installed shall be not more than 400 millimeter nor less than 200 millimeter above the roofing surfaces.

Flashing shall be installed in accordance with the NRCA Roofing and Waterproofing Manual applicable construction details.

3.4.5 Cant Strip Application

Cant strips shall be installed in the angles formed at wall and other vertical surfaces as backing for base flashings. Cant strips shall be laid in a solid coat of bituminous cement just prior to laying the roofing plies. Cants shall have a 140 millimeter face dimension, shall be continuous, and shall be installed in as long lengths as practical.

3.4.6 Valley Application

Valleys: Roofing shall be applied at valleys and waterways in the following manner:

Base sheets shall continue across valleys and terminate 450 millimeter from the valley.

Felt plies shall continue across valleys and terminate 300 millimeter from the valley. Exposed laps shall terminate on a line 300 millimeter from, and parallel to, the gutter valley. Two plies of felt, 225 and 300 millimeter wide, shall be successively mopped in over each felt line of the termination.

If the application can be completed without wrinkles, buckles, or fishmouths and if side laps do not face the direction of drainage, roofing felts and base sheets may be laid continuously across or parallel to shallow valleys such as those formed by reverse-slope roofs. For this application, valleys shall be reinforced with one ply of felt, 900 millimeter wide, centered on the valley gutter and laid in a solid mopping of asphalt over the top ply of roofing.

3.4.7 Walkway Application

Asphalt plank walkway systems for the protection of the roofing membrane shall be installed.

A heavy coating of adhesive shall be applied over the designated walkway areas and directly on the felt membrane. A 13 millimeter space shall be allowed between adjacent boards for drainage.

-- End of Section --

SECTION 07600

FLASHING AND SHEETMETAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1994; Rev A) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B 32	(1995) Specification for Solder Metal
ASTM C 920	(1995) Standard Specification for Elastomeric Joint Sealants
ASTM D 4586	(1993) Standard Specification for Asphalt Roof Cement, Asbestos Free

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1994) Structural Welding Code - Steel

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-02	(1993) Architectural Sheet Metal Manual
SMACNA-02A	(1980; 5th Ed) Architectural Sheet Metal Specifications

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication drawings for the following items shall include material, description, and thickness.

Installation drawings shall indicate location, dimensions, configuration, construction details, type of seams and fastening method for the following items:

Fabrication and installation drawings for accessories shall be in accordance with paragraphs entitled, "Minimum Dimensions and Thicknesses" and "Miscellaneous Components," and shall meet all design specifications as required by referenced standards within this section.

Flashing
Sheet Metal

SD-07 Certificates

Certificates for the following items shall be submitted showing conformance with referenced standards contained in this section.

Fasteners
Solder Materials
Cements
Sealing Compounds

Certificates for the following types of sheetmetal shall be submitted showing conformance with referenced standards contained in this section.

Aluminum
Galvanized Steel
Copper

PART 2 PRODUCTS

2.1 SHEET METAL MATERIALS

2.1.1 Corrosion-Resistant Steel

Corrosion-resistant steel shall be chromium-nickle steel conforming to ASTM A 167, Type 301, 302, 204, or 316, No. 2D finish, annealed temper as required for the end use.

2.1.2 Minimum Dimensions and Thicknesses

Materials shall be in accordance with SMACNA-02 or SMACNA-02A and shall be not less than the following minimum thicknesses and weights.

ITE	COPPER, KG PER SQUARE METE	ALUMINUM, THICKNESS MILLIMETE	CORROSION RESISTANT STEEL THICKNESS MILLIMETE	GALVANIZED STEEL THICKNESS MILLIMETE
Building expansion joints, cap	4.9	0.81	0.48	0.55
Bellows or flanges, U-type	4.9		0.48	0.55
Flashings				

ITE	COPPER, KG PER SQUARE METE	ALUMINUM, THICKNESS MILLIMETE	CORROSION RESISTANT STEEL THICKNESS MILLIMETE	GALVANIZED STEEL THICKNESS MILLIMETE
Base	6.1	0.81	0.48	0.85
Cap, roof penetration cap flashing, equipment and structural supports, pitch pans	4.9	0.81	0.48	0.55
Through-wall, above roof line, including coping and parapet	4.9	---	0.48	0.55
Cleats, 50 by 75 millimeter	4.9	0.81	0.55	0.70
Edge strips, 32 millimeter wide	7.3	1.27	0.70	1.0
Reglets	3.1	---	0.40	0.40
Cap flashing receivers	4.9	---	0.48	0.55
Gravel stop fascias:				
Corrugated sheets	4.9	0.81	0.48	0.55
Smooth sheets to 90 millimeter	4.9	0.81	0.48	0.55
Smooth sheets over 90 millimeter	6.1	1.27	0.55	0.85
Gutters and downspouts:				
Gutter sections, end caps	4.9	0.81	0.48	0.55
Continuous cleats, cover plates	4.9	0.81	0.48	0.55
Downspouts, conductor heads	4.9	0.61	0.40	0.55
Scupper linings	6.1	0.81	0.48	0.55
Strainer wire diameter		3.66 dia.	2.77 dia.	3.0 dia.
Downspout hangers, 50 mm	3.2 mm	3.18	1.3	3.5
Gutter hangers, 25 mm wide	3.2 mm	3.18	1.3	3.5
Splash pans	4.9	1.02	0.48	0.85

2.2 CEMENTS AND SEALING COMPOUNDS

2.2.1 Bituminous Plastic Cement

Bituminous plastic cement shall be an asphaltic-base material conforming to ASTM D 4586, compatible with the roofing asphalts and asphalt primer.

2.2.2 Sealing Compound

Sealing compound shall be gun grade, one-component, nonsag, elastomeric, conforming to ASTM C 920. Base material shall be polysulfide, resistant to 50-percent joint movement.

Aluminum-seam sealant shall be as recommended by the aluminum manufacturer.

2.3 SOLDER MATERIALS

Solder and flux shall meet the requirements of ASTM B 32. Solder shall be SN50.

2.4 FASTENERS

Fasteners shall be the same metal or a metal compatible with the material joined.

2.5 MISCELLANEOUS COMPONENTS

Metal scupper linings conforming to SMACNA-02, Plate 1.67, shall be provided through wall and roof openings.

PART 3 EXECUTION

3.1 GENERAL

Sheetmetal work shall conform to drawing details and to the applicable plate number and design and installation recommendations of SMACNA-02. Finished sheetmetal installation shall be free from water leakage.

Surfaces to receive sheetmetal work shall be clean, smooth, dry, and free from defects and projections which might affect the work. Surfaces shall be plumb and true to a tolerance of not more than 13 millimeter in 12.2 meter, with no dips, waves, or uneven surfaces exceeding 3.2 millimeter in 3000 millimeter in any direction. Lines, arises, and angles shall be sharp and uniform. Exposed edges of sheetmetal shall be folded back to form a 13 millimeter wide hem on the concealed side.

3.1.1 Fastening Methods

Fasteners shall be concealed. Only one edge shall be nailed to permit freedom of expansion perpendicular to the line of nailing. Nails shall be spaced at not more than 75 millimeter on center. Nails shall penetrate backing by not less than 25 millimeter.

Cleats shall be used for securing edges of sheetmetal members over 300 millimeter wide and at other designated locations. Cleats shall be fastened with two nails and the end folded over the nails. Other end of the cleat shall be locked into the seam or the folded edge of member being fastened. Cleats shall be spaced at not more than 300 millimeter on center.

Screws shall be fitted with neoprene washers to protect surface of metal sheet and provide a watertight connection.

3.1.2 Seams

Seams and lock joint construction shall conform to SMACNA-02, Plates 99 and 100.

Seams shall be straight and uniform in height, width, and finish as follows:

Flat-lock seams shall be not less than 19 millimeter wide.

Lap seams, when soldered, shall finish not less than 25 millimeter wide.

Lap seams, not soldered, shall overlap not less than 75 millimeter.

Joints, seams, and connections of copper shall be soldered except where other methods of joining are indicated.

Joints, seams, and connections of aluminum shall be welded except where a screw or riveted and hard-setting sealant connection is indicated.

Loose-lock expansion seams shall be not less than 75 millimeter wide and shall provide for not less than a 25 millimeter movement within the joint. Joint shall be completely filled with the specified sealant applied at not less than 3.2 millimeter bed thickness.

Flat seams shall be made in the direction of flow. Seams not soldered shall be completely filled with plastic cement.

Surfaces to be joined by soldering shall be cleaned, pretinned, heated, fluxed, and sweat-soldered through the full contact area in accordance with the best standards of practice in modern sheet metal shops. Flux residue and foreign matter shall be removed after soldering. Soldered surfaces shall be rinsed with water and wiped clean.

Procedures for manual shielded metal-arc welding, the appearance and quality of welds made, and the methods used in correcting welding work shall conform to AWS D1.1.

3.1.3 Dissimilar Metals

Dissimilar metals shall be isolated from each other by painting with bituminous paint.

3.2 FLASHING

3.2.1 Reglets and Flashing Receivers

Reglets and flashing receivers shall conform to SMACNA-02. Masonry joints or concrete shall be cut to form a saw-cut reglet. Slots shall be cut to a depth not less than 38 millimeter and approximately 0.19 millimeter thick.

3.2.2 Base Flashing

Metal base flashing shall be installed where the roof abuts vertical surfaces, in valleys, at ridges, and where the roof slope changes.

Configuration shall conform to SMACNA-02.

Flashing shall extend not less than 200 millimeter up vertical surfaces.

3.2.3 Cap and Counter Flashing

Metal cap or counter flashing shall be installed where horizontal roof surfaces abut vertical wall surfaces, at copings, at joints between existing and new construction, at penetrations of roof surfaces, and at equipment supports. Configuration shall conform to SMACNA-02.

Flashing shall be formed in 3000 millimeter lengths, except where shorter pieces are required; end joints shall be lapped not less than 75 millimeter. Joints shall not be soldered.

3.2.4 Edge Strips

Edge trim strips shall have a formed drip edge.

3.2.5 Flashing at Roof Penetrations and Equipment Supports

Metal flashing conforming to SMACNA-02 shall be installed where piping, conduit, or equipment supports penetrate roof surfaces.

Single-pipe vents shall be flashed with two-piece formed-metal housing of the specified sheetmetal, installed as indicated in SMACNA-02.

3.3 GRAVEL-STOP FASCIAS

Gravel-stop fascias shall be installed at exposed edges of built-up roofs. Configuration shall conform to SMACNA-02. Lower edge of each gravel-stop fascia section shall be secured in place by hooking over a continuous edge strip or cleat. Flanges of each section shall extend out on the top of roofing felts not less than 90 millimeter.

A 7 millimeter open joint shall be provided between each gravel-stop fascia section, with a 300 millimeter wide plate centered on the joint. System shall be installed in accordance with SMACNA-02.

3.4 GUTTERS AND DOWNSPOUTS

3.4.1 Gutters

Gutter design shall be in accordance with SMACNA-02.

Gutters shall be set level to a tolerance not to exceed 13 millimeter in 12.2 meter.

Gutters shall be pitched to drain at not more than 1.6 millimeter in 305 millimeter.

Gutters supports shall be in accordance with SMACNA-02. Support spacing shall not exceed 760 millimeter on center.

Back edges of gutters shall be folded to form a continuous hook not less than 13 millimeter deep. Gutters shall be supported by continuous cleat of not less than a 64 millimeter width.

Outlet tubes with flanges shall be riveted and soldered to gutters; tubes shall be extended 75 millimeter into downspouts.

A downspout strainer shall be inserted into each outlet tube.

3.4.2 Downspouts

Downspouts shall be provided on outside walls from gutters, conductor heads, and scuppers.

Downspouts shall be joined to the gutters at outlet tubes and joined to each other by telescoping end joints 38 millimeter into the lower section.

Downspout hangers shall be fabricated of the same material as downspouts. One hanger shall be provided at the top and bottom of each downspout section.

Elbows shall be installed where downspouts terminate on splash blocks or roof pans. Downspouts shall be fitted neatly into cast-iron boots or drain pipes where downspouts terminate in drainage lines; joints shall be filled to the full height of the bell with portland-cement mortar caps.

3.5 MISCELLANEOUS DRAINAGE ITEMS

3.5.1 Scupper Lining

Linings shall be projected beyond walls or fascias and terminated in conductor heads, spouts, or overflow openings. Surfaces to receive linings shall be coated with bituminous cement.

3.6 CLEANING

Exposed sheetmetal work shall be cleaned of all surface contaminants and imperfections at completion of installation.

-- End of Section --

SECTION 07920

SEALANTS AND CALKINGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 920	(1995) Standard Specification for Elastomeric Joint Sealants
ASTM D 1056	(1992) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubbe

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Flexible Cellular Backing
Bond-Preventative Material
Primer
Elastomeric Sealants
Solvents and Cleaning Agents

SD-04 Samples

The Contractor shall submit the following samples:

Three cured color bead samples of each color and type of Sealing Compound to be used in the work, approximately 6 millimeter wide by 25 millimeter long.

Three Labels for each sample container of sealants including the following information; supplier, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, life expectancy of the application, curing time, and shelf life.

Three Backup Material samples of each material, grade, rod size,

and tube size to be used in the work, full size by 300 millimeter long.

1.2.1 Samples

Provide three cured color bead samples of each color and type of Sealing Compound to be used in the work, approximately 6 millimeter wide by 25 millimeter long.

Three Labels for each sample container of sealants shall include the following information; supplier, name of material, formula or specification number, lot number, color, date of manufacture, mixing instructions, life expectancy of the application, curing time, and shelf life.

Three Backup Material samples of each material, grade, rod size, and tube size to be used in the work, full size by 300 millimeter long.

1.3 QUALITY ASSURANCE

1.3.1 Compatibility with Substrate

Sealants shall be verified for compatibility for use with joint substrates.

1.3.2 Joint Tolerance

Joint tolerances shall be in accordance with manufacturer's instructions.

1.4 SPECIAL WARRANTY

Sealant joint shall be guaranteed against failure of sealant and against water penetration through each sealed joint for five years.

PART 2 PRODUCTS

2.1 BACKUP MATERIAL

2.1.1 Flexible Cellular Backing

2.1.1.1 Sponge Rubber and Expanded Rubber

Sponge rubber and expanded rubber material shall be round, ASTM D 1056, Type 1, Class A, Grade 5, rubber.

2.1.2 Polyethylene

Polyethylene material shall be closed cell polyethylene as recommended by the sealant manufacturer.

2.2 BOND-PREVENTATIVE MATERIAL FOR SEALING COMPOUNDS

Bond-preventive material shall be pressure sensitive tape, as recommended by the sealant manufacturer to suit application.

2.3 PRIMER-TO-SEALANT COMPOUNDS

Primer shall be as recommended by sealant manufacturer to suit application.

2.4 SEALANTS

Manufacturer's Installation instructions shall be submitted for Thermoplastic Sealing Compound and Two-Component Elastomeric Sealant covering procedures, suggested mixing equipment, storage requirements, and procedures for surface preparation.

2.4.1 Elastomeric

Elastomeric Sealants shall be single component, conforming to ASTM C 920, Type S, Grade NS, Class 25. Base material shall be urethane.

2.5 SOLVENTS AND CLEANING AGENTS

Solvents, cleaning agents, and accessory materials shall be provided as recommended by the manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

Unsound substrates shall be repaired. Joint dimensions and surfaces receiving substrates shall be verified that they comply with the manufacturer's recommendations.

3.2 PREPARATION

Prepare and prime joints in accordance with manufacturer's instructions. Adjacent exposed surfaces shall be protected.

3.3 INSTALLATION

Backup material shall be installed with a blunt tool.

Backup material shall be 33 percent oversize for closed cell and at least 50 percent oversize for open cell material, unless otherwise indicated.

Sealants shall be applied within recommended temperature and humidity conditions.

Sealants shall be installed free of air pockets, foreign embedded matter, ridges and sags.

Sealant shall be installed to cover the following conditions:

Openings 6 millimeter and less between walls and partitions and adjacent casework, door frames, built in or surface mounted equipment and fixtures.

Perimeters of frames of doors, window, and access panels which adjoin

exposed interior concrete and masonry surfaces.

Joints between interior masonry walls and partitions and columns, pilasters, concrete walls, or exterior walls unless detailed otherwise.

Seats of metal thresholds for exterior doors.

Other interior locations where small voids between materials require filling for first class workmanship and painting.

3.4 INSPECTION AND ACCEPTANCE PROVISIONS

All work shall be inspected for proper installation. Calking and sealing shall be rejected for the following deficiencies:

Calking compound having a finished surface not conforming to specifications.

Sealing compound with color not matching the sample or surface not complying with specifications.

Sealing compound failing to adhere to side surfaces of joints.

3.5 CLEANING AND REPAIRING

Surfaces adjoining joint excess and smears resulting from installation shall be cleaned.

Defective work shall be removed and replaced with calking and sealing materials as indicated.

3.6 PROTECTION

Installed sealants shall be protected until cured.

-- End of Section --

SECTION 08100

METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(1994) Structural Welding Code - Steel

DOOR AND HARDWARE INSTITUTE (DHI)

DHI A115.1	(1990) Preparation for Mortise Locks for 1-3/8 Inch 35 millimeter and 1-3/4 Inch 44 millimeter Doors
DHI A115.2	(1988) Door and Frame Preparation for Bored or Cylindrical Locks for 1-3/8 Inch 35 millimeter and 1-3/4 Inch 44 millimeter Doors
DHI A115.4	(1994) Standard Steel Door and Frame Preparation for Lever Extension Flush Bolts

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 80	(1992) Standard for Fire Doors and Fire Windows

STEEL DOOR INSTITUTE (SDOI)

SDOI SDI-100	(1991) Standard Steel Doors and Frames
SDOI SDI-105	(1991) Erection Instructions for Steel Frames

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication drawings for the following items shall show location and size of all holes to be punched for hardware attachment, size, shape, gage and finish.

Steel Doors
Frames

SD-02 Shop Drawings

Installation drawings for the following items shall be in accordance with the paragraph entitled, "Installation," of this section.

Steel Doors
Frames

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Steel Doors
Frames
Finish Hardware
Reinforcement

1.3 DELIVERY, HANDLING, AND STORAGE

Doors, frames, and accessories shall be protected from damage during handling, transportation, and at the job site. Materials shall be stored at the site, under cover, and on wood blocking or suitable floors.

PART 2 PRODUCTS

2.1 GENERAL

Doors, frames, and accessories shall conform to SDOI SDI-100 and the requirements specified herein.

Welding shall be in accordance with the recommended practice of the Structural Welding Code, Sections 1 through 6, AWS D1.1 and as specified by the producer of the metal being welded. Welds behind finished surfaces shall cause no distortion or discoloration on the exposed side.

2.1.1 Steel Doors

Doors shall be heavy duty, 44 millimeter (1-3/4-inch), 1.3 millimeter, full flush or seamless hollow steel construction, electrolytic zinc-coated with honeycomb core reinforcement.

Door louvers shall be inserted type.

Exterior louvers shall be provided with a 1.40 by 1.00 millimeter (14- by 18-mesh) bronze insect screen secured to the louvers on the interior side of the door.

Fire-rated doors shall be the types that have been investigated and fire

tested as a fire door assembly, complete with the type of fire door hardware to be used in the work. Fire-rated doors shall be labeled with the applicable fire rating of the door construction provided.

2.1.2 Frames

Exterior frames shall be 1.6 millimeter full welded-unit-type.

Interior frames shall be 1.6 millimeter full welded-unit type.

Fire-rated frames shall be the types that have been investigated and fire tested as an assembly, complete with the type of hardware to be used in the work. Fire-rated frames shall be labeled with the applicable fire rating of the frame construction provided.

2.2 FINISH HARDWARE PREPARATIONS AND LOCATIONS

Preparation for hardware shall be in accordance with DHI A115.1, DHI A115.2, and DHI A115.4, as applicable.

Frames, except fire-rated labeled frames, shall be punched to receive molded-rubber door silencers. Single door frames shall be punched for three silencers in the lock side jamb. Double door frames shall be punched for one silencer in each leaf of the frame head. Lock strikes shall be set out to provide clearance for the silencer.

Hardware locations shall comply with SDOI SDI-100, Table V, except when template dimensions and multiple-item installations require an alternative location.

Reinforcement for finished hardware shall meet or exceed the requirements of SDOI SDI-100, Table IV.

2.3 FINISHING

Doors and frames shall be primed and finished in accordance with SDOI SDI-100.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Door Clearance

Clearances shall be those specified in SDOI SDI-100.

Clearances for fire-rated doors shall be as specified in NFPA 80.

3.1.2 Frame Installation and Tolerances

Frames shall be installed in accordance with SDOI SDI-105.

Fire-rated frames shall be installed in accordance with NFPA 80.

Frames shall be installed within the following tolerances:

Deviation in location from that indicated on the drawings	Plus or minus 6 millimeter
Deviation from plumb or horizontal:	
In 2438 millimeter	Not more than 1.6 millimeter
In 3658 millimeter	Not more than 3.2 millimeter

3.1.3 Finish-Hardware Installation

Hardware shall be installed and adjusted in accordance with the hardware manufacturer's printed directions.

After the installation is completed, hardware shall be adjusted and lubricated to ensure proper performance.

3.1.4 Final Adjustment

Before final acceptance, finish hardware shall be checked and readjusted as required to ensure proper operation of the finish hardware.

-- End of Section --

SECTION 08120

ALUMINUM DOORS AND FRAMES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ALUMINUM ASSOCIATION (AA)

AA SAS-30	(1986) Specifications for Aluminum Structures Construction Manual Series Section 1

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S328	(1986) Specification for Structural Steel Buildings Load and Resistance Factor Design

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG-671	(1986; Addendum 1989) Specification for the Design of Cold-Formed Steel Structural Members

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.22M	(1981; Rev 1990) Metric Plain Washers

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 501	(1993) Standard Specification for Hot-Formed Welded and Seamless Carbon-Steel Structural Tubing
ASTM A 563M	(1996) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A 570/A 570M	(1996) Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
ASTM B 209M	(1995) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM B 211M	(1995) Standard Specification for Aluminum

	and Aluminum-Alloy Bar, Rod, and Wire (Metric)
ASTM B 221M	(1995; Rev A) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes (Metric)
ASTM B 316/B 316M	(1995) Standard Specification for Aluminum and Aluminum-Alloy Rivet and Cold Heading Wire and Rods
ASTM C 509	(1994) Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM D 1730	(1967; R 1993) Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting
ASTM F 568	(1995) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(1993) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A5.1	(1991) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1	(1994) Structural Welding Code - Steel

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.1	(1988) Butts and Hinges
BHMA A156.18	(1987) Materials and Finishes
BHMA A156.4	(1992) American National Standards for Door Controls - Closers
BHMA A156.5	(1992) Auxiliary Locks & Associated Products
BHMA A156.6	(1994) Architectural Door Trim

COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)

CABO A117.1	(1992) American National Standards for Buildings and Facilities Providing Accessibility and Usability for Physically Handicapped People

FEDERAL SPECIFICATIONS (FS)

FS FF-B-588	(Rev D) Bolt, Toggle; and Expansion Sleeve, Screw
FS FF-S-325	(Int Amd 3) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
FS FF-W-84	(Rev A; Am 3) Washers, Lock (Spring)
FS TT-C-490	(Rev C; Am 2) Cleaning Methods for Ferrous Surfaces and Pretreatments for Organic Coatings
FS TT-C-494	(Rev B; Notice 1) Coating Compound, Bituminous, Solvent Type, Acid Resistant

UNDERWRITERS LABORATORIES (UL)

UL-02	(1995) Building Materials Directory

1.2 PERFORMANCE REQUIREMENTS

1.2.1 Allowable Design Stresses

Aluminum-Alloy framing member allowable design stresses shall be in accordance with AA SAS-30 for the specified aluminum alloy.

Hot-rolled Structural Steel member allowable design stresses and design rules shall be in accordance with AISC S328 for the specified structural steel.

Cold-formed light-gage steel structural member allowable design stresses and design rules shall be in accordance with AISI SG-671, for the specified structural-steel Sheet and Strip.

1.2.2 Design Wind Load

Design wind load shall be 718 pascal.

1.2.3 Structural Requirements

Doors and frames shall be designed to withstand the specified design wind load acting normal to the plane of the entrance wall either inward or outward.

Deflection of any metal framing member in a direction normal to the plane of the entrance wall, when the glazed entrance is subjected to the specified wind pressure, shall not exceed 1/175 of the clear span of the member or 19 millimeter, whichever value is the lesser.

Deflection of any metal member in a direction parallel to the plane of the entrance wall, when the metal member is carrying its full design load,

shall not exceed 75 percent of the design clearance dimension between that member and the glass, sash, panel, or other part immediately below it.

1.2.4 Provisions for Thermal Movement

Doors and frames shall be designed to provide for expansion and contraction of the component parts caused by an ambient temperature range of minus 18 to 38 degrees C without causing buckling, opening of joints, overstressing of fasteners, or other harmful effects.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication drawings for the following items shall be in accordance with the paragraph entitled, "Fabrication," of this section.

Finish Hardware
Aluminum Doors
Frames

SD-02 Shop Drawings

Welds shall be in accordance with AWS A2.4 welding symbols.

Location and details of materials that are to be embedded in cast-in-place concrete and masonry construction.

A finish hardware schedule indicating type, quantity, manufacturer's name, catalog number, location, and finish.

Finish Hardware
Aluminum Doors
Frames

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Aluminum Doors
Glazing Materials
Finish Hardware
Installation Materials
Thresholds
Frames
Weatherstripping

SD-04 Samples

Contractor shall submit the following samples:

An Aluminum Finish for exposed-to-view surfaces, approximately75 millimeter wide by 150 millimeter long, to illustrate the aluminum producer's standard color and appearance range.

Preformed Glazing Gaskets, full size by 12 inches long.

Anchorage Devices and Fasteners, one full size of each type to be used in the work.

Lock Cylinders, one full size.

After approval, full size samples may be used in the construction, provided each is clearly identified and its location is recorded.

SD-08 Manufacturer's Instructions

Preventive Maintenance and Inspection for the following shall be in accordance with the paragraph entitled, "Finishes, Except Hardware," of this section.

Cleaning Materials
Application Methods

SD-10 Operation and Maintenance Data

Operation and maintenance manuals shall be submitted for the following items:

Finish Hardware
Aluminum Doors
Frames

1.4 DELIVERY, HANDLING, AND STORAGE

Doors, frames, and accessories shall be protected from damage during handling, transportation, and at the job site. Materials shall be stored at the site under cover on wood blocking or on suitable floors.

Packaged materials shall be stored in their original, unopened packages.

1.5 FIELD MEASUREMENTS

Field measurements shall be taken prior to the preparation of drawings and fabrication.

PART 2 PRODUCTS

2.1 METALS FOR FABRICATION

2.1.1 Aluminum-Alloy Extrusions

Extrusions shall conform to ASTM B 221M.

Alloy and temper shall be 6063-T5.

Sheets and plates shall conform to ASTM B 209M,Alloy 5005, and Temper H16.

2.1.2 Structural Steel

Hot-rolled shapes, plates, and bars shall conform to ASTM A 36/A 36M.

Hot-formed tubing shall conform to ASTM A 501.

Sheet and strip for cold-formed light gage structural members shall conform to ASTM A 570/A 570M, Grade 33.

2.1.3 Metals for Fasteners

Metals for fasteners shall be a type recommended by the door manufacturer, or as follows:

Aluminum-alloy bolts and screws from rod conforming to ASTM B 211M, Alloy 2024 and Temper T351

Aluminum-alloy nuts from rod conforming to ASTM B 211M, Alloy 6061 and Temper T6

Aluminum-alloy washers from sheet conforming to ASTM B 209M, Alloy 2024 and Temper T4

Aluminum-alloy rivets from rod or wire conforming to ASTM B 316/B 316M, Alloy 6053 and Temper T61

Corrosion-resistant steel fasteners from corrosion-resistant chromium-nickel steel, Type 302, form and condition best suited for the work

2.2 PAINT MATERIALS

Shop paint for aluminum shall conform to FS TT-C-494, Type II, bituminous solvent type.

Shop paint for steel shall be the manufacturer's standard rust-inhibiting primer.

2.3 GLAZING MATERIALS

Preformed Glazing Gaskets shall be elastomeric compression type, extruded to shape with factory-made tight fitting corners to suit the type of flush glazing and glass size.

Material shall conform to ASTM C 509.

2.4 FINISH HARDWARE

2.4.1 Overhead Surface-Mounted Door Closers

Surface-mounted door closers shall be liquid-controlled, rack-and-pinion construction, of a size best suited for the door weight and opening, conforming to BHMA A156.4, Type C02012. Closers shall be the product of one manufacturer.

Closer arms and mounting brackets shall be provided as required. Drop plates shall be provided, sized for the door stile dimension.

2.4.2 Butt Hinges

Hinges shall be the full-mortise, template, extra-heavy, ball bearing, five-knuckle type with button tips, conforming to BHMA A156.1, Type A2111, size 130 by 100 millimeter (nominal). Hinges for exterior out-swinging doors shall have pins that cannot be removed when the door is in the closed position. Hinges shall be the product of one manufacturer.

2.4.3 Door Pulls

Door pulls shall be extruded aluminum and of the door manufacturer's standard push-pull plate type.

2.4.4 Lock Cylinders

Cylinders complying with BHMA A156.5, shall encase interchangeable seven-pin tumbler cores. Temporary cores shall be provided and maintained for each cylinder during the construction period and removed when directed. Security cores will be installed by the Government.

2.4.5 Pull Handles

Handles shall be extruded aluminum, door manufacturer's standard panic device pull handle.

2.4.6 Panic Exit Devices

Exit devices shall be the top- and bottom-locking type with vertical rods concealed in door stiles. Devices shall be listed in UL-02 and shall bear the UL label.

Exit devices shall be in accordance with CABO A117.1 for handicap requirements.

Soffit strikes, sill strikes, and dogging keys shall be provided.

2.4.7 Thresholds

Thresholds shall be extruded aluminum for doors hung on butt or pivot hinges, with grooved tread, conforming to BHMA A156.6, Type J601.

2.4.8 Hardware Finishes

Finish designations are Builders' Hardware Manufacturer Association (BHMA)

code numbers, and conform to BHMA A156.18.

Butt or pivot hinges shall be BHMA Code 626. Finish of the cover enclosing the closer case shall be BHMA Code 626. Finish of closer arms, mounting brackets, and drop plates shall be BHMA Code 626.

Finish of door handles and lock cylinders shall be the same as that specified for doors and frames.

Panic exit devices shall be BHMA Code 626.

2.4.9 Hardware Sets

Hardware sets shall be as follows:

1-1/2	Pairs of butt hinges, each leaf
1	Overhead surface-mounted door closer, each leaf
1	Pull handle, each leaf
2	Lock cylinders, each active leaf
1	Panic exit device for exit only, each inactive leaf
1	Threshold, each door opening.

2.5 FABRICATION

2.5.1 Workmanship

Metal parts shall be accurately formed. Joints, except those designed to accommodate movement, shall be accurately fitted and rigidly assembled.

Welding shall be in accordance with AWS D1.1 and shall be done with filler metals and by methods recommended by the producer of the metal being welded. Welds behind finished surfaces shall cause no distortion or discoloration on the exposed side. Welded joints shall be cleaned of all welding flux and dressed on all exposed and contact surfaces.

Insofar as practical, fitting and assembly of the work shall be done in the manufacturer's plant. Work that cannot be permanently factory assembled shall be marked before shipment for proper assembly at the site.

2.5.2 Preparation for Finish Hardware

Preparations for mortised and concealed hardware shall be done at the factory and shall include cutouts, recesses, mortises, reinforcing, drilling, and tapping to receive the specified hardware sets. Preparations for hardware shall be made to the template of the manufacturer of each hardware item. Where concealed closers and other mechanisms are required, the necessary space, cutouts, reinforcement, and provisions for secure fastening shall be made. Where butt or pivot hinges are required, doors and frames shall be reinforced with backing plates to ensure adequate

strength of the fastening.

2.5.3 Protection of Aluminum from Dissimilar Materials

Surfaces that will come in contact with dissimilar metals, masonry, concrete, or wood shall be shop primed.

Surfaces shall be prepared in conformance with ASTM D 1730, Type B, Method 2.

Surfaces shall be given one shop coat of paint which shall be applied to dry, clean surfaces to provide a continuous minimum dry-film thickness of 0.038 millimeter.

2.5.4 Shop-Painting Steel

Surfaces of steel concealed in doors and frames shall be shop primed.

Prior to the application of the shop coat of paint, scale, rust, and other deleterious materials shall be removed in accordance with FS TT-C-490.

Surfaces shall be given two coats of paint; the second coat shall have a color different from the first coat. Paint shall be applied to provide a continuous minimum dry-film thickness of 0.038 millimeter for the first coat and 0.025 millimeter for the second coat.

2.5.5 Aluminum Doors

Doors shall be swing type, full glazed, stile-and-rail construction with medium stile, of the size indicated.

Stiles and rails shall be fabricated of aluminum-alloy tubular extrusions having a wall thickness not less than 3.1 millimeter.Corners shall be joined by both concealed welding and mechanical fastening. Corner connections shall be accurately milled to a hairline watertight joint.

Single swing doors shall have not more than 2.4 millimeter clearance at jambs and heads, 4.7 millimeterclearance at meeting edges of pairs of doors, and 13 millimeter clearance at the bottom. Dimensions are nominal and subject to the manufacturer's tolerances. Lock edges of doors shall provide the proper operating clearance.

Glazing moldings shall be fabricated of aluminum-alloy extrusions with wall thicknesses not less than 1.3 millimeter. Moldings shall be the snap-in flush glazing type with preformed glazing gasket, sized to receive the type and thickness of the glass. Moldings on the exterior face of doors shall be the nonremovable type without exposed screws. Moldings shall be carefully fitted and joined at corners.

2.5.6 Frames

Frames shall be of the section dimensions and arrangements indicated.

Frames shall be fabricated of aluminum-alloy extrusions with a wall

thickness of not less than 3.1 millimeter. Frame joints shall be sealed to prevent leakage. Door stops applied to the frames shall be secured with concealed fasteners. Anchors shall be provided for securing the frames to building construction. Sizes, shapes, and methods of anchoring shall be as detailed on the approved drawings.

Structural steel members required for the reinforcement of framing sections shall be provided with the frames and shall be hot-rolled shapes, hot-formed tubing, or cold-formed light-gage steel. Reinforcement shall be concealed inside the frame members.

Glazed openings in frames shall be designed for flush glazing. Glazing moldings and preformed glazing gaskets shall be as specified for doors.

2.5.7 Finishes, Except Hardware

Preventive Maintenance and Inspection for the aluminum manufacturer's recommended Cleaning Materials and Application Methods shall be submitted, including detrimental effects to the aluminum finish when improperly applied.

Aluminum Finish for exposed-to-view aluminum surfaces of the doors and frames shall be polished frosted finish with Class II clear anodic coating.

2.5.8 Hardware Locations

Hardware locations shall be as follows:

HARDWARE ITE	LOCATION
Door handles	Centerline of grip 1067 millimeter above the floor
Door pulls	Top fastening 1143 millimeter above the floor
Deadlocks	Centerline of strike 1525 millimeter above the floor
Panic exit devices	Centerline of strike 1025 millimeter above the floor
Top butt hinges	300 millimeter from the rabbet section of the head of the frame to the centerline of the hinge
Bottom butt hinges	330 millimeter from the finished floor to the centerline of the hinge
Intermediate butt hinges	Equally spaced between the top and bottom butt hinges

2.5.9 Weatherstripping

Exterior doors shall be provided with weatherstripping at heads, jambs, and

meeting stiles.

Weatherstripping shall be silicone treated wool pile inserted in a corrosion-resistant steel or extruded aluminum-alloy housing. Weatherstripping at meeting stiles of pairs of doors shall be adjustable. Weatherstripping shall be mortised into the door edges, or frame, or both, as required to suit the conditions. Weatherstripping shall be designed for easy removal and replacement.

2.6 INSTALLATION MATERIALS

2.6.1 Masonry-Anchorage Devices

Devices shall be expansion shields conforming to FS FF-S-325, group, type, and class as follows:

Shields for machine screws 6 millimeter and smaller shall be lead group, head-out embedded nut type, single unit class, conforming to Group I, Type 1, Class 1.

Shields for standard steel bolts and machine screws larger than 6 millimeter shall be lead group, head-out embedded nut type, multiple unit class, conforming to Group I, Type 1, Class 2.

2.6.2 Toggle Bolts

Toggle bolts shall be tumble-wing type, class and style best suited for the work, conforming to FS FF-B-588, Type II.

2.6.3 Standard Threaded Fasteners

Standard threaded fasteners shall be as follows:

Standard steel bolts: Regular hexagon head, low-carbon steel, coarse-thread series, conforming to ASTM F 568.

Nuts: Plain hexagon, regular style, carbon steel, conforming to ASTM A 563M.

Plain washers: Round, general assembly purpose grade, carbon steel, conforming to ASME B18.22M.

Lockwashers: Helical-spring, carbon steel, of the style best suited for the work, conforming to FS FF-W-84, Class A.

2.6.4 Electrodes for Welding Steel

Electrodes for welding steel by the manual shielded metal-arc welding process shall meet the requirements of AWS D1.1 and shall be covered mild-steel electrodes conforming to AWS A5.1, E60 series.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Doors, Frames and Accessories

Doors, frames, and accessories shall be installed in accordance with the approved shop drawings and descriptive data.

3.1.2 Materials Embedded in Other Construction

Materials such as cement boxes for checking floor hinges, concrete inserts, and anchor bolts, which are to be embedded in cast-in-place concrete and masonry construction, shall be delivered to the project site in time to be installed before the start of the other construction. Setting drawings, templates, instructions, and directions shall be provided for the installation of the embedded materials.

3.1.3 Fastening to Construction-in-Place

Anchorage devices and fasteners shall be provided where necessary for fastening the specified work to construction in place and shall include threaded fasteners for concrete inserts embedded in cast-in-place concrete, masonry anchorage devices and threaded fasteners for solid masonry and concrete in place, toggle bolts for hollow masonry and stud partitions, and connections for structural steel. Fastening shall be provided as specified. Fastening to wood plugs in masonry or concrete in place is not permitted.

3.1.4 Setting Masonry Anchorage Devices

Devices shall be set in masonry or concrete in place in accordance with the manufacturer's printed instructions. Holes shall be the recommended depth and diameter and shall be drilled using the drill recommended by the manufacturer of the particular anchorage device used. Drilled holes shall be left rough, not reamed, and free from drill dust.

3.1.5 Installation Tolerances

Doors and frames shall be installed in a manner not to exceed the following limits of tolerance:

Deviation in location from that indicated on the drawings	Plus or minus 6 millimeter
Deviation from the plumb or horizontal:	
In 3660 millimeter	Not more than 3 millimeter
In 7.3 or more meter	Not more than 6 millimeter
Offset from true alignment at joints between members in line end-to-end	Not more than 1.5 millimeter

3.1.6 Placing Frames

Supporting members, including materials embedded in other construction, shall be completely in place before placing frames. Framing members shall be installed plumb, level, and in alignment within the limits of the installation tolerances specified. Temporary supports and bracing shall be provided as required to maintain the position, stability, and alignment of the framing members while they are being permanently connected.

3.1.7 Door Installation

Doors shall fit accurately in frames within the specified door clearances.

3.1.8 Finish Hardware Installation

Contractor shall drill and tap as required for the application of surface-mounted finish hardware. True position shall be located by template to ensure accurate placement. Hardware items shall be installed in accordance with the manufacturer's printed instructions.

Thresholds shall be bedded in mastic and secured with corrosion-resistant steel flathead machine screws and lead expansion shields.

After installation is completed, hardware shall be adjusted and lubricated to ensure proper performance.

3.2 CLEANING

Upon completion of the installation, work shall be cleaned to remove all mastic smears and other foreign materials.

Before final acceptance, exposed-to-view aluminum surfaces shall be thoroughly washed with clean water and soap and rinsed with clean water. Acid solutions, steel wool, or other harsh abrasives shall not be used. Stains that remain after washing shall be removed or the finish restored in accordance with the aluminum producer's recommendations.

3.3 FINAL ADJUSTMENT

Before final acceptance, finish hardware shall be checked and readjusted as required to ensure proper operation.

3.4 ACCEPTANCE PROVISIONS

Doors and frames will be rejected for, but not limited to, any of the following deficiencies:

Exposed-to-view aluminum surfaces having color and appearance that are outside the color and appearance range of the approved samples for aluminum finish

Doors and frames not conforming to the requirements for installation tolerances and door clearances specified

Hardware that is not complete and operating properly

Doors and frames having stained, discolored, abraded, or otherwise damaged exposed-to-view aluminum surfaces that cannot be restored by cleaning or repairing

3.5 REPAIR OF DEFECTIVE WORK

Defective work shall be removed and replaced with new at no additional cost to the Government.

-- End of Section --

SECTION 08331

OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 153/A 153M	(1995) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 27/A 27M	(1993) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 446/A 446M	(1993) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A 48M	(1994; Rev A) Standard Specification for Gray Iron Castings (Metric)
ASTM A 525M	(1991; Rev A) Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process (Metric)
ASTM A 526/A 526M	(1990) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality
ASTM A 53	(1996) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM D 2000	(1996) Standard Classification System for Rubber Products in Automotive Applications
ASTM A 780	(1993) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM E 152	(1981; Rev A) Standard Methods of Fire

	Tests of Door Assemblies
ASTM F 568	(1995) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B29.1M	(1993) Precision Power Transmission Roller Chains, Attachments, and Sprockets

FEDERAL SPECIFICATIONS (FS)

FS FF-B-171	(Rev A; Am 1) Bearings, Ball, Annular (General Purpose)
FS TT-C-490	(Rev C; Am 2) Cleaning Methods for Ferrous Surfaces and Pretreatments for Organic Coatings

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA ICS 6	(1993) Enclosures for Industrial Control and Systems
NEMA MG 1	(1993) Motors and Generators
NEMA ST 1	(1988) Specialty Transformers (Except General Purpose Type)

UNDERWRITERS LABORATORIES (UL)

UL 674	(1994; 3rd Ed) UL Standard for Safety Electric Motors and Generators for Use in Hazardous (Classified) Locations
UL-02	(1995) Building Materials Directory

1.2 PERFORMANCE REQUIREMENTS

1.2.1 Wind Loading

Doors shall be designed and reinforced to withstand a wind loading pressure of at least .96 kilopascal with a maximum deflection of 1/120 of the opening width.

1.2.2 Fire Doors, Frames, and Hardware

Fire doors, frames, and hardware shall be types that have been fire tested, rated, and labeled in accordance with ASTM E 152. They shall bear metal UL labels as evidence of the rating. Labels shall indicate the rating in hours of duration of exposure to fire, with a letter following the hourly rating to designate the location for which the assembly is designed and the temperature rise on the unexposed face of the door at the end of 30 minutes

of fire exposure.

Door frames shall bear the UL label: "Listed Fire Door Frame." Special frames constructed of materials other than steel and intended for use with doors rated at less than 3 hours shall bear a UL label indicating the hourly rating.

Metal UL labels shall be attached to each item of hardware in accordance with requirements specified in the UL-02.

1.2.3 Oversized Rolling Fire Doors

Where fire doors and frames exceed the size for which testing and labeling services are offered, certificates of inspection from the UL shall be furnished. Certificates shall state that except for size, doors, frames, and hardware are identical in design, materials, and construction to a door that has been tested and rated by the UL.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication drawings shall show complete assembly with hardware and framing details for the following items:

Overhead Coiling Doors
Counterbalancing Mechanism
Manual Door Operators
Electric Door Operators

Installation Drawings shall be submitted in accordance with paragraph entitled, "Overhead Coiling Door Assemblies," of this section.

SD-03 Product Data

Manufacturer's catalog data for the following items shall be submitted listing all accessories including supports, locks and latches, and weatherstripping.

Overhead Coiling Doors
Hardware
Counterbalancing Mechanism
Manual Door Operators
Electric Door Operators
Fire-Rated Doors

SD-05 Design Data

Equipment and performance data for the following items shall be

submitted in accordance with the paragraph entitled, "Performance Requirements," of this section.

Overhead Coiling Doors
Hardware
Counterbalancing Mechanism
Manual Door Operators
Electric Door Operators
Fire-Rated Doors

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals for Overhead Coiling Door Assemblies shall be submitted.

1.4 FIELD MEASUREMENTS

Field measurements shall be taken prior to preparation of drawings and fabrication.

1.5 WARRANTY

Contractor shall furnish a written guarantee that the helical spring and counterbalance mechanism are free from defects in material and workmanship and that they will remain so for not less than 2 years after completion and acceptance of the project.

Contractor shall warrant that upon notification by the Government, he will immediately make good any defects in material, workmanship, and door operation within the same time period covered by the guarantee, at no cost to the Government.

1.6 OVERHEAD COILING DOOR ASSEMBLIES

Installation Drawings for overhead coiling door assemblies shall show rough frame opening dimensions, hardware and anchor locations, and counterbalancing mechanism and door operator details.

Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 days prior to testing the Overhead Coiling Door Assemblies. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

Operation and maintenance manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Test data shall be legible and of good quality.

PART 2 PRODUCTS

2.1 OVERHEAD COILING DOORS

2.1.1 Curtain Construction

Curtains shall be fabricated from steel sheets conforming to ASTM A 446/A 446M, Grade A, or to ASTM A 526/A 526M, with the additional requirement of a minimum yield point of 228 Megapascal.Sheets shall be galvanized in accordance with ASTM A 525M.

Doors shall be fabricated from interlocking cold-rolled slats, with section profiles as specified, designed to withstand the specified wind loading. Slats shall be continuous without splices for the width of the door.

Doors shall be provided with thermal insulation on interior surface of slats.

For doors not exceeding 4270 millimeter in width, slats shall be: flat-profile design, with a depth not less than 15.9 millimeter, a center-to-center width not more than 69.9 millimeter, and not less than a 1.21 millimeter uncoated thickness.

2.1.2 Curtain Bottom Bar

Curtain bottom bars shall be pairs of angles not less than 50 by 50 millimeter by 4.8 millimeter. Angles shall be steel conforming to ASTM A 36/A 36M. Angles and fasteners shall be galvanized in accordance with ASTM A 525M. Welds and abrasions shall be coated with paint conforming to ASTM A 780.

2.1.3 Wind Locks

Wind locks shall be cast steel conforming to ASTM A 27/A 27M, Grade B. Locks shall be galvanized in accordance with ASTM A 525M, and secured to the curtain slats. A wind lock shall be provided on every other curtain slat.

2.1.4 Weatherstripping

Weatherstripping for door heads shall be 3.2 millimeterthick sheet natural rubber or neoprene rubber air baffles secured to the insides of hoods with galvanized-steel fasteners through continuous galvanized-steel pressure bars at least 15.9 millimeterwide and 3.2 millimeter thick.

Weatherstripping for door-jamb guides shall be 3.2 millimeter thick strip natural rubber or neoprene rubber secured to the exterior sides of jamb guides with galvanized-steel fasteners through continuous galvanized-steel pressure bars at least 15.9 millimeter wide and 3.2 millimeter thick.

Bottom astragals shall be 3.2 millimeter thick sheet natural rubber or neoprene rubber secured to the bottom bars.

Weatherstripping and astragals shall be natural rubber or neoprene rubber conforming to ASTM D 2000.

2.2 HARDWARE

2.2.1 Curtain Jamb Guides

Curtain jamb guides shall be fabricated from a combination of steel angles of sufficient size to retain the curtain against the specified wind loadings. Guides shall be fabricated from rolled structural-quality carbon-steel angles conforming to ASTM A 36/A 36M. Guide assembly shall be galvanized in accordance with ASTM A 525M. Bolt holes shall be slotted for track adjustment. Welds and abrasions shall be coated with paint conforming to ASTM A 780.

2.2.2 Equipment Supports

Door-operating equipment supports shall be fabricated from steel shapes and plates conforming to ASTM A 36/A 36M, galvanized in accordance with ASTM A 525M. Shapes and plates shall be sized in accordance with the manufacturer's standard practices for the size, weight, and type of door installation.

2.2.3 Threaded Fasteners

Threaded fasteners shall consist of unfinished low-carbon steel bolts and nuts conforming to ASTM F 568,galvanized per ASTM A 153/A 153M, Table 1.

2.3 COUNTERBALANCING MECHANISM

Doors shall be counterbalanced by an adjustable, steel, helical torsion spring mounted around a steel shaft in a spring barrel and connected to the door curtain with the required barrel rings.

2.3.1 Brackets

Mounting brackets shall be the manufacturer's standard with one located at each end of the counterbalance barrel. Brackets shall be gray cast iron conforming to ASTM A 48M.

2.3.2 Hoods

Hoods shall be fabricated from steel sheets conforming to ASTM A 446/A 446M, Grade A, or to ASTM A 526/A 526M, with the additional requirement of a minimum yield strength of 227.5 Megapascal. Sheets shall be galvanized in accordance with ASTM A 525M. Material shall have an uncoated thickness of not less than 0.76 millimeter. Hoods shall be reinforced to prevent hood deflection.

2.3.3 Counterbalance Barrels

Counterbalance-barrel components shall be as follows:

Spring barrels shall be hot-formed structural-quality carbon-steel, welded or seamless pipe conforming to ASTM A 53, Type E or S, Grade A, with the steel yield point and design stresses conforming to ASTM A 36/A 36M. Pipe shall be of sufficient diameter and wall thickness to limit deflection to a maximum of 1/360 of the span. Barrels shall be hot-dip galvanized, inside and outside, in conformance with ASTM A 525M.

Counterbalance springs shall be oil-tempered helical steel springs

designed with a safety factor of not less than 4. Springs shall be sized to counterbalance the weight of the curtain at any point of its travel, and shall be capable of being adjusted to counterbalance not less than 125 percent of the normal curtain load. Spring adjustment shall be arranged in such a way that the curtain need not be raised or lowered to secure the adjustment.

Counterbalance shafts shall be case-hardened steel of the proper size to hold the fixed ends of the spring and carry the torsional load of the spring.

Barrel plugs shall be fabricated from cast steel machined to fit the ends of the barrel. Plugs shall secure the ends of the spring to the barrel and the shaft. Plugs shall be galvanized in conformance with ASTM A 525M.

Barrel rings shall be fabricated from malleable iron of the proper involute shape to coil the curtain in a uniformly increasing diameter.

Shaft bearings shall be factory-sealed ball bearings conforming to FS FF-B-171 and of the proper size for load and shaft diameters.

2.4 ELECTRIC DOOR OPERATORS

Electrical wiring shall conform to the applicable requirements of Section 16145, "Standard Wiring Systems."

Door operator controls shall conform to the applicable requirements of Section 16286, "Overcurrent Protective Devices."

Electric door-operator assemblies shall be the sizes and capacities recommended and provided by the door manufacturer for specified doors. Assemblies shall be complete with electric motors and factory-prewired motor controls, gear reduction units, solenoid-operated brakes, clutches, remote-control stations, manual or automatic control devices, and control of stations and accessories as required for proper operation of the doors.

Operators shall be so designed that motors may be removed without disturbing the limit-switch adjustment and without affecting the emergency auxiliary operators.

A manual operator of crank-gear or chain-gear mechanisms with a release clutch shall be provided to permit manual operation of doors in case of power failure. Emergency manual operator shall be so arranged that it may be put into and out of operation from floor level, and its use shall not affect the adjustment of the limit switches. An electrical or mechanical device shall be provided which will automatically disconnect the motor from the operating mechanism when the emergency manual operating mechanism is engaged.

2.4.1 Door-Operator Types

Door operators shall be wall-mounted units consisting of an electric motor, a worm-gear drive from the motor to the reduction gear box, a chain or worm-gear drive from the reduction gear box to the gear wheel mounted on

the counterbalance shaft, and a quick-clutch disconnect release for manual operation. Motor, clutch, and drive assembly shall be the wattage rating and design determined by the door manufacturer for the size of the door and as specified.

2.4.2 Motors

Motors shall be the high-starting-torque, reversible, constant-duty electrical type with overload protection. Motors shall be of sufficient torque and wattage to move the door in either direction from any position and produce a door-travel speed of not less than 0.2 nor more than 0.3 meter per second without exceeding the wattage rating.

Motors shall conform to NEMA MG 1 and to the requirements specified.

Fractional wattage motors up to 375 watts shall be single-phase, 115-volt, 60-hertz, or 115/230-volt, 60-hertz. A dual voltage rating may be provided at the option of the Contractor.

Motors 375 watts and larger shall be three-phase, 230/460-volt, 60-hertz.

Motor frame sizes shall conform to NEMA MG 1.

Motor enclosures shall be totally enclosed nonventilated or fan-cooled enclosures certified for continuous operation at full nameplate power output in an ambient temperature of 40 degrees C.Enclosures shall be fitted with plugged drains.

Explosionproof motors shall be certified for continuous operation at full nameplate power output in an ambient temperature of 40 degrees C. Enclosures shall be fitted with UL-approved drains and breathers. Explosionproof motors shall be certified and labeled to indicate conformance to the following:

UL 674, Class I, Groups C and D

2.4.3 Motor Bearings

Bearings shall be bronze-sleeve or heavy-duty ball or roller antifriction type with full provisions for the type of thrust imposed by the specific duty load.

Bearings in motors less than 375 watts shall be prelubricated and factory sealed.

Motors coupled to worm-gear reduction units shall be equipped with either ball or roller bearings.

Bearings in motors 375 watts or larger shall be equipped with lubrication service fittings. Lubrication fittings shall be fitted with color-coded plastic or metal dust caps.

In any motor, bearings that are lubricated at the factory for extended duty periods shall not need to be lubricated for a given number of operating

hours. An appropriate tag or label on the motor shall display this information.

2.4.4 Motor Starters, Controls, and Enclosures

Each door motor shall have a factory-wired, unfused, disconnect switch; a reversing, across-the-line magnetic starter with thermal overload protection; 120-volt operating coils with a control transformer limit switch; and a safety interlock assembled in a NEMA ICS 6 type enclosure as specified herein.

Adjustable switches, electrically interlocked with the motor controls and set to stop the door automatically at the fully open and fully closed position, shall be provided.

2.4.5 Control Enclosures

Control enclosures shall conform to NEMA ICS 6 for explosionproof NEMA Type 9, group as indicated.

2.4.6 Transformer

Starters with 230/460 to 115 volt control transformers with one secondary fuse shall be provided when it is required to reduce the voltage on control circuits to 120 volts or less. Transformers shall conform to NEMA ST 1.

2.4.7 Safety-Edge Device

Each door shall be provided with a pneumatic safety device extending the full width of the door and located within a U-section neoprene or rubber astragal mounted on the bottom rail of the bottom door section. Device shall immediately stop and reverse the door upon contact with an obstruction in the door opening during downward travel and shall cause the door to return to full-open position. Safety device shall not be a substitute for a limit switch.

Safety device shall be connected to the control circuit through a retracting safety cord and reel.

2.4.8 Remote-Control Stations

Interior remote-control stations shall be full-guarded, momentary-contact three-button, heavy-duty, surface-mounted NEMA ICS 6 type enclosures as specified. Buttons shall be marked "OPEN," "CLOSE," and "STOP." The "CLOSE" button shall be the type requiring a constant pressure to maintain the closing motion of the door. When the door is in motion and the "STOP" button is pressed, the door shall stop instantly and remain in the stopped position; from the stopped position, the door may then be operated in either direction.

Exterior control stations shall be full-guarded, momentary-contact three-button standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosures, key-operated, with the same operating functions as specified herein for interior remote-control stations.

2.4.9 Speed-Reduction Units

Speed-reduction units shall consist of hardened-steel worm and bronze worm gear assemblies running in oil or grease and encased in a sealed casing, coupled to the motor through a flexible coupling. Drive shafts shall rotate on ball- or roller-bearing assemblies that are integral with the unit.

Minimum ratings of speed reduction units shall be in accordance with AGMA provisions for class of service.

Worm gears shall be ground to provide accurate thread form; all other types of gearing shall have machined teeth. All gears shall be surface hardened.

Bearings shall be the antifriction type equipped with oil seals.

2.4.10 Chain Drives

Roller chains shall be power-transmission series steel roller type conforming to ASME B29.1M, with a minimum safety factor of 10 times the design load.

Roller-chain side bars, rollers, pins, and bushings shall be heat-treated or otherwise hardened.

Chain sprockets shall be high-carbon steel with machine-cut hardened teeth, finished bore and keyseat, and hollow-head setscrews.

2.4.11 Brakes

Brakes shall be internally expanding 360-degree shoe brakes or shoe and drum brakes, solenoid-operated and electrically interlocked to the control circuit to set automatically when power is interrupted.

2.4.12 Clutches

Clutches shall be the 100 millimeter diameter, multiple face, externally adjustable friction type or adjustable centrifugal type.

2.5 SURFACE FINISHING

Zinc-coated steel materials shall be chemically cleaned, rinsed, given a zinc-phosphate conversion coating, rinsed with cold water, and then sealed with a chromic-acid rinse in accordance with FS TT-C-490, Method III, Type I. Minimum weight of the pretreatment coating shall be not less than 1.6 gram per square meter.

PART 3 EXECUTION

3.1 GENERAL

Doors, tracks, and operating equipment shall be installed complete with specified preparatory framing, jamb and head mold stops, anchors, inserts,

hangers, and equipment supports in accordance with approved drawings, manufacturer's printed instructions, and as specified.

Door guide-track assembly shall be fastened to steel or wood framing with M13 galvanized machine bolts or lag screws, not more than 600 millimeter on center, and erected plumb and true to a vertical alignment with not more than 3.2 millimeterdeviation in 6100 millimeter.

3.2 ACCEPTANCE PROVISIONS

After installation, doors, track, and operating equipment will be examined and tested by the Government for general operation, for operation against the specified wind pressure, and for resistance to weather.

Doors that fail the required tests shall be adjusted and retested. Doors that have been adjusted and which fail subsequent tests shall be removed and replaced with new doors. New doors shall be tested and adjusted at no additional cost to the Government.

3.2.1 Maintenance and Adjustment

Not more than 90 days after completion and acceptance of the project, the Contractor shall examine, lubricate, test, and re-adjust doors as required for proper operation.

-- End of Section --

SECTION 08710

DOOR HARDWARE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ALUMINUM ASSOCIATION (AA)

AA 45	(1980) Designation System for Aluminum Finishes

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.1	(1988) Butts and Hinges
BHMA A156.13	(1994) Mortise Locks and Latches
BHMA A156.16	(1989) Auxiliary Hardware
BHMA A156.18	(1987) Materials and Finishes
BHMA A156.2	(1989) Bored and Preassembled Locks and Latches
BHMA A156.21	(1989) Thresholds
BHMA A156.3	(1994) Exit Devices
BHMA A156.4	(1992) American National Standards for Door Controls - Closers
BHMA A156.5	(1992) Auxiliary Locks & Associated Products
BHMA A156.6	(1994) Architectural Door Trim

STEEL DOOR INSTITUTE (SDOI)

SDOI SDI-100	(1991) Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL-02	(1995) Building Materials Directory

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330,

"Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Fasteners
Hinges
Locksets
Exit Devices
Thresholds
Lever Extension Flush Bolts
Closers
Astragals
Coordinating Device
Door Holders
Door Stops
Door Silencers
Metal Kick Plates
Metal Mop Plates
Door-Sill Weatherstripping
Rain drips

1.3 GENERAL

A Finish Schedule shall include a Hardware Scheduleindicating the door and frame location, type, size, swing, bevel, material, hardware type by Builders' Hardware Manufacturers Association (BHMA) numbers, and the respective manufacturer's type, name, number, finish, and design, Material, Equipment and Fixture Lists shall be provided prior to the hardware schedule, showing a list of the proposed Finish Hardware by manufacturer, type, name, series, material and finish.

Manufacturer's Instructions for finish hardware shall indicate the manufacturer's recommended method and sequence of installation.

PART 2 PRODUCTS

2.1 FASTENERS

Fasteners of the proper type, size, quantity, and finish for each hardware item shall be provided. All visible fasteners shall be phillips-head, bronze or stainless steel finished to match specified hardware.

2.2 HINGES

Hinges shall be full mortise, heavy weight, anti-friction bearing, button tip, template type conforming to BHMA A156.1, Grade 1. Size shall be nominal 114- by 114 millimeter.

2.3 LOCKSETS

2.3.1 General

Cylinder bored locksets and latchsets shall conform to BHMA A156.2, plain design and wrought trim.

Mortise locksets and latchsets shall conform to BHMA A156.13.

Locksets and latchsets shall have standardized fronts, cases, and strikes so that varying functions will be interchangeable and will require only one mortise for their installation. Locks and latches shall have beveled bronze fronts, bronze bolts and strikes, brass hubs, and cases with specified finish. Locks shall have cylinders conforming to BHMA A156.5.

Locksets and lock cylinders shall be master keyed to the key system established for the installation.

2.3.2 Mortise Locksets

Mortise locksets and latchsets for fire-rated doors shall be UL listed and labeled, heavy duty, Series 1000, Grade 1.

Heavy duty usage mortise locksets and latchsets shall be Series 1000, Grade 1.

2.4 EXIT DEVICES (PANIC HARDWARE)

Exit devices shall be Concealed Vertical Rod Type as defined in BHMA A156.3.

2.5 THRESHOLDS

Thresholds shall be extruded aluminum 6063-alloy mill finish conforming to BHMA A156.21, Type J604 (vinyl) weatherstrip.

Thresholds shall be provided for the full width of the opening at exterior doors.

2.6 LEVER EXTENSION FLUSH BOLTS

Flush bolts shall be cast or extruded brass or aluminum, specified finish, conforming to BHMA A156.16, with 300 millimeter lever extensions.

Flush bolts shall be a type listed in UL-02 for fire-rated doors.

2.7 CLOSERS

Closers shall conform to BHMA A156.4.

Closers shall be the surface mounted heavy duty, parallel arm type, Grade 1. Style shall be modern.

Brackets, reinforcing plates, and accessory fittings shall be provided as required.

2.8 ASTRAGALS

Astragals shall be prime steel, 2.3 millimeter minimum by 41 millimeter side minimum.

2.9 COORDINATING DEVICE

A coordinating device shall be provided for each pair of doors with an overlapping astragal or with rabbeted stiles.

Coordinating devices shall conform to BHMA A156.3, bronze or stainless steel, finish to match the locksets.

2.10 MISCELLANEOUS AND SHELF HARDWARE

2.10.1 General

Miscellaneous hardware shall conform to BHMA A156.16, except as noted, and shall match or have the same finish as lockset finish.

2.10.2 Door Stops

Door stops and bumpers shall conform to BHMA A156.16.

Wall mounted stops shall be Type L02101 (wall bumper). Where impossible to install wall mounted stops, floor mounted stops, Type L02141 (dome type) or Type L02161 (dome type for door with thresholds) shall be provided.

2.10.3 Door Silencers

Door silencers conforming to BHMA A156.16 shall be provided except on fire-rated door frames.

Door silencers shall be Type L03011 for metal frames and Type L03021 for wood frames.

2.10.4 Metal Kick Plates

Plates shall be 1.3 millimeter thick stainless steel, bevel edge, Type J102 (Kick), conforming to BHMA A156.6, finish as specified herein. Width of kick plates shall be 50 millimeter less than the door width. Height of kick plates shall be 200 millimeter. When the bottom rail of the door is less than 215 millimeter, the kick plates shall extend to within 13 millimeter of the panel mold or bead.

2.11 WEATHERSTRIPPING MATERIALS

2.11.1 Door-Sill Weatherstripping

Weatherstripping shall consist of a 3-millimeter thick by 35-millimeter high neoprene strip housed in an extruded, anodized aluminum housing approximately 1.8-millimeter thick by 32-millimeter high by the full width of the door and attached to the door with countersunk screws.

2.11.2 Rain Drips

Drip for installation on the door exterior at the sill shall be extruded aluminum approximately 2.4 millimeter thick by 35-millimeter deep by 16 millimeter projection.

2.11.3 Meeting Rails

Weatherstripping for pairs of single-acting exterior doors shall consist of 3-millimeter thick by 19-millimeter wide feather-edged neoprene strips housed in extruded anodized aluminum Z-shape strips 1.65-millimeter thick by 25-millimeter wide by the full height of the opening. There shall be one strip on each leaf overlapping.

2.12 FINISHES

Hardware shall receive the following finish(es) conforming to BHMA A156.18, as follows:

Hinges, locksets and latchsets	Satin chromium plated on brass or bronze, BHMA Code 626
Hinges at labeled openings	Satin chromium plated on steel, BHMA Code 652
Exit bolts (panic hardware)	Match locksets and latchsets
Closers	Sprayed, matching locksets and latchsets
Lever extension flush bolts	Satin aluminum, clear anodized, BHMA Code 628
Push-pulls	Satin aluminum, clear anodized, BHMA Code 628
Door stops, door holders, weatherstripping, astragals	Match locksets and latchsets

Aluminum hardware items shall be anodized to an Architectural Class II natural finish not less than 0.01 millimeter thick conforming to AA 45 (designation AA M21 C22 A31).

PART 3 EXECUTION

3.1 GENERAL

Hardware shall be installed and adjusted in accordance with the hardware manufacturer's printed instructions and to template dimensions.

Temporary-construction cores shall be furnished, installed, and maintained in locks during construction and removed when directed.

3.2 HARDWARE LOCATION

Hardware shall be located in accordance with SDOI SDI-100, Table V, except when template dimensions and multiple-item installations require alternate locations.

3.3 HARDWARE SCHEDULE

Hardware Set No. 1:

1-1/2 PAIR HINGES	BB1168 X 114MM X 114MM FINISH US26D	KAWNEER
1 PULL	210mm CLEAR ANODIZED STYLE "G-3"	KAWNEER
1 EACH CYLINDER	1E74, 7 PIN REMOVABLE CORE, FINISH US26D	BEST
1 EA CLOSER	4040 ALUM CLOSURE WITH PARALLEL ARM	LCN
1 EA EXIT DEVICE	CONCEALED ROD ACTIVATING PANEL CONCEALED WITHIN DOOR CROSSRAIL PANELINE II	KAWNEER
1 EA THRESHOLD	12mm x 101mm MILL FINISH ALUMINUM	KAWNEER
1 EACH WEATHERSTRIP	MILL FIN ALUMINUM	KAWNEER

Hardware Set No. 2:

1-1/2 PAIR HINGES	BB1168 X 114MM X 114MM FINISH US26D	HAGER
1 EACH LOCKSET	ML 2230 WITH "NEWPORT" LEVER HANDLE, FINISH US32D	CORBIN/RUSSWIN
1 EACH CYLINDER	1E74, 7 PIN REMOVABLE core, FINISH US26D	BEST
1 EA DOOR STOP(WALL)	236W, FINISH US32D	HAGER

Hardware Set No. 3:

1-1/2 PAIR HINGES	BB1168 X 114MM X 114MM FINISH US26D	HAGER
1 EACH LOCKSET	ML 2230 WITH "NEWPORT" LEVER HANDLE, FINISH US32D	CORBIN/RUSSWIN

1 EACH CYLINDER	1E74, 7 PIN REMOVABLE core, FINISH US26D	BEST

Hardware Set No. 4:

1-1/2 PAIR HINGES	BB1168 X 114MM X 114MM FINISH US26D	HAGER
1 EACH LOCKSET	DL2700 PROGRAMABLE 12 BUTTON KEYPAD WITH LEVER HANDLE	WESTGUARD
1 EA DOOR STOP(WALL)	236W, FINISH US32D	HAGER
1 EACH CLOSER	4110 ALUM CLOSURE WITH PARALLEL ARM	LCN

Hardware Set No. 5:

1-1/2 PAIR HINGES	BB1168 X 114MM X 114MM FINISH US26D	HAGER
1 EACH LOCKSET	ML 2251, WITH "NEWPORT" LEVER HANDLE, FINISH US32D	CORBIN/RUSSWIN
1 EACH CYLINDER	1E74, 7 PIN REMOVABLE core, FINISH US26D	BEST
1 EA DOOR STOP(WALL)	236W, FINISH US26D	HAGER

Hardware Set No. 6:

3 PAIR HINGES	BB1168 X 114MM X 114MM FINISH US26D	HAGER
1 EACH LOCKSET	ML 2251, WITH "NEWPORT" LEVER HANDLE, FINISH US32D (ACTIVE LEAF ONLY)	CORBIN/RUSSWIN
1 EACH CYLINDER	1E74, 7 PIN REMOVABLE core, FINISH US26D (ACTIVE LEAF ONLY)	BEST
1 EACH CLOSER	4110 ALUM CLOSURE WITH PARALLEL ARM (ACTIVE LEAF ONLY)	LCN
1 EA FLUSH BOLT	MANUAL FLUSH BOLT WITH LEVER EXTENSION, 28D, FINISH US26D (TOP & BOTTOM OF INACTIVE LEAF ONLY)	HAGER

1 EA KICK PLATE	203MM X 864MM X 1.6MM THICK STAINLESS STEEL, INTERIOR SIDES OF BOTH LEAFS	
1 EACH THRESHOLD	254X226AN, MILL FIN ALUM	PEMKO
1 EACH WEATHERSTRIP	297AS, MILL FIN ALUM, JAMBS & ASTRAGAL	PEMKO

Hardware Set No. 7:

3 PAIR HINGES	BB1168 X 114MM X 114MM FINISH US26D	HAGER
1 EACH LOCKSET	ML 2251, WITH "NEWPORT" LEVER HANDLE, FINISH US32D (ACTIVE LEAF ONLY)	CORBIN/RUSSWIN
1 EACH CYLINDER	1E74, 7 PIN REMOVABLE CORE, FINISH US26D (ACTIVE LEAF ONLY)	BEST
1 EACH CLOSER	4110 ALUM CLOSURE WITH PARALLEL ARM (ACTIVE LEAF ONLY)	LCN
1 EA FLUSH BOLT	MANUAL FLUSH BOLT WITH LEVER EXTENSION, 28D, FINISH US26D (TOP & BOTTOM OF INACTIVE LEAF ONLY)	HAGER
1 EA KICK PLATE	203MM X 864MM X 1.6MM THICK STAINLESS STEEL (BOTH SIDES OF BOTH LEAVES)	

Hardware Set No. 8:

1-1/2 PAIR HINGES	BB1168 X 114MM X 114MM FINISH US26D	HAGER
1 EACH LOCKSET	ML 2251, WITH "NEWPORT" LEVER HANDLE, FINISH US32D	CORBIN/RUSSWIN
1 EACH CYLINDER	1E74, 7 PIN REMOVABLE CORE, FINISH US26D	BEST
1 EACH CLOSER	4110 ALUM CLOSURE WITH PARALLEL ARM	LCN
1 EACH THRESHOLD	254X226AN, MILL FIN ALUM	PEMKO

1 EACH WEATHERSTRIP	290AS, MILL FIN ALUM	PEMKO

Hardware Set No. 9:

3 PAIR HINGES	BB1168 X NRP 127MM X 114MM FINISH US26D	HAGER
1 EACH LOCKSET	DL2700 PROGRAMABLE 12 BUTTON KEYPAD WITH LEVER HANDLE (ACTIVE LEAF ONLY)	WESTGUARD
1 EACH CLOSER	4110 ALUM CLOSURE WITH PARALLEL ARM & STOP	LCN
1 EA FLUSH BOLT	MANUAL FLUSH BOLT WITH LEVER EXTENSION, 28D, FINISH US26D (TOP & BOTTOM OF INACTIVE LEAF ONLY)	HAGER
2 EA KICK PLATE	203MM X 864MM X 1.6MM THICK STAINLESS STEEL (BOTH SIDES OF BOTH LEAVES)	

Hardware Set No. 10:

3 PAIR HINGES	BB1168 X 114MM X 114MM FINISH US26D	HAGER
2 EACH EXIT DEVICE	ED5400 X 5400, WITH "NEWPORT" LEVER HANDLE, FINISH US32D	CORBIN/RUSSWIN
2 EACH CYLINDER	1E74, 7 PIN Removable CORE, FINISH US26D	BEST
2 EACH CLOSER	4110 ALUM CLOSURE WITH PARALLEL ARM & STOP	LCN
1 EACH THRESHOLD	254X226AN, MILL FIN ALUM	PEMKO
2 EACH KICKPLATE	203MM X 1170MM X 1.6MM THICK STAINLESS STEEL (INTERIOR SIDE OF BOTH LEAVES)	

1 EACH WEATHERSTRIP	297AS, MILL FIN ALUM JAMBS & ASTRAGAL	PEMKO

-- End of Section --

SECTION 08805

GLASS AND GLAZING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 800	(1992) Voluntary Specifications and Test Methods for Sealants

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z97.1	(1984; R 1994) American National Standards for Safety Glazing Material Used in Buildings - Safety Performance Specifications and Methods of Test

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 1036	(1991) Standard Specification for Flat Glass
ASTM C 669	(1995) Standard Specification for Glazing Compounds for Back Bedding and Face Glazing of Metal Sash
ASTM C 920	(1995) Standard Specification for Elastomeric Joint Sealants

FLAT GLASS MARKETING ASSOCIATION (FGMA)

FGMA-01	(1990) Glazing Manual

UNDERWRITERS LABORATORIES (UL)

UL-02	(1995) Building Materials Directory

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the referenced standards and tests contained in this section.

Glass Materials
Glazing Materials
Safety Rated Tempered Glass
Fire-Rated Wired Glass

1.3 DELIVERY, STORAGE AND HANDLING

Manufactured glass units shall be delivered and stored until installation in the manufacturer's container's and shall be clearly marked on the exterior as to type, and quantity of units.

When special moisture protection is required, glass shall be stored in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 GLASS MATERIALS

2.1.1 Clear Glass

Glass shall be float type conforming to ASTM C 1036, Type I, Class 1, Quality q3.

Maximum allowable areas of glass subject to wind pressure shall conform to the glass manufacturer's recommendations.

2.1.2 Heat-Absorbing Glass

Glass shall be float type conforming to ASTM C 1036, Type I, Class 2, Style A, Quality q3. Edges shall be factory clean-cut.

Maximum allowable areas of glass subject to wind pressure shall conform to the glass manufacturer's recommendations.

2.1.3 Safety-Rated Tempered Glass

Glass shall conform to ANSI Z97.1 and shall bear the ANSI safety glass marking.

Glass before tempering shall be the float type conforming to ASTM C 1036, Type I, Class 1, Quality q3.

Glass shall be factory-cut to suit each opening. Edges shall be clean cut.

2.1.4 Fire-Rated Wired Glass

Glass shall be UL approved for fire windows and doors, shall be listed in the UL-02, Guide Designation KCMZ, and shall bear the UL listing and marking.

Polished wire glass shall conform to ASTM C 1036, Type II, Class 1, Form 1, Mesh m1.

Figured fire-rated glass shall conform to ASTM C 1036, Type II, Class 1, Form 2, Mesh m1 or m2. Pattern shall be hexagonal.

2.1.5 Double-Glazing Units

Units shall be factory fabricated, shall be two panels of flat glass separated by a hermetically sealed, dehydrated air space.

Maximum allowable areas of glass subject to wind pressure shall conform to the glass manufacturer's recommendations.

Tinted double-glazing units shall be as follows:

OUTER PANE GLASS, THICKNES	INNER PANE GLASS, THICKNES	AIR SPACE WIDT	EDGE SEAL
Tinted light tint, 6 millimeter thick	Clear float 6 millimeter thick	12 millimeter	Dual Seal

2.2 GLAZING MATERIALS

2.2.1 Elastic Glazing Compound

Elastic glazing compound shall conform to ASTM C 669.

Color of the sealing compound shall match the color of the metal sash as closely as possible.

2.2.2 Glazing Tape

Tape shall be nonskinning, nonoily, reinforced class, butyl- or polyisobutylene-base resilient preformed compound conforming to AAMA 800.

2.2.3 Elastomeric Sealing Compound

Compound shall be the two-component, nonsag type, resistant to 50 percent total joint movement, conforming to ASTM C 920, Type S, Class 25.

Compound shall match the color of the metal sash as closely as possible.

Primer for the compound shall be as recommended by the elastomeric sealing compound manufacturer.

2.2.4 Solvents and Cleaning Agents

Solvents, cleaning agents, and other cleaning materials shall be as recommended by the glazing-material manufacturer.

2.2.5 Glazing Clips

Clips shall be zinc-coated or copper-clad spring-steel wire or nonferrous metal and shall be the type, sizes, and shapes suitable for the intended use.

2.2.6 Resilient Setting Blocks and Spacers

Blocks shall be solid chloroprene elastomeric extrusions having a Shore A durometer hardness between 70 and 90. Thickness shall be approximately the same as the glass-edge clearance dimension; the length shall be 100 millimeter, minimum.

Spacers shall be solid chloroprene elastomeric extrusions having a Shore A durometer hardness between 40 and 50. Spacers shall be 25 to 75 millimeter long with thickness and height to suit the application.

PART 3 EXECUTION

3.1 GENERAL

Glass shall be installed in accordance with the manufacturer's printed instructions.

Field cutting, or nipping or grinding the edges of glass will not be permitted.

Sheet glass shall be installed with the wave horizontal.

Figured glass for exterior openings shall be installed with the smooth side to the exterior.

Operable sash shall move freely and properly in the frame of the unit prior to the start of glazing. Movable items shall be securely fixed or in a closed and locked position until the glazing material has set.

Sizes of glass shown on drawings are approximate. Sizes and proper edge clearances shall be determined by measuring the actual unit to receive glass. Except where specified otherwise, each piece of glass shall bear the manufacturer's label to identify its type as well as thickness and quality. Labels shall not be removed until final approval is obtained.

3.2 TEMPERATURE AND ATMOSPHERIC CONDITIONS

Glazing materials shall not be installed when the ambient temperature is below 4 or above 38 degrees C.

Exterior glazing shall not be performed in damp or rainy weather.

3.3 GLAZED OPENINGS PREPARATION

Surface of rabbets shall be clean and dry prior to the start of glazing.

Surfaces in contact with glazing materials shall be clean and free of loose particles, surface dust, and other foreign matter.

When elastomeric sealing compound is used, the surfaces shall be cleaned with a solvent that leaves no residue. Surfaces shall be wiped dry before the solvent has air dried.

3.4 CLEARANCES AND POSITIONING GLASS

Face and edge clearances and positioning glass with setting blocks and spacers shall be as recommended in the FGMA-01.

3.5 APPLICATION OF GLAZING COMPOUNDS

Glazing compounds shall be installed in accordance with the manufacturer's printed instructions and as follows:

Elastic glazing compound shall be knife-applied as it comes from the container, without adulteration.

Thermoplastic sealing compound shall be warmed. Compound shall be gun-applied to fill the cavity without air pockets.

Glazing tape shall be compressed slightly to obtain a positive bond and neatly mitered or butted at corners. Backing paper shall be removed prior to installation of the glass.

Elastomeric sealing-compound components shall be mixed. Compound shall be gun-applied to fill the cavity without air pockets.

3.6 SINGLE GLASS IN METAL SASH WITH FACE GLAZING

Single-glass lights up to 1270 united millimeterin size, with the greatest dimension not exceeding 760 millimeter, shall be set in metal sash with elastic glazing-compound back bed, heel bead, and front putty.

Single-glass lights between 1270 and 2540 united millimeter in size, with the greatest dimension between 760 and 1270 millimeter, shall be set in metal sash with a glazing-tape back bed, an elastic-glazing compound heel bead, and front putty.

Front of each glass light edge in the sash rabbet shall be face-puttied with elastic glazing compound to form a triangular fillet, stopping 2 millimeter short of the sight line. Corners shall be mitered finish and excess compound shall be removed. Surplus back-bed material shall be stripped at an angle without undercutting.

3.7 DOUBLE UNITS IN METAL SASH WITH CHANNEL GLAZING

Double-glazing units shall be set in metal sash with channel glazing in accordance with the recommendations of the FGMA-01.

A void shall be provided at the head and jambs. Excess elastomeric glazing compound on the sash shall be removed with a glazing knife at a slight angle over the sight line.

3.8 GLASS PROTECTION

Glazed openings shall be identified during the construction period by tapes or flags that are not in contact with the glass.

Temporary labels shall be removed immediately after the glass and glazing work has been approved.

3.9 CLEANING

Upon completion of work, glass surfaces shall be cleaned and shall be free of glazing- or sealing-compound, smears, and other defacement.

-- End of Section --

SECTION 09260

GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 111	(1990) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel, Products

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 641M	(1991) Standard Specification for Zinc Coated (Galvanized) Carbon Steel Wire (Metric)
ASTM C 36	(1995) Gypsum Wallboard
ASTM C 473	(1995) Physical Testing of Gypsum Board Products and Gypsum Lath
ASTM C 475	(1994) Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 514	(1994) Standard Specification for Nails for the Application of Gypsumboard
ASTM C 515	(1986; R 1992) Chemical-Resistant Ceramic Tower Packings
ASTM C 557	(1993; Rev A) Adhesives for Fastening Gypsum Wallboard to Wood Framing
ASTM C 645	(1995) Non-Load (Axial) Bearing Steel Studs, Runners (Track) and Rigid Furring Channels for Screw Applications of Gypsum Board
ASTM E 119	(1995; Rev A) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E 84	(1995) Standard Test Method for Surface Burning Characteristics of Building

Materials

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.2.3.7M	(1979) Metric Heavy Hex Screws
ASME B18.2.4M	(1979; Rev 1989) Metric Hex Nuts

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-02	(1993) Architectural Sheet Metal Manual
SMACNA-02A	(1980; 5th Ed) Architectural Sheet Metal Specifications

1.2 SYSTEM DESCRIPTION

Manufacturer's catalog data shall be submitted Special Framed Openings and Rated Wallboard Assemblies, meetin all design specifications as required by referenced standards within this section. Data shall include fire ratings, sound transmission classification, and permeance requirements where applicable.

Certificates shall be submitted for gypsum wallboard systems indicating that the proposed materials meet or exceed the project specifications and the listed reference specifications.

1.2.1 Partition Configurations

1.2.1.1 Single-Layer Partitions

Single layer drywall partitions shall be fire retardant gypsum wallboard, thickness as indicated.

1.2.2 Performance Requirements

1.2.2.1 Fire Retardant Requirements

Type X gypsum wallboard shall provide at least 1 hour fire-retardant rating for 15.9 millimeter thick material or 3/4-hour fire-retardant rating for 12.7 millimeter material when applied in single-layer, nailed on each face of load-bearing, wood framing members, and when tested in accordance with ASTM E 119.

When tested in accordance with ASTM E 84, gypsum wallboard shall have a maximum flame-spread rating of 15, fuel contributed 15, and smoke developed 15.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items including fire ratings, sound transmission classification, and permeance requirements where applicable.

Gypsum Wallboard
Furring
Joint Tapes
Compounds
Steel-Stud Framing
Fasteners
Adhesives
Floor and Ceiling Runners

Manufacturer's catalog data shall be submitted for the following items in accordance with paragraphs entitled, "Framed Openings" and "System Description," of this section.

Special Framed Openings
Rated Wallboard Assemblies

SD-07 Certificates

Certificates shall be submitted for gypsum wallboard systems in accordance with paragraph entitled, "System Description," of this section.

1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be protected from weather, soil, and damage during delivery, while stored, and during construction.

Materials shall be delivered in the manufacturer's original packages; containers or bundles shall bear the brand name and the name of the manufacturer.

Materials shall be stored in dry, weathertight, and properly ventilated areas.

Gypsum wallboard shall be neatly stacked flat, with care taken to avoid sagging or damage to edges, ends, and surfaces.

Wallboard delivered to the building shall be kept protected and banded with midpoint slat spaces of 50 by 13 millimeter material extended full width between each layer of gypsum wallboard.

1.5 PROJECT/SITE CONDITIONS

1.5.1 Environmental Requirements

1.5.1.1 Temperature

A temperature of not less than 13 degrees C shall be provided in areas of work during the application of the materials and shall be maintained until the joint treatment compounds are dry.

1.5.1.2 Ventilation

Ventilation shall be provided to eliminate moisture within the building.

1.5.1.3 Moisture Control

Gypsum wallboard installation and joint treatment shall be accomplished in a uniform temperature with sufficient ventilation to ensure that throughout the application period the wallboard moisture does not exceed 8 percent.

Wallboard that has a moisture content in excess of 8 percent shall not be installed.

1.5.2 Field Measurements

Field measurements shall be taken before installation of materials to verify the indicated dimensions and to ensure proper fit of the work.

PART 2 PRODUCTS

2.1 WALLBOARD MATERIALS

2.1.1 General Requirements for Wallboard

Gypsum wallboard shall conform to ASTM C 36 of grade and form as specified for each type of board. Wallboard shall be 1200 millimeter wide, shall have thickness as indicated, and a maximum practical length for end use.

2.1.2 Fire-Retardant Gypsum Wallboard

Fire-retardant gypsum wallboard shall be Grade X, Form a, at least 15.9-millimeter thick.

2.1.3 Joint Materials

2.1.3.1 Joint Tapes

Joint tape shall be plain or perforated material conforming to ASTM C 475, Type II, Styles 1 and 2.

2.1.3.2 Compounds and Adhesives

Joint compound shall be an adhesive, without fillers, conforming to ASTM C 475, Type I.

Laminating adhesive shall be joint compound of the type used for embedding tape or a material recommended by the manufacturer of the gypsum board. Ready-mixed joint compound (Style 3) shall not be used as laminating adhesive.

Adhesive for fastening gypsum wallboard to wood framing shall conform to ASTM C 557.

2.1.4 Metal Fasteners

Nails shall be steel, diamond point, with mechanically deformed shank, and shall conform to ASTM C 515.

Screws shall be steel, self-tapping drywall type, bugle head, self-drilling point; the length shall be as recommended by the drywall manufacturer for the type of system being installed.

Screws for anchorage of runner channels to studs and securing gypsum backing board to metal studs and furring channels shall be 25 millimeter long. Screws for temporary support of gypsum wallboard face ply shall be 41 millimeter long of the same type.

Bolts shall be steel and conform to ASME B18.2.3.7M. Type II, regular hexagon bolts.

Nuts shall be steel, plain, hexagon, Type II, and shall conform to ASME B18.2.4M.

Expansion shields shall conform to ASTM C 514, Group, Type, and Class as required.

Staples shall conform to ASTM C 514, galvanized steel, Table IV-A, size as required.

Wire for tying insulation shall be galvanized soft steel wire conforming to ASTM A 641M, steel number 1010, Class 1 light zinc coating.

2.1.5 Metal Framing Materials

2.1.5.1 Steel-Stud Framing

Steel studs, floor and ceiling runners, angle runners, and furring channels shall be electrogalvanized, cold-rolled steel conforming to ASTM C 645 ordinary zinc coated (commercial).

Metal studs shall be formed, zinc-coated sections of channel or Z-shape, of 0.55 millimeter minimum thickness, and of widths indicated on the drawings. Stud flanges that come in contact with gypsum wallboard shall be a minimum of 32 millimeter wide, with a 7 millimeter stiffening lip with turned or folded edges. Holes shall be regularly punched in studs to facilitate installation of electrical wiring, conduit, or horizontal bracing.

Floor and ceiling runners shall be not less than 0.55 millimeter steel before galvanizing, with 32 millimeter flanges, sized to nest with steel stud.

Angle runners shall be 34 by 22 millimeterand not less than 0.85 millimeter.

2.1.6 Metal Accessories and Trim

2.1.6.1 Corner Beads and Trim

Corner beads shall be 0.40 millimeter minimum, hot-dip galvanized steel, with 32 by 32 millimeterflanges and a 3 millimeter beaded corner.

Corner beads shall be formed to an angle of 90 degrees and shall be zinc-coated steel not lighter than 0.40 millimeterbefore coating with wings not less than 23 millimeter wide and perforated for nails and cement treatment. Zinc-coated steel shall conform to SMACNA-02, SMACNA-02A, and AASHTO M 111, Type I, Class C.

Casing trim shall be 0.47 millimeter nominal thickness, hot-dip galvanized steel channel, depth as required for wallboard, with attached tape flange.

2.2 SOURCE QUALITY CONTROL

Gypsum wallboard shall be tested at the manufacturing plant in accordance with ASTM C 473 for flexural strength, thickness and weight of paper and predecorated board surfacing, and thickness of edge of recessed or tapered-edge gypsum wallboard.

PART 3 EXECUTION

3.1 PREPARATION

Defective wall and ceiling surfaces shall be corrected prior to application of drywall materials.

3.2 ERECTION, INSTALLATION, AND APPLICATION

3.2.1 Framing

Framing members to receive gypsum wallboard shall be straight, plumb, and true and spaced not to exceed the maximum spacings for the board thickness.

3.2.2 Board Length

Boards of maximum practical length shall be used to minimize the number of end joints. Edges of boards shall be butted together but shall not be forced.

3.2.3 Staggering Boards

Joints shall be staggered and shall not be aligned with the edge of an opening nor positioned so that the corners of four boards will meet at a common point.

3.2.4 Joints

All abutting ends or edge joints shall occur over solid bearing, (wood joists, wood furring, or over the web surface of furring channels) and shall be fitted neatly and accurately, with all end joints staggered. Wallboard shall be supported as recommended by the manufacturer, with

additional framing at all cutouts and openings.

3.2.5 Wall Trim

Trim shall be applied to wall and accurately aligned with the finished ceiling. Ceiling board edges that adjoin walls shall be laid on the horizontal leg of the trim strip, and the space behind the junction shall be closed with a dust membrane. Membrane shall be applied in advance of the wallboard application.

3.2.6 Corners and Edges

Exposed corners and edges and the perimeter of door, window, and borrowed-light frames shall be finished with the specified metal trim.

3.2.7 Tolerance and Alignment

Finished wallboard application shall be plumb and true, with all joints aligned to within a 1.6 millimeter tolerance and with all surfaces shimmed and aligned to a plane and even surface having a maximum variation of 3 millimeter in 2438 millimeter.

3.2.8 Midheight Horizontal Bracing

Midheight horizontal bracing shall be continuous in partitions for all heights above 2600 millimeter. Bracing shall be standard runner channel for stud size specified. Channel shall be secured rigidly in place at each stud.

3.2.9 Partition Bracing

Where gypsum wallboard partitions do not extend to the underside of construction above, they shall be braced at the top channel with a V-frame perpendicular to the line of the partition located 5690 millimeter maximum on center where partitioning is not intersected or otherwise braced. V-braces shall be composed of two 50 by 50 by 3 millimeter angles attached to metal clips. When brace is in final position, it shall be welded, or holes shall be drilled and the brace bolted in permanent position. Partitions shall not exceed 4880 millimeter in height.

3.2.10 Ply

Wallboard shall be applied to walls in single-ply, horizontal and vertical application, and in two-ply as specified herein and in accordance with the drywall manufacturer's instructions for the type and classification of wall assembly indicated.

3.2.11 Fastening

Board shall be fastened with power-driven, phillips-head screws at a maximum spacing of 300 millimeter on center in the field of the board and at 200 millimeter on center at edges and along abutting ends.

Screws shall be placed not closer than 10 millimeter to ends or edges of

boards.

3.2.12 Trim

Edges of exposed drywall shall be trimmed with the specified metal bead.

3.2.13 Joint Finishing

Joints between wallboard panels and joints at metal trim shall be reinforced with joint tape and embedding-type joint compound and concealed with at least two applications of finishing compound in accordance with the printed instructions of the manufacturer of the gypsum wallboard. Screw depressions shall be filled with at least three coats of joint compound. Flanges at corner beads, edge trim, and control joints shall be concealed with at least two applications of joint compound, feathered and sanded smooth.

3.2.14 Steel Stud Framing

Floor and ceiling runner tracks shall be accurately aligned and securely attached to floors, structural ceilings, finished ceilings, or roof deck. Track shall be attached to concrete slabs with concrete stud nails; track shall be attached to steel framing or steel joists with machine bolts at 600 millimeter on center.

Runners shall extend beyond open-end partitions for at least 300 millimeter. Upon installation of end studs, runner extensions shall be bent and nested with the stud and attached with at least two sheet metal screws.

Runners shall be furnished in longest practical lengths with butt joints.

Steel studs shall be size indicated, spaced at 600 millimeter on center. A maximum height span of 3660 millimeter shall be used for 68 millimeter studs. Maximum height span for 92 millimeter studs shall be 4880 millimeter.

Studs for pipe chases, ventilating shaft framing, and steel column or beam fireproofing shall be the size indicated, spaced 400 millimeter on center.

Studs shall be positioned plumb in ceiling and floor runners and attached with at least one self-tapping screw on each side of the stud ends. Studs shall be installed in continuous lengths with no splicing.

Stud shall be placed no more than 13 millimeter from door frames, framed openings, abutting partitions, and partition corners. Studs shall be securely anchored direct or with spacers to door and borrowed-light frames by screw attachment.

Top-runner channels of intersecting partitions shall have the web extended across the intersected channel. Extended web shall be fastened with two screws. Flanges of the intersecting channel shall be cut, bent, and fastened to the flanges of the continuously intersected channel with two screws in each flange.

Partition reinforcement shall be provided over door and borrowed-light frame openings and, where required, for support of plumbing fixtures, accessories, and electrical and mechanical equipment. Reinforcement shall consist of cut-to-length sections of runner track or cold-rolled channels extending at least 600 millimeter on each side of the opening and braced and fastened to studs in accordance with the manufacturer's directions.

Head and jamb framing at door openings shall consist of a tube made up of one runner channel and one stud. Tubes at door jambs shall extend the full height of the partition and shall be fastened together with screws at a minimum of 600 millimeter center-to-center each flange. Tube over the door head shall be fastened together with a minimum of three screws each flange. Runner channel section of the header tube shall be cut 300 millimeter longer than the span between the two jamb studs. A web bend shall be made with 150 millimeter extended in a vertical direction on each jamb tube and fastened with a minimum of two screws. Flanges shall be extended horizontally and fastened to the flanges of the vertical stud. Cut-to-length studs shall then be positioned at not more than 400 millimeter spacing over the door opening and secured to the tube with a web flange bend with a minimum of two screws. Runner channel sections of tubes shall be secured to the door frame head and jamb with two M6 (1/4-inch) machine bolts, nuts, and washers.

3.2.15 Steel Framed Drywall Partitions

3.2.15.1 Single-Layer Partition Over Steel Framing

Gypsum wallboard shall be applied and finished as specified and in accordance with the drywall manufacturer's written instructions for a UL-approved, 1-hour fire-rated, single-layer, screw-stud drywall partition, with an STC of at least 41. All perimeter joints shall be calked.

3.2.16 Surface Finishing

Surface defects and damage shall be corrected to leave wallboard smooth, uniform in appearance, and ready to receive finish as specified in other sections of these specifications.

Joints shall be sanded when dry after each application of joint compound. Final finish shall be uniformly smooth and flush with the paper face of the wallboard.

Surfaces of the work, and adjacent surfaces soiled as a result of this work shall be cleaned.

-- End of Section --

SECTION 09514

ACOUSTIC CEILINGS, EXPOSED GRID

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 489	(1993) Standard Specification for Carbon Steel Eyebolts
ASTM B 221M	(1995; Rev A) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes (Metric)
ASTM C 423	(1990; Rev A) Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C 635	(1994) Standard Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings
ASTM C 636	(1992) Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels
ASTM E 1264	(1990) Standard Classification for Acoustical Ceiling Products
ASTM E 90	(1990) Standard Test Method for Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B18.6.7M	(1985; R 1993) Metric Machine Screw

1.2 PERFORMANCE REQUIREMENTS

1.2.1 Noise Reduction Coefficient Grade

Noise reduction coefficient (NRC) grade of acoustic ceilings shall be tested or certified by an approved testing laboratory in accordance with ASTM C 423, and shall be as follows:

MOUNTING TYP	NRC GRADE
No. 7	0.50 to 0.60

1.2.2 Ceiling Sound-Transmission Classification

Sound Transmission Classification (STC) of the indicated acoustic ceilings shall be an 11-frequency test method conforming to ASTM E 90, and shall be as follows:

CONDITION AT PARTITION	CEILING STC
Continuous	35 to 39

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following drawings shall e submitted in accordance with paragraph entitled, "Acoustical Ceiling Information," of this section.

Fabrication Drawings
Installation Drawings

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items showing UL classification of fire-rated ceilings giving materials, construction details, types of floor and roof constructions to be protected, and UL design number and fire protection time rating for each required floor or roof construction and acoustic ceiling assembly.

Acoustic Materials
Suspension System Materials

SD-04 Samples

Samples of the following shall be submitted in accordance with paragraph entitled, "Acoustical Ceiling Information," of this section.

Acoustic Units
Suspension System Members
Anchorage Devices and Fasteners

After approval, samples may be used in the construction provided

each sample is clearly identified and its location recorded.

1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered and stored in their original, unopened packages bearing labels clearly identifying manufacturer's name, brand name, material, type or class, UL listing when applicable, and other pertinent data.

1.5 FIELD MEASUREMENTS

Field measurements shall be taken prior to preparation of drawings and fabrication, to ensure proper fitting of the work.

1.6 MAINTENANCE INSTRUCTIONS

The Contractor shall follow the acoustic material Manufacturer's Instructions for recommended cleaning and application methods, including precautions in the use of cleaning materials that may be detrimental to acoustic surfaces and the finish of exposed metal components. Finish of exposed-to-view surfaces of the units shall be factory-applied white finish.

PART 2 PRODUCTS

2.1 ACOUSTIC MATERIALS

2.1.1 Mineral Fiber Acoustic Units

Units shall be prefabricated, mineral-composition type, not more than 25 flame spread index class and 0.75 or more light reflectance coefficient grade, conforming to ASTM E 1264.

2.1.2 Acoustic Panels

Panels shall be mineral-fiber 610 by 610 millimeter by not less than 16 millimeter thick, with square trimmed and butt edges.

Pattern shall be fissured.

2.2 SUSPENSION SYSTEM MATERIALS

2.2.1 Aluminum Extrusions

Extrusions shall be aluminum Alloy 6063, Temper T5, conforming to ASTM B 221M.

2.2.2 Exposed, Indirect Hung, Main Runners

Main runners shall be cold-formed, Z-shape sections fabricated from specified steel sheets not less than 0.531 millimeter thick. The bottom flange main runners shall be 25 millimeter nominal width.

The structural classification shall be intermediate duty in accordance with ASTM C 635.

Finish of the exposed-to-view surfaces shall be baked-on white enamel. Finish shall pass the high humidity test specified in ASTM C 635.

2.2.3 Cross Runners and Accessories

Cross runners shall be designed for use with the type and structural classification of the main runners used, in accordance with ASTM C 635. Cross runners shall be fabricated from specified steel sheets not less than 0.455 millimeter thick. The bottom flange shall be suitable for the tile joint used.

Antibreather splines, hold-down clips, main runner connectors, and other accessories required to complete the ceiling installation shall be provided. Such accessories shall be designed for use with the type of main runner used.

Finish of the exposed-to-view surfaces shall be baked-on white enamel. Finish shall pass the high humidity test specified in ASTM C 635.

2.2.4 Wall Moldings

Moldings shall be cold-formed angle sections, fabricated from specified steel sheets not less than 0.531 millimeter thick.

Height of moldings shall be as required to accommodate the type of runners used. Where exposed main runners are used, the exposed leg width of moldings shall be the same as the flange width of the runners. Where bullnose masonry units are used for wall and partition construction, inside-and outside-corner caps shall be provided. Corner caps shall be one-piece, shop-fabricated units having a radius conforming to the bullnose and exposed face width the same as the exposed width of the adjoining wall molding. Corner caps shall extend at least 300 millimeter on each side of the corner, and shall be butt-joined to the adjacent wall molding with concealed fastenings.

Finish of exposed-to-view surfaces of moldings and corner caps shall be the same as the runners.

2.3 SUSPENSION MATERIALS

2.3.1 Hanger Inserts

Inserts shall consist of a wire loop and steel shell embedded in concrete and designed to provide a single wire loop exposed flush with the concrete surface. Wire shall be galvanized carbon steel not less than 4.50 millimeter in diameter. Shell shall be formed from galvanized carbon steel sheets, not less than 0.455 millimeter thick.

Inserts shall not be removable when embedded in concrete of 20 Megapascal compressive strength and subjected to a 1334 newton tension load test in an axial direction; nor shall the concrete show evidence of failure attributed to the hanger insert.

2.3.2 Eyebolts

Eyebolts shall be weldless, forged-carbon-steel, with a straight-shank in accordance with ASTM A 489. Eyebolt size shall be not less than 7 millimeter, zinc coated.

2.3.3 Masonry Anchorage Devices

Anchorage devices for eyebolts and machine screws shall be in accordance with ASTM C 636.

2.3.4 Hanger Wire

Hangar wire shall be 2.8 millimeter galvanized, soft annealed, mild steel wire in accordance with ASTM C 636.

2.3.5 Machine Screws

Machine screws shall conform to ASME B18.6.7Mof zinc-coated carbon steel.

PART 3 EXECUTION

3.1 ACOUSTIC MATERIAL

Acoustic material shall be installed in accordance with the manufacturer's recommendations.

3.2 CONDITIONS AT BUILDING

Work above the ceiling line shall be completed, and approved, prior to the start of acoustic work.

Spaces to receive acoustic materials shall be maintained at 16 to 29 degrees C and not more than 70 percent relative humidity for at least 48 hours prior to and during the installation of acoustic work, and until final acceptance.

Installation shall be per ASTM C 636, and as directed.

3.3 ITEMS EMBEDDED IN OTHER CONSTRUCTION

Placement locations and installation instructions shall be provided for items embedded in other construction.

3.4 ARRANGEMENT OF ACOUSTIC CEILINGS

Acoustic units shall be so arranged that units less than one-half width do not occur unless otherwise required to suit conditions.

Ceilings shall be so arranged that either the tile joint or the tile centerline centers on ceiling fixtures.

Acoustic units shall be so arranged that joints are parallel with room axis in both directions, and straight and in alignment.

Runners shall be so arranged that the main runners are parallel with the room axis indicated, and in straight parallel alignment to each other.

3.5 PLACING SUSPENSION SYSTEM MEMBERS

Hanger wires shall be vertical and suspended from structural supporting members as follows:

Wires shall be secured to precast concrete by anchorage devices and wire-tying.

Wires shall be secured to the bottom chord of joists or structural members by wire-tying or by metal clips especially designed for the purpose.

Direct-hung suspension system members shall be supported by hangers spaced not more than 150 millimeter from each end, and not more than 1200 millimeter on center between end hangers. Members shall be kept 13 millimeter away from walls or partitions. Hangers shall be attached to the members to prevent vertical movement or rotation of the member. Members shall be installed level within 3.2 millimeter in 3658 millimeter. Leveling shall be performed with the hanger wires taut to prevent subsequent downward movement of the members when the ceiling loads are imposed. Kinks or bends shall not be made in the hanger wires as a means of leveling the members.

Indirect-hung suspension system members shall be attached at right angles to the carrying channels by means of spring clips that maintain tight contact between the indirect-hung member and the carrying channel when the ceiling loads are imposed. Members shall be installed so they are level within 3.2 millimeter in 3658 millimeter. Leveling shall be performed with the indirect-hung members in firm contact with the carrying channels to prevent subsequent downward movement when the ceiling loads are imposed.

Cross runners shall be installed at the required center distances within 0.8 millimeter. This tolerance shall be noncumulative beyond 3600 millimeter. Intersecting cross runners shall form a 90-degree angle.

Abutting and intersecting runners shall be joined by approved methods. A joint connection shall provide the following alignment:

Exposed surfaces of two abutting main runners shall lie within a vertical distance of 0.4 millimeter of the same horizontal plane, and within a horizontal distance of 0.4 millimeter of the same vertical plane.

Exposed surfaces of two intersecting cross runners shall lie within a vertical distance of 0.4 millimeter of the same plane with the cross runner always above the main runner.

There shall be no visually apparent angular displacement of the longitudinal axis of one runner with respect to the other runner.

The horizontal gap between the exposed surfaces of abutting or intersecting members shall not exceed 0.51 millimeter.

Wall moldings shall be installed so that the extended leg of angle moldings, or the bottom flange of channel moldings, lies in the same horizontal plane as that of the runners resting on the molding. Wall molding at inside corners shall be cut and bent to conform to the corner and at outside corners shall be neatly butted. Corner caps shall be provided where the corners are constructed of bullnose masonry units. Moldings shall be fastened to wall at not more than 75 millimeter from each end, and not more than 400 millimeter on center between the end fastener holes. Fastening to wood plugs in masonry or concrete is not permitted.

3.6 SETTING MASONRY ANCHORAGE DEVICES

Masonry anchorage devices shall be set in masonry or concrete in accordance with the anchorage device manufacturer's printed instructions. Drilled holes shall be left rough, not reamed, and free from drill dust.

3.7 FRAMING OPENINGS FOR CEILING FIXTURES

Support members shall be provided at openings for ceiling fixtures or as indicated. Support members shall be of the size required to support the load without permitting deflection of the ceiling in excess of the performance requirements for the suspension system structural classification specified. Intermediate supports and hangers shall be provided if required.

3.8 ACOUSTIC LAY-IN-PANELS FOR EXPOSED-GRID CEILINGS

Exposed, direct-hung main runners shall be arranged as indicated and spaced not more than 610 millimeter on center.

Where recessed lighting fixtures are indicated, exposed main runners shall be located parallel with the long dimension and on both sides of each fixture.

Exposed cross runners shall be spaced nominally 610 millimeter on center.

When 610 by 610 millimeter lay-in panels are used, intermediate, exposed cross runners, 610 millimeter on center, shall be provided, installed parallel to the main runner, and intersecting the 610 millimeter long exposed cross runners at midpoint.

Moldings shall be installed at walls and other vertical surfaces, except where movable metal partitions having caps designed to receive suspension system members are indicated.

Lay-in panels shall be installed with edges resting on the flanges of the suspension system members and held in place with approved hold-down clips. Four holddown clips shall be provided for each acoustic lay-in panel. Clips shall be located approximately at the center of the sides and ends of each panel.

3.9 MARKING LOCATION OF MECHANICAL SYSTEM CONTROLS

Access units in acoustic ceilings that are located directly below mechanical system controls shall be marked with an identification plate. Plate shall be 0.813 millimeter thick aluminum, 19 millimeter in diameter, stamped with the letters "AP" finished the same as the acoustic material, and attached by an approved method near one corner on the face of each access unit.

-- End of Section --

SECTION 09650

RESILIENT FLOORING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 221M	(1995; Rev A) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes (Metric)
ASTM F 1066	(1995; Rev A) Standard Specification for Vinyl Composition Floor Tile

FEDERAL SPECIFICATIONS (FS)

FS SS-T-312	(Rev B; Notice 1) Tile, Floor; Asphalt, Rubber, Vinyl, Vinyl-Asbestos
FS SS-W-40	(Rev A; Int Am 1, Notice 1) Wall Base: Rubber, and Vinyl Plasti

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Vinyl Composition Tile
Base
Vinyl Reducer Strips
Substrate Primer/Sealer
Adhesive
Edge Strips

SD-04 Samples

Samples of Manufacturer's Standard Color Charts shall be submitted in accordance with paragraph entitled, "Manufacturer's

Information," of this section.

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered to the project site in their original packages or containers bearing labels clearly identifying the manufacturer, brand name, and quality or grade.

Materials shall be stored in their original unbroken packages or containers in the area in which they will be installed.

1.4 MANUFACTURER'S INFORMATION

Manufacturer's Standard Color Charts shall be submitted for resilient flooring showing the manufacturer's recommended color and finish selections.

Manufacturer's Instructions shall be submitted showing printed instructions covering installation of resilient flooring systems.

Preventive Maintenance and Inspection shall be submitted showing the resilient flooring material manufacturer's recommended cleaning and application methods.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General Requirements

Resilient flooring, base, and edging strips shall be the manufacturer's standard color range.

2.1.2 Vinyl Composition Tile

Tile shall conform to ASTM F 1066, Composition I, 305 by 305 millimeter square, Class 1. Thickness shall be 3 millimeter.

2.1.3 Base

Base shall be vinyl composition and the selected style conforming to FS SS-W-40.

Base, exclusive of corners, shall be furnished in 3700 millimeter lengths. Each wing of corners shall be not less than 50 millimeter long.

2.1.4 Vinyl Reducer Strips

Vinyl reducer strips shall conform to FS SS-T-312.

Strips shall be 25 millimeter wide, in the lengths required to minimize joints, and 3 millimeter thick.

2.1.5 Substrate Primer/Sealer

Substrate primer sealer shall comply with the resilient flooring manufacturer's recommendations for the type and location of substrate and the end use of the area to be covered. Primer/sealer shall be nonstaining to the resilient flooring.

2.1.6 Adhesive

Emulsion adhesive shall be used with emulsion primer. Cutback adhesive shall be used with cutback primer. Adhesive shall be nonstaining to the resilient flooring. Adhesive for stair treads shall be the type recommended by the manufacturer.

2.1.7 Edge Strips

Edge strips shall be extruded-aluminum alloy conforming to ASTM B 221M, Temper F, 3 millimeter thick and 20 millimeter wide, butt type, and beveled on the exposed edge. Strips shall be installed in accordance with the manufacturer's recommendation.

PART 3 EXECUTION

3.1 CONDITIONS AT BUILDING

Specified materials shall be installed only when normal temperature and humidity conditions approximate the interior conditions of the building that will exist when occupied.

3.2 PREPARATION OF SUBSTRATE SURFACES

Surfaces to receive specified materials shall be clean, smooth, cured, and free from materials detrimental to achieving the required bond.

Concrete substrate surfaces shall be coated completely with a primer/sealer in accordance with the resilient-material manufacturer's recommendations.

Cracks, rough areas, joints, and other surface defects in the concrete shall be filled with a material recommended by the stair-tread manufacturer. Ridges, trowel marks, and other surface projections shall be ground smooth.

Before the start of stair-tread application, substrate surfaces shall be tested for moisture content to ensure against a moisture invasion of the adhesive.

3.3 APPLICATION OF FLOORING AND BASE

Application of flooring shall be in accordance with the flooring manufacturer's recommendations.

3.4 APPLICATION OF VINYL STRIPS

Vinyl reducer strips shall be applied in conjunction with the specified flooring materials where required. Reducer strips shall be tightly butted to the resilient flooring with the fewest possible seams, in accordance

with the manufacturer's instructions.

Vinyl feature strips shall be applied in conjunction with the flooring materials and patterns. Feature strips shall be tightly butted to the resilient flooring with the fewest possible seams, as approved by the manufacturer.

3.5 APPLICATION OF EDGE STRIPS

Edge strips shall be installed at exposed edges of resilient flooring and where thresholds are not required. Top surface shall be flush with resilient flooring. Strips shall be secured to the subfloor as recommended by the manufacturer.

3.6 CLEANING AND PREPARATION

Following application of flooring, the Contractor shall thoroughly clean and prepare the floor.

Stair-tread surfaces shall be cleaned of foreign substances in accordance with the stair tread manufacturer's cleaning instructions.

3.7 ACCEPTANCE PROVISIONS

3.7.1 Rejection

Floor surfaces will be rejected when colors or patterns do not match the color or pattern of approved samples, and when chipped, cracked, stained, or mismatched stair treads occur.

3.7.2 Repairing

Damaged and unacceptable portions of the completed work shall be removed and replaced with new work to match adjacent surfaces at no additional cost to the Government.

3.7.3 Cleaning

Surfaces of the work, and adjacent surfaces soiled as a result of the work, shall be cleaned. Equipment, surplus materials, and rubbish from the work shall be removed from the site.

3.8 EXTRA MATERIAL

Upon completion of the vinyl composition tile flooring installation, spare tiles of each type, color, and pattern from the same lot as those installed shall be furnished at the rate of five tiles for each 1,000 tiles or fraction thereof installed.

-- End of Section --

SECTION 09680

CARPET

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 648	(1994; Rev A) Standard Test Method Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source

CARPET AND RUG INSTITUTE (CRI)

CRI 104	(1991) Installation of Commercial Textile Floorcovering Materials

FEDERAL SPECIFICATIONS (FS)

FS SS-W-40	(Rev A; Int Am 1, Notice 1) Wall Base: Rubber, and Vinyl Plastic

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 258	(1989) Standard Research Test Method for Determining Smoke Generation of Solid Materials

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Carpet
Base

SD-04 Samples

The following samples shall be submitted:

Three samples, each 100 millimeter square, of each type of Carpet

and Carpet Pads to be used.

The following samples shall be submitted in accordance with the paragraph entitled, "Installation," of this section.

Seam Tape
Edge Molding
Accessories

PART 2 PRODUCTS

2.1 CARPET TYPE AND CONSTRUCTION

The following specifies the construction for broadloom carpet.

Type shall be tufted.

Finished pile height shall be 4.5 mm.

Stitches per millimeter shall be .40.

Face weight shall be 1.0 kilograms/㎡.

Backing: Primary and Secondary shall be polypropylene.

Dye method shall be 75 percent solution dyed and 25 percent space dyed.

Total weight shall be 2.2 kilograms/㎡.

Weight density factor shall be 221.91.

2.1.1 Flammability

Radiant panel test shall be Class I, 0.45 watt/cm2 or greater in accordance with ASTM E 648.

Smoke density shall be 450 or less in accordance with NFPA 258.

2.1.2 Color and Pattern

Color and pattern shall be chosen from the manufacturer's catalog data.

2.2 CARPET MOLDINGS

Carpet moldings, either vinyl or aluminum, shall be installed where floor covering material changes or carpet edge does not abut a vertical surface.

2.3 BASE

Base shall be vinyl conforming to FS SS-W-40.

Minimum overall thickness of base shall be not less than 3 millimeter, color as selected from manufacturer's full line.

Cove style, 100 millimeter high.

Corners shall be premolded with wings not less than 50 millimeter long.

PART 3 EXECUTION

3.1 INSTALLATION

Samples of each type of Seam Tape, Edge Molding, and any other Accessories to be used shall be submitted.

Carpeting shall be installed in accordance with CRI 104 and the carpet manufacturer's instructions.

Type of installations required for this project is as follows:

Direct Glue Down

Contiguous carpeting shall be a product of the same dye lot.

Corrections in measurements made by the Contractor shall be at no additional cost to the Government.

Transportation of carpet within the jobsite shall be the responsibility of the Contractor.

3.2 PREPARATORY WORK

Contractor shall verify that surfaces to receive carpet are thoroughly clean, dry, dust-free, and in a satisfactory condition to be carpeted. Contractor shall notify the Government in writing of any conditions that will prevent the production of unsatisfactory work. Start of carpet installation shall be an indication of acceptance of the surfaces as being satisfactory for installing carpeting and he shall automatically assume the responsibility for any unacceptable finish work caused by floor conditions.

3.3 ACCEPTANCE PROVISIONS

Contractor shall be fully responsible for the installation upon completing of each area. Installation will be inspected and approved by the Contracting Officer prior to acceptance.

Damaged and unacceptable portions of completed work shall be removed and replaced with new carpeting.

3.4 CLEANING

Surfaces of new carpeting and adjacent surfaces soiled as a result of this work shall be cleaned thoroughly. Equipment, surplus materials, and rubbish from work shall be removed from the site.

-- End of Section --

SECTION 09915

PAINTING

PART 1 GENERAL

1.1 REFERENCES (Not Applicable)

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for paint materials as listed in the paragraph entitled, "General," of this section.

SD-04 Samples

Manufacturer's Standard Color Charts shall be submitted for paint materials in accordance with paragraph entitled, "General," of this section.

PART 2 PRODUCTS

2.1 GENERAL

The following are products that meet the required performance standards.

	PITTSBURG	SHERWIN WILLIAM	GLIDDEN
Inhibitive metal primer	6-712	B66WW1	6970
Pigmented sealer	6-2	B28W200	5111
Latex block filler	6-7	B42W46	5317
Alkali resistant primer	6-3	A5V2	5212
Enamel undercoat	6-755	B49W200	300
Exterior wood primer	6-809	Y24W538	3651

	PITTSBURG	SHERWIN WILLIAM	GLIDDEN
Acrylic latex, flat	72 line	B36 Series	6500
Acrylic latex gloss	78 line	A-100A8	6600
Water base acrylic epoxy	16 line	B70/B60V15	5277/5278

Manufacturer's Standard Color Charts shall be submitted for paint materials showing the manufacturer's recommended color and finish selections. Three color chip samples shall be submitted for each color and gloss scheduled.

Certificates shall be submitted for paint materials showing conformance with the referenced standards contained in this section.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Manufacturer's recommendations for surface preparation, thinning, mixing, handling, and applying his product shall be considered a part of this specification.

Surfaces shall be clean, dry, and free from contaminants and foreign matter. Mildew and chalking shall be removed and the surface thoroughly sterilized. Chipped, peeling, or blistered paint shall be removed and the surface spot-primed. Hard glossy surfaces shall be dulled and roughened to ensure proper adhesion.

3.1.1 Metal

Surfaces shall be dry and free from dirt, oil, grease, wax, and other contaminants. Oxide or corrosion shall be removed by hand, power tool, or blast cleaning.

3.1.2 Wood

Surfaces shall be clean, dry, smooth, and free from oil, grease, and dirt. Knots shall be sealed with a mixture of equal parts of shellac and alcohol. Nail holes, cracks, and other defects shall be filled with plastic wood or putty. Concealed surfaces shall be back-primed before installation.

3.1.3 Masonry

Surfaces shall be free from dirt, oil, grease, wax, form-release compounds, laitance, and other contaminants. Large cracks, voids, and other major surface imperfections shall be cleared of loose material and filled with mortar.

3.1.4 Plaster and Drywall

Surfaces shall be clean and dry. Cracks and other surface imperfections shall be filled with spackling compound and sanded smooth.

3.2 MIXING AND APPLICATION

Exterior painting shall not be allowed in rainy weather or when rain is imminent. Paints or coatings shall not be applied when the temperature or humidity exceeds the manufacturer's recommendations.

Each coat of material applied shall be free from evidence of poor application. Variations in color, gloss, and texture shall not be acceptable.

Finish coats shall show good hiding characteristics and uniform appearance.

Newly painted surfaces shall be protected from damage.

There shall be at least 3 coats of paint applied in accordance with the manufacturer's instructions.

Each coat shall be applied uniformly at the wet-film thickness as specified by the manufacturer.

Spot-painting to correct damaged surfaces will be allowed only when touch-up area blends into the surrounding finish. Otherwise, the entire area shall be recoated. Touchup shall be accomplished using the same method of application as was used to apply the original material.

3.3 PROTECTION REQUIREMENTS

"WET PAINT" signs shall be posted to indicate newly painted surfaces.

3.4 PAINT SCHEDULE

SURFAC	PRIME	UNDERCOAT AND FINISH COAT
Interior metal	Inhibitive metal primer	Water-base acrylic enamel
Interior masonry (rough/porous)	Latex block filler	Water-base acrylic enamel
Interior masonry (smooth)	Pigmented sealer	Water-base acrylic enamel
Exterior masonry (rough/porous)	Latex block filer	Acrylic latex
Exterior masonry (smooth)	Alkali-resistant primer	Acrylic latex

SURFAC	PRIME	UNDERCOAT AND FINISH COAT
Interior wood	Water-base enamel undercoat	Water-base acrylic enamel
Exterior wood	Exterior wood primer	Acrylic latex
Interior plaster	Pigmented sealer	Water-base acrylic enamel
Interior drywall	Pigmented sealer	Water-base acrylic enamel

-- End of Section --

SECTION 10523

FIRE EXTINGUISHERS

PART 1 GENERAL

1.1 REFERENCES

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 10	(1994) Standard for Portable Fire Extinguishers

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication drawings shall be submitted for the following items consisting of fabrication and assembly details to be performed in the factory. Installation drawings shall be submitted for the following items in accordance with the paragraph entitled, "Installation," of this section.

Fire Extinguishers
Adjuncts
Wall Brackets

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Fire Extinguishers
Adjuncts
Wall Brackets
Replacement Parts

SD-04 Samples

One Fire Extinguishers of each type to be installed

Three samples of Wall Brackets and Accessories of each type to be used

Approved samples may be used for installation, with proper identification.

SD-07 Certificates

Certificates shall be submitted showing the following:

Certification that Fire Extinguishers comply with local codes and regulations

Certification that Fire Extinguishers comply with OSHA requirements

Fire Extinguishers will be free of defects in materials, fabrication, finish, and installation and that they will remain so for a period of not less than 1 year after completion.

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be protected from weather, soil, and damage during delivery, storage, and construction.

Materials shall be delivered in their original packages, containers, or bundles bearing the brand name and the name of the material.

PART 2 PRODUCTS

2.1 TYPES

Fire Extinguishers shall conform to NFPA 10.

Fire extinguishers shall be dry-chemical type.

2.2 MATERIAL

Extinguisher shell shall be enameled steel.

2.3 SIZE

Extinguishers shall be 9.5 liter.

2.4 ADJUNCTS

Pressure gage

2.5 WALL BRACKETS

Fire extinguishers shall have wall-hook brackets.

Wall bracket and Accessories shall be as approved.

PART 3 EXECUTION

3.1 INSTALLATION

Fire Extinguishers shall be installed where indicated. Exact locations shall be verified prior to installation.

Installation of extinguishers shall comply with the manufacturer's recommendations.

Extinguishers shall be fully charged and ready for operation upon installation.

3.2 ACCEPTANCE PROVISIONS

3.2.1 Repairing

Damaged and unacceptable portions of completed work shall be removed and replaced with new work at no additional cost to the Government.

Replacement Parts list shall be provided by the Contractor indicating specified items replacement part, replacement cost, and name, address and contact for replacement parts distributor.

3.2.2 Cleaning

Surfaces of the work, and adjacent surfaces soiled as a result of the work, shall be cleaned in an approved manner. Equipment, surplus materials, and rubbish from the work shall be removed from the site.

-- End of Section --

SECTION 10800

TOILET AND BATH ACCESSORIES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A112.18.1M	(1996) Plumbing Fixture Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1992; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 366/A 366M	(1996) Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
ASTM A 385	(1980; R 1991) Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM A 525M	(1991; Rev A) Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process (Metric)
ASTM A 526/A 526M	(1990) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality
ASTM A 568/A 568M	(1996) Standard Specifications for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM B 456	(1994) Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
ASTM C 1036	(1991) Standard Specification for Flat Glass
ASTM D 2092	(1995) Standard Practice for Preparation

of Zinc-Coated Galvanized Steel Surfaces for Paint

COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)

CABO A117.1 (1992) American National Standards for Buildings and Facilities Providing Accessibility and Usability for Physically Handicapped People

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Mirror Glass
Mounting Devices and Fasteners
Paper Towel Dispensers
Waste Receptacle
Toilet Tissue Dispenser
Liquid-Soap Dispenser
Shelf
Framed Mirrors
Grab Bars
Robe Hook

SD-04 Samples

Samples shall be submitted in accordance with paragraph entitled, "Accessories," of this section.

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be protected from weather, soil, and damage during delivery, storage, and construction.

Materials shall be delivered in their original packages, containers, or bundles bearing the brand name and the name of the material.

PART 2 PRODUCTS

2.1 MATERIALS

Corrosion-resistant steel shall conform to AISI, Type 302. The exposed surfaces shall have a No. 4 finish, unless otherwise specified.

Brass shall be cast, in accordance with ANSI A112.18.1M.

Steel sheet shall conform to ASTM A 366/A 366M and ASTM A 568/A 568M. Surface preparation and pretreatment shall be provided as required for the subsequent finish.

Galvanized-steel sheet shall be hot-dipped, minimum spangle, conforming to ASTM A 526/A 526M, with not less than a 35 gram zinc coating in accordance with ASTM A 525M. The surface preparation for painting shall conform to ASTM D 2092, Method A.

2.2 COATINGS

Chromium coating shall be nickel and chromium electrodeposited on brass, conforming to ASTM B 456, type and class as specified. Coating shall have a satin finish unless otherwise specified.

Enamel coating shall be factory applied, gloss white, baked acrylic. Coating shall be washable and suitable for the intended use.

2.3 MIRROR GLASS

Mirror glass shall be Type 1, Class 1, quality q1, 6-millimeter thick polished plate glass with silvering, copper backing, and protective coating, in accordance with ASTM C 1036.

2.4 MOUNTING DEVICES AND FASTENERS

Concealed mounting devices and fasteners for accessories shall be fabricated from the same materials as the accessories or from galvanized steel, conforming to ASTM A 385 and ASTM A 123. Exposed mounting devices and fasteners shall be finished to match the accessories. Fasteners shall be the theft-resistant type.

2.5 ACCESSORIES

Samples of each toilet and bath accessories to be used shall be submitted prior to installation. Approved full-size samples may be installed in the work provided they are properly identified.

2.5.1 Waste Receptacle

Surface-mounted receptacles shall be rectangular in shape and fabricated from not less than 0.79-millimeter thick corrosion-resistant steel. Exposed surfaces shall be seamless construction with a continuously welded bottom pan. Receptacle shall have a capacity of not less than 76 liter. Heavy-duty vinyl removable liners shall be provided for refuse. Liner shall be secured to the receptacle at four points with grommeted holes hung from corrosion-resistant steel hooks.

2.5.2 Shelf

Shelf shall be fabricated from not less than 1.3-millimeter thick corrosion-resistant steel, full length without seams, with not less than a 13-millimeter edge face and exposed edges rolled. Mounting brackets shall be fabricated from not less than 1.6-millimeter thick corrosion-resistant

steel welded to the bottom of the shelf. Provide two brackets for the first 600 millimeter of shelf and one additional bracket for each additional 305 millimeter of length.

2.5.3 Mirrors

Framed Mirrors shall be fabricated to the size indicated. Mirror frame shall be fabricated from not less than 0.79-millimeter thick corrosion-resistant steel with corners mitered, welded, and ground smooth and a face width of not less than 15 millimeter. Backing sheet shall be fabricated from not less than 1.0-millimeter thick galvanized steel secured to the frame with concealed screws. Edges and back of the mirror glass shall be protected with continuous wood fill strips and moisture-proof shock-absorbing back padding. Concealed galvanized-steel wall hanger of the size required for the mirror size shall be provided. Mirror shall be hung and locked in place with not less than two vandal-resistant locking screws per mirror.

End shelf shall be fabricated from not less than 0.79-millimeter corrosion-resistant steel not less than 127 millimeter wide with a 19 millimeter return edge. Shelf shall be secured to the mirror frame and reinforced with not less than 1.6-millimeter thick corrosion-resistant steel concealed brackets.

2.5.4 Grab Bars

Bars shall be fabricated from not less than 1.24 millimeter thick, 35 millimeter outside diameter seamless corrosion-resistant steel tubing. Wall flanges shall be fabricated for a concealed installation from not less than 2.39-millimeter thick corrosion-resistant steel not less than 79 millimeter in diameter. Flanges shall be fully welded to the grab bar. A concealed mounting plate shall be fabricated from corrosion-resistant or galvanized steel. Secure flanges to the mounting plate with not less than four corrosion-resistant steel vandal-resistant setscrews. Exposed surfaces shall have a finish as specified unless the finish is indicated as nonslip. Nonslip finish shall have a peened or light knurled finish.

2.5.5 Robe Hook

Hook shall be the double type fabricated from satin-finish chromium-plated brass. The projection from the back of the flange to the end of the hook shall be not less than 50 millimeter. The concealed mounting bracket shall be fabricated from solid brass. Hook shall be secured to the mounting bracket with a locking setscrew.

PART 3 EXECUTION

3.1 GENERAL

Field measurements shall be taken prior to the preparation of drawings and fabrication to ensure proper fits.

Accessories shall be secured to the supporting substrates with anchors of the types indicated by the following substrate construction.

3.2 SOLID MASONRY, CONCRETE, OR TILE SET IN MORTAR

Accessories shall be secured with lead expansion shields or cast-in integral anchors. Lead expansion shields shall be not less than No. 8 wood screws with a shield length of not less than 25 millimeter. Integral anchors shall be deformed bars not less than 38 millimeter in length cast into a predrilled hole with quickset mortar or plaster of paris.

3.3 GRAB-BAR ANCHORS

Through-bolt anchors shall be used for solid masonry or concrete walls where the backplate is concealed or covered with a subsequent finish. An adhesive-applied anchor plate shall be used only when a through-bolt plate would be exposed. An embedded plate anchor shall be used for hollow partitions and solid gypsum partitions.

Through-bolt anchors shall be designed and installed to have a withdrawal strength of not less than 1335 newton per anchor. Front and back plates shall be fabricated from not less than 4.75 millimeter thick steel with the surface area required for the design strength. Through bolts shall be not less than 6 millimeter diameter threaded rod with a hexnut and lockwasher. The length of the rod shall be determined by the wall thickness.

3.4 HANDICAP ACCESSORIES

Toilet and bath accessories designated for handicap requirements shall be installed in accordance with CABO A117.1.

3.5 CLEANING

Surfaces of the work, and adjacent surfaces soiled as a result of the work, shall be cleaned as recommended by the manufacturer.

-- End of Section --

SECTION 13930

FIRE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC M017	(1992) Manual of Steel Construction, Volume II, Connections

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A112.18.1M	(1996) Plumbing Fixture Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 126	(1995) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 135	(1993) Electric-Resistance-Welded Steel Pipe
ASTM A 183	(1983; R 1990) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 234/A 234M	(1997) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 53	(1996) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 563M	(1996) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM B 370	(1992) Standard Specifications for Copper Sheet and Strip for Building Construction
ASTM B 749	(1997) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM C 592	(1980) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type

	Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C 920	(1995) Standard Specification for Elastomeric Joint Sealants
ASTM D 2000	(1996) Standard Classification System for Rubber Products in Automotive Applications
ASTM F 568	(1995) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.34	(1996) Valves - Flanged, Threaded and Welding End
ASME B16.39	(1986) Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300
ASME B16.4	(1992) Cast-Iron Threaded Fittings Classes 125 and 250
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.1	(1995) Power Piping

AMERICAN WATERWORKS ASSOCIATION (AWWA)

AWWA C104	(1990; 1st Ed) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	(1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm through 1200 mm), for Water and Other Liquids
AWWA C111	(1990) Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151	(1991) Ductile-Iron Pipe, Centrifugally for Water or Other Liquids

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825	(1990; Supple I, II & III) Approval Guide

FEDERAL SPECIFICATIONS (FS)

FS FF-S-325	(Int Amd 3) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
FS WW-P-421	(Rev D) Pipe, Cast, Gray and Ductile Iron, Pressure (For Water and Other Liquids)

FEDERAL STANDARDS (FED-STD)

FED-STD 595	(Rev B) Colors Used in Government Procurement

MILITARY STANDARDS (MIL-STD)

MIL-STD 101	(Rev B) Color Code For Pipelines and For Compressed Gas Cylinders

MILITARY SPECIFICATIONS (MS)

MS MIL-C-18480	(Rev B; Notice 1) Coating Compound, Bituminous, Solvent, Coal-Tar Base

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(1994) Installation of Sprinkler Systems
NFPA 13E	(1989) Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems
NFPA 14	(1993) the Installation of Standpipe and Hose Systems
NFPA 1963	(1993) Screw Threads and Gaskets for Fire Hose Connections
NFPA 24	(1992) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 291	(1988) Fire Flow Testing and Marking of Hydrants
NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997; 11th Ed) UL Standard for Safety -

Rigid Metal Condui

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section. Design Analysis and Calculations and installation shall be in accordance with NFPA 13.

Records of Existing Conditions shall be submitted showing the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Records of Existing Conditions shall be submitted in accordance with the paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Connection diagrams shall be submitted indicating the relations and connections of the following items. Drawings shall indicate the general physical layout of all controls, and internal tubing and wiring details.

Piping Materials
Supporting Elements
Fire-Department Connections
Fire Alarm System
Sprinkler Heads
Valves
Underground Piping Materials

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Underground Piping Materials
Aboveground Piping Materials
Valves
Fire-Department Connections
Riser Alarm Equipment
Sprinkler Heads
Miscellaneous Materials
Supporting Elements

Equipment and Performance Data shall be submitted in accordance with paragraph entitled, "General," of this seciton.

SD-05 Design Data

Design Analysis and Calculations shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-06 Test Reports

Test reports shall be submitted for the following tests in accordance with the paragraph entitled, "System Testing," of this section.

Pressure Tests
System Operating Tests
Air Tests
Valve-Operating Tests
Drainage Tests

PART 2 PRODUCTS

2.1 GENERAL

Fire-protection system materials and equipment provided under this section shall conform to the requirements of Underwriters Laboratories (UL) or the Factory Mutual (FM P7825) Approval Guide.

Products with UL label or seal or listing in UL 6, and products with FM label or listed in the FM P7825 Approval Guide are acceptable fire-protection system materials and equipment. Materials and equipment furnished shall be compatible with existing system.

Equipment and Performance Data shall be submitted for fire protection sprinkler systems consisting of information on use life, system functional flows, safety features, and mechanical automated details.

2.2 UNDERGROUND PIPING MATERIALS

Ells, tees, reducing tees, wyes, couplings, increasers, crosses, transitions, and end caps shall be the same type and class of material as the pipe or shall be material having equal or superior physical and chemical properties.

2.2.1 Type CIWP

Cast-iron waterpipe shall be mechanical joint or push-on type, centrifugally cast, UL listed and labeled, conforming to FS WW-P-421and, as applicable, to AWWA C151, AWWA C110, AWWA C111. Piping shall be Class 150. Bell-and-spigot fittings shall conform to AWWA C110.

For FS WW-P-421 wall-thickness criteria only, depth of cover shall be 1500 millimeter unless drawings indicate less, in which case, drawing

requirements shall apply; field-laying conditions shall be B (flat-bottom trench, without blocks, tamped backfill).

Flanged cast-iron pipe fittings shall be Class 125 conforming to ASME B16.1.

Piping and fittings shall be coated on the outside with a bituminous sealer in accordance with AWWA C104.

Piping and fittings shall be coated on the inside with a mortar lining in accordance with AWWA C104.

Restraining joint against endwise separation due to internal pressure may be accomplished by NFPA-recommended metal harness consisting of clamping devices and bolting or by hardened-metal retainers molded into a push-on gasket and engaged by a groove in the spigot end.

Where electrical continuity is indicated, pipe shall be supplied with factory-brazed heavy cross section copper connectors to be joined with copper fasteners upon joint assembly. Connectors, as a minimum, shall be equal to No. 1/0.

2.2.2 Type DIWP

Ductile-iron water pipe shall be mechanical-joint or push-on type, centrifugally cast, UL listed and labeled, conforming to applicable provisions of AWWA C111, and AWWA C151. Wall-thickness criteria shall be 1380 kilopascal working pressure plus 690 kilopascal surge allowance, AASHTO H-20 loading with specified trench conditions. Gasket elastomer shall be chloroprene.

Piping shall be coated on the outside with a bituminous sealer in accordance with AWWA C104.

Piping and fittings shall be coated on the inside with a mortar lining in accordance with AWWA C104.

Restraining joint against endwise separation due to internal pressure may be accomplished by using a metal harness consisting of clamping devices and bolting or by hardened-metal retainers molded into a pushon gasket and engaged by a groove in the spigot end.

Where electrical continuity is indicated, pipe shall be supplied with factory-brazed heavy cross section copper connectors to be joined with copper fasteners upon joint assembly. Connectors, at a minimum, shall be equal to No. 1/0.

2.3 ABOVEGROUND PIPING MATERIALS

2.3.1 Type BCS - Black Carbon Steel

Pipe(DN25 through DN40): Schedule 40 furnace butt weld black-carbon steel conforming to ASTM A 53, or ASTM A 135, Type F furnace butt welded; Schedule 10 conforming to ASTM A 135, Grade B

Pipe (DN50 through DN206, where indicated): Schedule 40 seamless or electric-resistance welded black carbon steel, conforming to ASTM A 53 or ASTM A 135, Type S seamless, Grade B; Schedule 10 conforming to ASTM A 135, Grade B

Unions (DN50 and under): 2068 kilopascal working steam pressure (wsp) female, screwed, black malleable iron, with ground joint and brass-to-iron seat conforming to ASME B16.39

Standard pipe couplings: Extra-heavy screwed black steel

Grooved pipe couplings (all sizes): 1207 kilopascal minimum working pressure with a housing fabricated in two or more parts of black malleable-iron castings. Coupling gasket shall be molded of synthetic rubber, conforming to requirements of ASTM D 2000. Coupling bolts shall be oval-neck, track-head type with heavy hexagonal nuts, conforming to ASTM A 183

Fittings (DN100 and under): 1207 kilopascal working pressure, cast iron, screwed, conforming to ASTM A 126, Class A, and ASME B16.4

Fittings (DN150 and larger): 1207 kilopascal working pressure, cast iron, conforming to ASTM A 126, Class A, screwed, conforming to ASME B16.4, or flanged, conforming to ASME B16.1

Fittings (DN200 and under): Couplings shall be rolled-groove type or mechanical locking (push-on) type. Grooves for rolled-groove type shall be rolled only; cut grooving will not be allowed. Rolled grooves shall be dimensionally compatible with the couplings.

Grooved fittings (all sizes): 1207 kilopascal working pressure fittings used with grooved couplings shall be fabricated of black malleable-iron castings. If a manufacturer's standard-size malleable-iron fitting pattern is not available, fabricated fittings shall be used; fittings shall be fabricated from Grade B seamless-steel pipe and long-radius seamless welding fittings, with wall thickness to match pipe, conforming to ASTM A 234/A 234M and ASME B16.9.

2.4 SUPPORTING ELEMENTS

Piping system components and miscellaneous supporting elements shall be provided, including, but not limited to, building-structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical-pipe attachments; horizontal-pipe attachments; restraining anchors; and guides. Supporting elements shall be suitable for stresses imposed by systems pressures and temperatures, natural, and other external forces.

Supporting elements shall be FM approved or UL listed and shall conform to ASME B31.1, MSS SP-58, and ASME B16.34.

2.4.1 Building-Structure Attachments

2.4.1.1 Anchor Devices, Concrete and Masonry

Anchor devices shall conform to FS FF-S-325:

Group I: Shield, expansion (lead, bolt, and stud anchors)

Group II: Shield, expansion (bolt anchors), Type 2, Class 2, Style 1 or 2

Group III: Shield, expansion (self drilling tubular expansion shell bolt anchors

Cast-in floor-mounted equipment-anchor devices shall provide adjustable positions.

Powder-actuated anchoring devices shall not be used to support mechanical-systems components.

2.4.1.2 Beam Clamps

Beam clamps shall be center-loading Types 21, 28, 29, and 30, UL listed, cataloged, and load-rated commercially manufactured products.

Type 20 beam clamps shall be used for pipe DN50 and under.

Two Type 25 beam clamps shall be used per point of pipe support.

2.4.1.3 C-Clamps

C-clamps shall be used to support piping sizes DN40 and smaller. C-clamps shall be FM approved and UL listed, with hardened cup-tip setscrew, locknut, and retaining strap. Retaining-strap section shall be not less than 6 by 25 millimeter. Beam-flange thickness to which clamps are attached shall not exceed 15 millimeter.

2.4.1.4 Inserts, Concrete

Concrete inserts shall be constructed in accordance with the requirements of MSS SP-58 for Type 18 or 19 and ASME B16.34. When applied to piping in sizes DN50 iron pipe size (ips) and larger, and where otherwise required by imposed loads, a 300 millimeter length of 15 millimeter reinforcing rod shall be inserted and wired through wing slots.

2.4.2 Horizontal-Pipe Attachments

2.4.2.1 Single Pipes

Piping in sizes up to and including DN50 ips shall be supported by Type 1, 5, 6, 7, 9, 10, 11, or 12 solid, split-ring, or band type attachments.

Piping in sizes DN65 and larger shall be supported by Type 1, 2, 3, or 4 attachments or with Type 41 or Type 49 pipe rolls.

2.4.2.2 Parallel Fire-Protection Pipes

Trapeze hangers fabricated from approved structural steel shapes, with

U-bolts, shall be used when so specified. Structural-steel shapes shall conform to supplementary steel requirements or the support shall be of commercially available, approved proprietary-design rolled steel.

2.4.3 Vertical-Pipe Attachments

Single vertical-pipe attachments shall be Type 8.

2.4.4 Hanger Rods and Fixtures

Only circular solid cross section rod hangers shall be used to connect building structure attachments to pipe-support devices. Pipe, straps, or bars of equivalent strength shall be used for hangers.

Turnbuckles, swing eyes, and clevises shall be provided as required by support system to accommodate temperature changes, pipe accessibility, and adjustment for load and pitch.

2.4.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, such supplementary steel shall be designed and fabricated in accordance with AISC M017.

2.5 FIRE-DEPARTMENT CONNECTIONS

Hose connections shall have National Firehose standard-thread form and rocker lugs in accordance with NFPA 1963. Hose-connection sizes and threads shall be compatible with the equipment used by the fire department serving the facility.

2.5.1 Wall Siamese

Unit shall be cast brass or bronze flush-mounted escutcheon-plate type, with two DN65, fire-department, swivel, female inlets; double-clapper valves; rocker-lug caps and chains; and cast-in function-identifying lettering. Finish shall be chrome-plated or polished surface. Chrome plate shall be in accordance with ANSI A112.18.1M.

2.5.2 Fire Hydrants

Hydrants shall be dry-barrel type, with low-profile and modern appearance. Hydrants shall be designed to remain closed if hydrant barrel is sheared or damaged. Unit shall have two DN65, hose outlets and one DN115 hose outlet complete with nonbinding caps and cap chains. Hydrant direction of opening shall be counterclockwise. Surface shall be filled, primed, and finished with a multiple-coat high-gloss weather-resistant enamel. All surfaces below grade shall receive a coating of bitumen not less than 0.508 millimeter thick. Care shall be exercised not to plug barrel drainage provisions. Color shall be standard for the project site.

2.6 RISER ALARM EQUIPMENT

Riser alarm equipment shall be UL listed or FM approved for fire-protection use.

2.6.1 Wet-Pipe Alarm Check Valve

Wet-pipe alarm check valve shall be complete with standard accessories and trim necessary to give an alarm and shall include pressure gages, retard chamber, testing provisions, and all necessary intercomponent piping, fittings, and valves. Pilot valve and clapper shall have individual elastomer seats.

2.6.2 Standard Check Valve

Check valve shall be FM-approved or UL-listed standard swing-check type with elastomer-disc seat. Pressure gages shall be provided on both sides of the clapper. Water-flow alarm shall be vane type.

2.6.3 Water-Flow Alarm Device

Vane-type flow alarm shall make or break an alarm circuit upon deflection by a volume of flowing water that equals or exceeds the capacity of a single sprinkler. Alarm shall have an instant-recycle pneumatic-retard time delay.

2.7 SPRINKLER HEADS

2.7.1 Head Types

Standard 13 millimeter orifice sprinkler heads shall be used. Heads shall be automatic on-off type. On-off type heads shall be installed only in wet-pipe systems.

Heads in finished areas below suspended ceilings shall be flush chrome-plated brass. Escutcheon plate shall be baked enamel finished to match ceiling.

Heads in finished areas below suspended ceiling shall be flush or pendant type. Heads and escutcheon plates shall be chrome-plated brass.

Heads in unfinished areas below suspended ceilings shall be pendant type. Heads in all other locations shall be upright type.

Corrosion-resistant heads shall be lead-coated.

2.7.2 Temperature Rating

Fusible links shall be for ordinary hazard, except where otherwise indicated.

2.7.3 Spares

Spares shall be furnished for each type of sprinkler head, complete with appropriate storage cabinet and wrench.

2.7.4 Head Protection

Heads shall be protected with paper or plastic bags during painting operations. Protection shall be removed immediately upon finishing painting operations.

Head guards shall be provided wherever mechanical damage could occur. Guard finish shall be red enamel.

2.8 VALVES

2.8.1 Underground

2.8.1.1 Fire-Hydrant Service Valves

Fire-hydrant service valves shall be standard FM-approved or UL-listed inside-screw gate valve, with valve box connection flange.

2.8.1.2 Valve Boxes

Valve boxes shall be not less than 5 millimeter thick cast-iron construction with locking cover that has a cast-in identification legend. Boxes shall be adjustable extension type with screw- or slide-type adjustment. Base flange shall be fitted to the valve flange. Full extended length of box shall be greater than required by depth of cover by not less than 100 millimeter. One valve-operating wrench shall be supplied for each size valve nut. Guide rings shall be provided where operating rods are longer than 2 meter.

2.8.2 Aboveground

Gate, globe, and check valves (all sizes) shall be FM approved or UL listed.

Ball valves, DN50 and under, shall be FM approved, rated 2070 kilopascal, with provisions to wire or lock handle in place where critical alarm function may be isolated.

Butterfly valves, DN150 and DN200 shall be FM approved, rated 1200 kilopascal, cast-iron bodied wafer type, with elastomer liners and seals. Liners shall act as gasket between standard piping-system flanges. Operator shall be worm-gear type, with permanently lubricated gears, and oiltight and watertight case, complete with handle and automatic position indication.

2.9 MISCELLANEOUS MATERIALS

2.9.1 Bituminous Coating

Bituminous coating shall be a solvent cutback, heavy-bodied material to produce not less than a 0.305 millimeter dry-film thickness in one coat and shall be as recommended by the conduit manufacturer for compatibility with factory coating and rubber joints.

For previously coal-tar-coated and for uncoated ferrous surfaces

underground, bituminous coating shall be solvent cutback coal-tar type, conforming to MS MIL-C-18480.

2.9.2 Bolting

Flange and general-purpose bolting shall be hex-head and shall conform to ASTM F 568, Class 4.8 or higher. Heavy hex-nuts shall conform to ASTM A 563M.Square-head bolts and nuts are not acceptable.

2.9.3 Elastomer Calk

Polysulfide- or polyurethane-base elastomer-calking material shall be two-component type, conforming to ASTM C 920.

2.9.4 Escutcheons

Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated, except when AISI 300 series corrosion-resistant steel is provided. Metals and finish shall conform to ANSI A112.18.1M.

Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing and one-piece or split-pattern type elsewhere. Escutcheons shall have provisions consisting of internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.9.5 Flashing

2.9.5.1 Lead

Sheet lead shall conform to ASTM B 749, and shall weigh not less than 20 kilogram per square meter.

2.9.5.2 Copper

Sheet copper shall conform to ASTM B 370 and shall weigh not less than 4.88 kilogram per square meter.

2.9.6 Flange Gaskets

Gaskets shall be suitable for the intended use and shall contain no asbestos.

2.9.7 Pipe-Thread Compounds

Tetrafluoroethylene tape or other suitable compounds shall be used.

2.10 FIRE-PROTECTION SYSTEM IDENTIFICATION

A coordinated system of piping and equipment identification shall be provided which includes the following:

Framed and plastic-protected diagrammatic layout of all piping systems, identifying and locating piping, equipment, and valves. Where existing systems are being modified, existing layouts shall be brought up to

date.

Metal-tag-identified major valves, piping-system components, and equipment

Metal identification plate at controlling alarm valve identifying system and area protected

Service-labeled piping

Color coding shall be used for flow-capacity identification of fire hydrants only. Color coding shall be in accordance with NFPA 291. Numbering of post-indicator valves, hydrants, and other components shall be an extension of existing systems.

2.10.1 Diagrams

Chart listing of equipment shall be by designation number and shall show pertinent data. Diagrams shall be neat, mechanical drawings mounted in extruded aluminum frames, with 3 millimeter thick acrylic plastic protection. Location shall be as directed by the Contracting Officer. A minimum of one mounted chart and diagram, plus one extra copy of each, shall be provided for each fire-protection system.

2.10.2 Metal Tags

Identification tags made of brass or aluminum and indicating function of valve or similar component, shall be installed on such system devices. Tags shall be not less than 50 millimeter in diameter and marking shall be stamped.

Equipment shall be provided with metal identification tags bearing an equipment designation number matching the drawing or diagram designations.

Tags shall be secured to valve or equipment items with 2.7 millimeter galvanized wire.

2.10.3 Service Labeling

Piping, including that concealed in accessible spaces, shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction. Labels or tag designations shall be as follows:

SERVIC	LABEL OR TAG DESIGNATION
Main sprinkler supply	MAIN SPRINKLER SUPPLY
Sprinkler riser number	SPRINKLER RISER NO.
Sprinkler branch	SPRINKLER BRANCH

Piping shall be labeled and arrowed in accordance with the following:

Each point of entry and exit through walls

Each change in direction

In congested or hidden areas, at each point required to clarify service or indicate hazard

In long straight runs, labels shall be located at a distance visible to each other, but in no case shall the distance between labels exceed 12.2 meter.

Label lettering shall be 50 millimeter high. Where the size of pipes is 65 millimeter outside diameter and smaller, labels shall be attached to 1.6 millimeter aluminum sheet which shall be attached to the pipe with 2.7 millimeter galvanized wire. Labels shall be legible from the primary service and operating area.

Labels shall be made of self-sticking plastic film designed for permanent installation. Labels shall have red letters on white background.

Label and valve tag schedule above shall not be construed as defining or limiting the work. All piping systems shall be labeled.

2.11 PAINTING

Equipment of the manufacturer's standard product shall be furnished with the manufacturer's standard finish coat.

Other mechanical equipment shall be furnished with a shop-applied prime paint.

PART 3 EXECUTION

3.1 GENERAL

Installation of system materials and equipment shall be in accordance with the recommendations and provisions of NFPA 13, NFPA 13E, NFPA 14, and NFPA 24. Work shall be performed in the presence of the Contracting Officer who shall be notified by the Contractor 48 hours in advance of the start of work.

All installation work shall be performed by licensed fire protection sprinkler contractors, licensed for such work in the state where the work is to be performed.

3.2 UNDERGROUND PIPING INSTALLATION

Installation of piping materials shall conform to the written or published instructions of the manufacturer.

Pipes passing through walls below grade and ground-floor slab shall pass through pipe sleeves one size larger than pipe and shall be calked watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.

In fill areas, pipe passing under or through building grade beams shall have a minimum clearance of 100 millimeter in all directions.

Rubber- or elastomer-jointed piping embedded in concrete walls shall have a joint within 150 millimeter of the face of the wall, capable of absorbing movement without leakage.

Piping penetrating earth or concrete grade shall be extended-joint or flange-bolt height plus 150 millimeter above the grade.

Underground piping below supported or suspended slabs shall be supported from the slab with a minimum of two supports per length of pipe. Supports shall be protected with a coating of bitumen.

On excavations near and below building footings, the backfilling material shall consist of 13.8 Megapascal cured-strength concrete poured or pressure-grouted up to the level of the footing.

After piping has been inspected, and not less than 48 hours prior to being lowered into a trench, external surfaces of the piping, valves, valve operators, and valve boxes shall be coated with a compatible bituminous coating suitable for protection against brackish ground water. Application shall be in accordance with the manufacturer's instructions to a dry-film thickness of not less than 0.305 millimeter.

3.2.1 Construction Tolerances for Types CIWP and DIWP

Maximum deviation from design elevation at any point along piping shall not exceed 65 millimeter for all sizes of piping.

Maximum deviation from line at the end of an 5.5 meter length of piping shall be 65 millimeter and cumulatively shall not exceed 150 millimeter. Corrections from line within preceding tolerances shall be made at a rate not to exceed 65 millimeter for any one length of piping.

Maximum deflection for curves for 5.5 meter lengths of cast ferrous pipe shall be in accordance with NFPA 24.

When the alignment requires deflections in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within established limits, as approved.

3.2.2 Fire Hydrants

Hydrant outlets shall be 600 millimeter, minimum, to 900 millimeter, maximum, above grade. The DN115 outlet shall face the road or area of access.

3.2.3 Valve Boxes

Valves and valve boxes and shall be set plumb. Valve boxes shall be centered on the valves. Where feasible, valves shall be located outside

traffic areas. Soil shall be carefully tamped around each valve box to a distance of 1.2 meter on all sides of the box or to the undisturbed trench face when less than 1.2 meter.

Class 3000A concrete slabs 600 millimeter square by 100 millimeter thick shall be provided to protect valve boxes, unless other protection is indicated.

3.2.4 Thrust Blocks

Thrust blocks shall be provided to absorb hydraulic thrust at caps, plugs, and at system change-of-direction fittings.

Thrust block shall be 20 Megapascal cured-strength concrete placed against undisturbed soil, with an area sufficient to provide load transmittal.

3.3 ABOVEGROUND PIPING-SYSTEMS INSTALLATION

Piping shall run parallel with the lines of the building. Piping and components shall be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there will be not less than 13 millimeter of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel shall be arranged to be in line with each other and parallel to the lines of the building.

Load rating for pipe-hanger supports shall be based on all lines filled with water. Deflection per span shall not exceed slope gradient of pipe. Schedule 40 and heavier ferrous pipe supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing. For concentrated loads such as valves, allowable span shall be reduced proportionately.

PIPE SIZE (DN) (MILLIMETRE	ROD SIZE (MILLIMETRE	HANGER SPACING FOR STEEL PIPE (MILLIMETRE)
Up to 25	10	2400
32	10	3600
40	10	4500
65 to 90	10	4500
125	15	4500
100	15	4500
150	15	4500
200	22.5	5500

Vertical risers shall be supported at the base where possible and at

intervals specified. Piping shall be guided for lateral stability as necessary. Clamps shall be placed under fittings wherever possible. Carbon-steel pipe shall be supported at each floor at not more than 4.5 meter intervals for pipe DN50 and smaller, and at not more than 6.1 meter intervals for pipe DN65 and larger.

Piping shall be securely supported with allowance for thrust forces and thermal expansion and contraction and shall not be subject to mechanical, chemical, vibrational, or other damage, in conformance with ASME B31.1.

3.4 SOUND STOPPING

Effective sound stopping and adequate operating clearance shall be provided to prevent structure contact where piping penetrates walls, floors, or ceilings; into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces include space above ceiling where no special acoustic treatment of ceiling is provided. Penetrations shall be finished to be compatible with surface being penetrated.

Sound stopping and vapor-barrier sealing of pipe shafts, and large floor and wall openings may be accomplished by packing with properly supported mineral fiber insulation or by foaming-in-place with self-extinguishing, 0.9 kilogram density polyurethane foam to a depth not less than 150 millimeter. Foam shall be finished with a rasp. Vapor barrier shall be not less than 3 millimeter thickness of vinyl mastic applied to visible and accessible surfaces. Where fire stopping is a consideration, only mineral fiber shall be used, and, in addition, openings shall be covered with 1.6 millimeter sheet metal.

3.5 SLEEVES

Sleeves shall be provided where piping passes through roofs, masonry or concrete walls, or floors.

Sleeves passing through steel decks shall be continuously welded or brazed to the deck.

Sleeves extending through floors, roofs, or load-bearing walls, and sleeves through fire barriers shall be continuous and fabricated from Schedule 40 steel pipe with welded anchor lugs. Other sleeves shall be formed by molded linear polyethylene liners or similar materials that are removable. Diameter of sleeves shall be large enough to accommodate pipe, insulation, and jacketing without touching the sleeve, and additionally shall provide a minimum 10 millimeter clearance. Sleeve shall accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and generation of noise.

Space between a pipe and the inside of a pipe sleeve or a construction surface penetration shall be packed solid with mineral fiber conforming to ASTM C 592 wherever the piping passes through firewalls, equipment-room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between

occupied spaces. Where sleeves or construction-surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction-surface penetration shall be filled with an elastomer calk to a depth of 15 millimeter. Surfaces to be calked shall be oil- and grease-free.

Exterior wall sleeves shall be calked watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.

3.6 ESCUTCHEONS

Escutcheons shall be provided at penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, escutcheons shall be provided on both sides of the partition. Where suspended ceilings are installed, plates shall be provided at the underside only of such ceilings. Escutcheons shall be chrome plated in occupied spaces and shall conceal openings in building construction. Escutcheons shall be firmly attached.

3.7 FLASHINGS

Flashings at systems penetrations of building boundaries shall be provided as indicated.

3.8 BRANCH-LINE TESTERS

Branch-line testers shall permit testing and flushing lines without shutdown of system or loss of fire-protection capability. Line testers shall be fitted with chain-attached caps.

Line testers shall be installed where indicated and on most remote branch lines being served by cross mains, so that testing may be accomplished at the dead corners of each sprinkler system.

3.9 PAINTING

Manufacturer's standard-finish equipment surfaces damaged during construction shall be brought to as-new condition by touchup or repainting to the satisfaction of the Contracting Officer, or replaced with new undamaged equipment at no additional cost to the Government.

Pipe hangers, supports, and other iron work in concealed spaces shall be thoroughly cleaned and painted with one coat of primer paint.

All firex piping, valves, and appurtenances, including hose racks and reels, but excluding hoses, hose nozzles and siamese connections, shall receive two coats of enamel, color No. 11105 (red) in accordance with MIL-STD 101 and FED-STD 595.

3.10 ELECTRICAL WORK

Electrical work is specified in Division 16, "Electrical," except for control and fire alarm wiring which shall be provided under this section in accordance with NFPA 70. Rigid metal conduit or intermediate metal conduit

shall be used, except that electrical metallic tubing may be used in dry locations not enclosed in concrete or where not subject to mechanical damage.

Motors, controllers, contactors, and disconnects shall be furnished with their respective pieces of equipment, except that controllers indicated as part of the motor control centers shall be provided under Section 16345, "Motor Control." Motors, controllers, contactors, and disconnects shall conform to and shall have electrical connections provided under Section 16145, "Standard Wiring Systems." Controllers and contactors shall have maximum 120-volt control circuits, and auxiliary contacts for use with the controls furnished. When motors and equipment are furnished larger than sizes indicated, the cost of providing additional electrical service and related work shall be included under this section.

3.11 SYSTEM TESTING

Prior to acceptance of the work, completed systems shall be tested in the presence of the Contracting Officer. Upon approval, certificates of testing shall be provided.

Tests shall be hydrostatic, unless otherwise specified. Only potable water shall be used for testing.

Air Tests, Valve-Operating Tests, and Drainage Tests shall be performed for dry-pipe systems.

Full-flow System Operating Tests shall be performed for standpipe systems.

Government will supply testing water at a location determined by the Contracting Officer, but the Contractor shall be responsible for approved disposal of contaminated water.

Contractor shall prepare and maintain test records of piping-system tests. Records shall show personnel responsibilities, dates, test-gage identification numbers, ambient and test-water temperatures, pressure ranges, rates of pressure drops, and leakage rates. Each test acceptance shall require the signature of the Contracting Officer.

3.11.1 Test Gages

Test gages, to be acceptable, shall have 115 millimeter dials or larger with accuracy of plus or minus 1/2 of 1 percent of full-scale range and dial graduations and pointer width compatible with readability to within one-half of the accuracy extremes. Maximum permissible scale range for a given test shall be such that the pointer during a test shall have a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 days prior to the test, test gage number, and the project number.

3.11.2 Pneumatic Testing

Pressure Tests shall be pneumatic when freezing conditions may occur and

upon prior approval by the Contracting Officer. Compressed air used for testing shall be oil-free.

Pneumatic testing shall include swabbing all joints under a test pressure of 34 kilopascal with a standard high film strength soap solution and observing for bubbles.

Duration of the test will be determined by the Contracting Officer and will be for 2 hours, minimum, to 24 hours, maximum. Test may be terminated by direction of the Contracting Officer at any point during this period after it has been determined that the permissible leakage rate has not been exceeded.

3.11.3 Test and Acceptable Criteria

Aboveground systems shall have Pressure Tests at 1380 kilopascal and the applied pressure shall be maintained without further addition of test media for not less than 2 hours. Maximum allowable pressure drop shall be 14 kilopascal.

Underground rubber-jointed ferrous-pipe water systems shall be tested at 1380 kilopascal, and the applied test pressure shall be maintained for not less than 2 hours. Maximum allowable pressure drop shall be 14 kilopascal. After satisfactory hydrostatic testing, piping shall be tested for leakage as follows:

Duration of each leakage test shall be not less than 2 hours; during the test, the main shall be subjected to 200 psi pressure based on the elevation of the lowest section under test and corrected to the elevation of the test gage.

Leakage shall be defined as the quantity of water supplied into the laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

No piping installation will be accepted if the leakage in gallons per hour exceeds 2.04 times the number of joints in the length of the pipe line tested times the nominal diameter of the pipe in inches times the square root of the average test pressure expressed as psig. Amount of leakage at the joints shall not exceed 1.89 liter per 100 joints regardless of pipe diameter.

Hydrostatic tests shall be applied to piping with concrete thrust blocking only after the concrete has cured for more than 7 days.

Backflow prevention into connected potable-water systems and system devices shall be tested for proper functioning under conditions normal to their application.

Dripping or weeping joints shall be repaired.

3.12 DISINFECTION

Water piping, including valves, fittings, and other devices, shall be disinfected with a solution of chlorine and water. Solution shall contain not less than 50 parts per million (ppm) of available chlorine. Solution shall be held for a period of not less than 8 hours, at which time the solution shall contain a minimum residue of 2 ppm of available chlorine or the system shall be re-disinfected. After successful disinfection the piping shall be thoroughly flushed before placing into service. Water for disinfection, and flushing will be furnished by the Government.

3.13 CLEANING AND ADJUSTING

At the completion of the work, all parts of the installation shall be thoroughly cleaned. Equipment, pipes, valves, and fittings shall be cleaned of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system. Automatic control devices shall be adjusted for proper operation.

-- End of Section --

SECTION 15003

GENERAL MECHANICAL PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A13.1	(1981; R 1993) Scheme for the Identification of Piping Systems

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1992; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM B 766	(1986; R 1993) Standard Specification for Electrodeposited Coatings of Cadmium

CODE OF FEDERAL REGULATIONS (CFR)

40 CFR 82	(1996) Protection of Stratospheric Ozone

MILITARY SPECIFICATIONS (MS)

MS MIL-T-704	(Rev K) Treatment and Painting of Material

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-08	(1991, 1st Ed.) Seismic Restraint Manual Guidelines for Mechanical Systems (Available only from 401 Shatto Place, No. 101, Los Angeles, CA 90020) Sheet Metal Industry Fund (SMIF)

UNDERWRITERS LABORATORIES (UL)

UL 6	(1997; 11th Ed) UL Standard for Safety - Rigid Metal Conduit
UL-02	(1995) Building Materials Directory

1.2 SUBMITTALS (Not Applicable)

1.3 COORDINATION

Contractor shall coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work will be avoided. All necessary offsets in piping and all fittings, etc., required to install the work properly shall be furnished complete in place at no additional cost to the Government.

1.4 MECHANICAL SYSTEMS IDENTIFICATION

1.4.1 Diagrams

Chart listing of equipment shall be by designation numbers and capacities such as flow rates, pressure and temperature differences, heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics. This requirement shall not apply for accessories or minor equipment items, such as vents, but is required for such equipment as pumps, water heaters, air-handling system equipment, refrigeration compressors, heat exchangers, and boilers.

Diagrams shall be neat mechanical drawings provided with extruded aluminum frames and 6 millimeter acrylic plastic protection. Location shall be as directed by the Contracting Officer. The number of charts and diagrams shall be equal to or greater than the number of mechanical equipment rooms. Where more than one chart per space is required, these shall be mounted in edge pivoted, swinging leaf, extruded aluminum frame holders which open to 170 degrees.

1.4.2 Identification Tags

Identification tags made of brass or aluminum indicating function of a control or similar component shall be installed on such system devices. Tags shall be 50 millimeter in diameter and marking shall be stamped.

Equipment shall be provided with metal identification tags displaying an equipment designation number matching drawing or control diagram designation.

Tags shall be wired to valve or equipment items with No. 12 AWG 2 millimeter diameter corrosion-resistant steel wire.

1.4.3 Service Labeling

All piping, including that concealed in accessible spaces; exposed, bare and painted; and insulated, shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction. Labels and valve tag schedule shall be in accordance with the typical examples below:

SERVIC	LABEL AND TAG DESIGNATION
Cold potable water	COLD POT. WATER
Hot potable water supply	HOT POT. WATER SUPPLY

SERVIC	LABEL AND TAG DESIGNATION
Rain water leader	RAIN WATER
Sanitary sewer	SAN. SEWER
Sanitary drain	SAN. DRAIN
Sanitary vent	SAN. VENT
Storm drain	STORM DRAIN
Storm sewer	STORM SEWER
Natural Gas	NAT. GAS
Air handling unit No. 1	AIR HAND. UNIT NO. 1
Automatic temperature control	AUTO. TEMP. CONTROL
Hot water supply	HHW SUPPLY
Hot water return	HHW RETURN
Makeup water	MAKEUP WATER
Condensate Drain	COND. DRAIN

Similar services with different temperatures or pressures shall be identified. Where pressures may exceed 860 kilopascal, the maximum system pressure shall be included in the label.

Piping shall be labeled and arrowed in accordance with the following:

Each point of entry and exit of pipe passing through walls

Each change in direction, i.e., elbows, tees

In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

In long straight runs, labels shall be located at distances within eyesight of each other but in no case shall the distance between labels exceed 20 meter. All labels shall be visible and legible from the primary service and operating area.

For Bare or Insulated Pipes for Outside Diameters o	Lettering
13 thru 32 millimeter	13 millimeter
40 thru 90 millimeter	19 millimeter
100 millimeter and larger	30 millimeter

Labels shall be made of self-sticking, plastic film designed for permanent

installation.

1.5 COLOR CODING

Color coding of all piping systems shall be in accordance with ANSI A13.1.

1.6 APPROVAL REQUIREMENTS

Except as otherwise specified, approval of materials and equipment will be based on manufacturer's published data.

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL-02, and UL 6 will be acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, the Contractor may submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Methods of testing used by the specified agencies shall be outlined.

Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the American Society for Testing and Materials (ASTM), the American Society of Mechanical Engineers (ASME), or other standards, a manufacturer's certificate of compliance of each item will be acceptable as proof of compliance.

Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

1.7 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given rust-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123 for exterior locations and cadmium-plated in conformance with ASTM B 766 for interior locations.

1.8 OZONE DEPLETING SUBSTANCES USED AS REFRIGERANTS

Releases of Ozone Depleting Substances (ODS) during repair, maintenance, servicing or disposal of appliances containing ODS's will be minimized by complying with all applicable sections of 40 CFR 82 Part 82 Subpart F. Any person conducting repair, maintenance, servicing or disposal of appliances owned by NASA comply with the following:

No Class I or Class II substances used as a refrigerant may be knowingly vented or otherwise released into the environment.

No appliances may be opened without meeting the requirements of 40 CFR 82 Part 82.156 Subpart F, regarding required practices regardingevacuation and collection of refrigerant, and 40 CFR 82 Part 82.158 Subpart F, regarding standards of recycling and recovery equipment.

No work may be conducted on appliances containing refrigerant except by persons who comply with 40 CFR 82 Part 82.161 Subpart F, regarding technician certification.

In addition, copies of all applicable certifications must be provided to the Contracting Officer at least 10 working days prior to initiating maintenance, repair, servicing, dismantling or disposal of appliances, including:

Proof of Technician Certification

Proof of Equipment Certification, if recovery or recycling equipment is to be provided by the Contractor

Proof of availability of certified recovery or recycling equipment, if equipment is to be provided by the Contractor

1.9 USE OF OZONE DEPLETING SUBSTANCES, OTHER THAN REFRIGERANTS

The use of Class I or Class II ODS's listed as nonessential in 40 CFR 82 Part 82.66 Subpart C is prohibited. These prohibited materials and uses include:

Any plastic party spray streamer or noise horn which is propelled by a chlorofluorocarbon

Any cleaning fluid for electronic and photographic equipment which contains a chlorofluorocarbon; including liquid packaging, solvent wipes, solvent sprays, and gas sprays

Any plastic flexible or packaging foam product which is manufactured with or contains a chlorofluorocarbon, including, open cell foam, open cell rigid polyurethane poured foam, closed cell extruded polystyrene sheet foam, closed cell polyethylene foam and closed cell polypropylene foam except for flexible or packaging foam used in coaxial

Any aerosol product or other pressurized dispenser which contains a chlorofluorocarbon, except for those listed in 40 CFR 82 Part 82.66 Subpart C.

A waiver may be requested should a programmatic of facility requirement dictate that a prohibited material is necessary to achieve project goals. A waiver request must be submitted in writing to the Test Operations and Institutional Safety Branch. The waiver will be evaluated and dispositioned by a Hazardous Materials Review subcommittee.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, engraved laminated phenolic identification plates shall be provided for each piece of mechanical equipment. Identification plates shall designate the function of the equipment. Designation shall be submitted with the shop drawings.

Identification plates shall be three layers, black-white-black, engraved to show white letters on black background. Letters shall be upper case. Identification plates 40 millimeter high and smaller shall be 1.6 millimeter thick, with engraved lettering 3 millimeter high; identification plates larger than 40 millimeter high shall be 3 millimeter thick, with engraved lettering of suitable height. Identification plates 40 millimeter high and larger shall have beveled edges. Identification plates shall be installed using a compatible adhesive.

2.2 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the equipment manufacturer and shall be located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

2.3 SEISMIC ANCHORAGE

Equipment shall be anchored in accordance with applicable seismic criteria for the area and as defined in SMACNA-08.

2.4 PAINTING

Equipment units shall be painted in accordance with MS MIL-T-704 or in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouching shall be accomplished only if approved; otherwise equipment shall be returned to the factory for refinishing.

PART 3 EXECUTION

3.1 INSTALLATION

Materials and equipment shall be installed in accordance with the requirements of the contract drawings and approved recommendations of the manufacturers. Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

3.2 EQUIPMENT PADS

Equipment pads shall be provided and shall be of dimensions shown or, if not shown, they shall conform to the shape of each piece of equipment

served with a minimum 75 millimeter margin around the equipment and supports.

3.3 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching of the building structure.

Holes in exposed locations, in or through existing floors, shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

Holes through masonry walls to accommodate sleeves shall be made with an iron pipe masonry core saw.

3.4 CLEANING

Exposed surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish painting or are enclosed within the building structure.

Before final acceptance, mechanical equipment, including piping, ducting, and fixtures, shall be clean and free from dirt, grease, and finger marks.

-- End of Section --

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S328	(1986) Specification for Structural Steel Buildings Load and Resistance Factor Design

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A112.18.1M	(1996) Plumbing Fixture Fittings
ANSI B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 126	(1995) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 183	(1983; R 1990) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 197M	(1987; R 1992) Standard Specification for Cupola Malleable Iron (Metric)
ASTM A 234/A 234M	(1997) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 276	(1995) Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A 278M	(1993) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 345 Degrees C (Metric)
ASTM A 312/A 312M	(1995; Rev A) Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipe

ASTM A 480/A 480M	(1995) Flat Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip, General Requirements for
ASTM A 53	(1996) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 563M	(1996) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A 6/A 6M	(1995) Standard Specification for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use
ASTM A 74	(1994) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM B 32	(1995) Specification for Solder Metal
ASTM B 370	(1992) Standard Specifications for Copper Sheet and Strip for Building Construction
ASTM B 62	(1993) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 749	(1997) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM B 88M	(1995) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C 109/C 109M	(1995) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C 190	(1985) Standard Test Method for Tensile Strength of Hydraulic Cement Mortars
ASTM C 404	(1994) Standard Specification for Aggregates for Masonry Grouts
ASTM C 476	(1991) Standard Specification for Grout Masonry
ASTM C 564	(1995) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 67	(1994) Standard Test Methods of Sampling and Testing Brick and Structural Clay Tile

ASTM C 920	(1995) Standard Specification for Elastomeric Joint Sealants
ASTM E 1	(1995) Standard Specification for ASTM Thermometers
ASTM F 104	(1995) Standard Classification System for Nonmetallic Gasket Materials
ASTM F 568	(1995) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.19.2M	(1995) Vitreous China Plumbing Fixtures
ASME B1.21M	(1978; R 1991) Metric Screw Threads - MJ Profile
ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.25	(1996) Buttwelding Ends
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(1992) Malleable-Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(1986) Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME-16	(1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME-17	(1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS-02	(1990) Welding Handbook; Eighth Ed; Vol Two - Welding Process

FEDERAL SPECIFICATIONS (FS)

FS HH-I-558	(Rev C) Insulation, Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)
FS FF-S-325	(Int Amd 3) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

FLUID SEALING ASSOCIATION (FSA)

FSA-01	(1991) Rubber Expansion Joints and Flexible Rubber Pipe Connectors Handbook

MILITARY SPECIFICATIONS (MS)

MS MIL-C-18480	(Rev B; Notice 1) Coating Compound, Bituminous, Solvent, Coal-Tar Base
MS MIL-E-17813	(Rev F) Expansion Joints, Pipe, Metallic Bellows

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(1995) Butterfly Valves
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-70	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Section 15072, "Vibration Isolation for Air Conditioning Equipment," applies to work specified in this section.

Section 15055, "Welding Mechanical," applies to work specified in this section.

Equipment Foundation Data for piping systems shall include plan dimensions

of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

Fabrication Drawings shall be submitted for pipes, valves and specialities consisting of fabrication and assembly details to be performed in the factory.

Material, Equipment, and Fixture Lists shall be submitted for pipes, valves and specialties including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. A complete list of construction equipment to be used shall be provided.

Manufacturer's Standard Color Charts shall be submitted for pipes, valves and specialties showing the manufacturer's recommended color and finish selections.

Listing of Product Installations for piping systems shall include identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. List shall include purchaser, address of installation, service organization, and date of installation.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for construction equipment to be used.

SD-02 Shop Drawings

The following shall be submitted for pipes, valves and specialties showing conformance with the referenced standards contained within this section.

As-Built Drawings
Coordination Drawings

Installation Drawings shall be submitted for pipes, valves and specialties in accordance with the paragraph entitled, "Pipe Installation," of this section.

SD-03 Product Data

Equipment and performance data shall be submitted for the following items consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

Pipe and Fittings
Piping Specialties
Valves
Miscellaneous Materials
Supporting Elements

Equipment Foundation Data shall be in accordance with paragraph entitled, "General Requirements," of this section.

Manufacturer's catalog data shall be submitted for the following items:

Pipe and Fittings
Piping Specialties
Valves
Miscellaneous Materials
Supporting Elements

SD-04 Samples

Manufacturer's Standard Color Charts shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-05 Design Data

Design analysis and calculations shall be submitted for the following items consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Data shall also include pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

Pipe and Fittings
Piping Specialties
Valves

SD-06 Test Reports

Test reports on the following tests shall be submitted in accordance with paragraph entitled, "Piping Installation," of this section.

Hydrostatic Tests
Air Tests
Valve-Operating Tests
Drainage Tests
Pneumatic Tests
Non-Destructive Electric Tests
System Operation Tests

SD-07 Certificates

Listing of Product Installations for piping systems shall be submitted verifying proper qualifications.

Certificates shall be submitted for the following in accordance with paragraph entitled, "Pipe Installation," of this section.

Surface Resistance
Shear and Tensile Strengths
Temperature Ratings
Bending Tests
Flattening Tests
Transverse Guided Weld Bend Tests

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 Type BCS, Black Carbon Steel

Pipe (DN6 through DN300) shall be Schedule 40 black carbon steel, conforming to ASTM A 53.

Pipe (DN6 through DN250) shall be Schedule 40 seamless black carbon steel, conforming to ASTM A 53, Type S (seamless). Grade A should be used for permissible field bending, in both cases.

Fittings (DN50 and under) shall be 1034 kilopascal working steam pressure (wsp) banded black malleable iron screwed, conforming to ASTM A 197M and ASME B16.3.

Unions (DN50 and under) shall be 1724 kilopascal (250 psi) female, screwed, black malleable iron with brass-to-iron seat, and ground joint, conforming to ASME B16.39.

Fittings (DN65 and over) shall be Steel butt weld, conforming to ASTM A 234/A 234M and ASME B16.9 to match pipe wall thickness.

Flanges (DN65 and over) shall be 1034 kilopascal (150-pound) forged-steel conforming to ASME B16.5, welding neck to match pipe wall thickness.

2.1.2 Type GCS, Galvanized Carbon Steel

Pipe (DN15 through DN250), and where indicated shall be Schedule 40 seamless or electric-resistance welded galvanized steel conforming to ASTM A 53, Type E, Grade B (electric-resistance welded) or Type S (seamless).

Pipe (DN300 and over) shall be 9.52 millimeter wall, seamless, galvanized steel, conforming to ASTM A 53, Grade B.

Fittings (DN50 and under) shall be 1034 kilopascal wsp banded galvanized malleable iron screwed, conforming to ASTM A 197M and ASME B16.3.

Unions (DN50 and under) shall be 1034 kilopascal wsp female, screwed, galvanized malleable iron with brass-to-iron seat and ground joint.

Fittings (DN65 and over) shall be 862 kilopascal wsp cast-iron flanges and flanged fittings, conforming to ASTM A 126, Class A and ASME B16.1.

Grooved pipe couplings and fittings shall conform to paragraph entitled, "Grooved Pipe Couplings and Fittings."

Contractor has the option of using 1034 kilopascal wsp banded galvanized malleable iron screwed fittings, conforming to ASTM A 197M and ASME B16.3.

2.1.3 Type GCS-DWV, Galvanized Steel Drain, Waste and Vent

Pipe (all sizes) shall be Schedule 40 seamless galvanized carbon steel, conforming to ASTM A 53, Grade A.

Risers DN80 and larger shall be Type CISP-DWV.

Fittings shall be galvanized, screwed, cast iron, recessed pattern drainage fittings, conforming to ASTM A 126.

2.1.4 Type CISP-DWV, Cast-Iron Drain, Waste and Vent

Soil pipe drain, waste, and vent bell-and-spigot type pipe shall be cast iron, conforming to ASTM A 74. Joints may be two-gasket system type chloroprene, conforming to ASTM C 564. Pipe class shall be extra heavy (CISP-DWV-XH).

2.1.5 Type CPR, Copper

2.1.5.1 Type CPR-A, Copper Above Ground

Tubing DN50 and under shall be seamless copper tubing, conforming to ASTM B 88M, Type L (hard-drawn for all horizontal and all exposed vertical lines, annealed for concealed vertical lines).

Fittings DN50 and under shall be 1034 kilopascal wsp wrought-copper solder joint fittings conforming to ASME B16.22.

Unions DN50 and under shall be 1034 kilopascal wsp wrought-copper solder joint, conforming to ASME B16.22.

Solder shall be 95-5 tin-antimony, alloy Sb-5, conforming to ASTM B 32.

2.1.5.2 Type CPR-U, Copper Under Ground

Piping shall be Type K seamless copper tube, conforming to ASTM B 88M. Socket-joint fittings shall be wrought copper, conforming to ASME B16.22. Fittings for connection to corporation cocks shall be cast bronze,

flared-type, conforming to ASME B16.26. Joints shall be brazed.

2.1.6 Grooved Pipe Couplings and Fittings

Couplings shall have a housing, fabricated in two or more parts, of black, ungalvanized malleable iron castings. Coupling gasket shall be molded synthetic rubber, conforming to ASTM D 2000. Coupling bolts shall be oval-neck, track-head type, with hexagonal heavy nuts conforming to ASTM A 183.

All pipe fittings used with couplings shall be fabricated of black, ungalvanized malleable iron castings. Where a manufacturer's standard-size malleable iron fitting pattern is not available, approved fabricated fittings may be used.

Fittings shall be fabricated from Schedule 40 or 19 millimeter (0.75-inch) wall ASTM A 53, Grade B seamless steel pipe; long radius seamless welding fittings with wall thickness to match pipe, conforming to ASTM A 234/A 234M and ASME B16.9.

2.2 PIPING SPECIALTIES

2.2.1 Air Separator

Air separated from converter discharge water shall be ejected by a reduced-velocity device vented to the compression tank.

Commercially constructed separator shall be designed and certified to separate not less than 80 percent of entrained air on the first passage of water and not less than 80 percent of residual on each successive pass. Shop drawings shall detail piping connections proposed for this work.

Air separator shall be carbon steel, designed, fabricated, tested, and stamped in conformance with ASME-16 for service pressures not less than 862 kilopascal.

2.2.2 Air Vents

Manual air vents shall be 10 millimeter (3/8-inch) globe valves.

Automatic air vents on pumps, mains, and where indicated shall be of ball-float construction. Vent inlet shall be not less than DN20, and the outlet shall be not less than 8 millimeter (1/4-inch ips). Orifice shall be 3 millimeter. Trim shall be corrosion-resistant steel conforming to ASTM A 276 or ASTM A 480/A 480M. Vent shall be fitted with try-cock. Vent shall discharge air at any pressure to 1034 kilopascal (150 psi). Outlet shall be copper tube routed.

2.2.3 Compression Tank

Compression tank shall be designed, fabricated, tested, and stamped for a working pressure of not less than 862 kilopascal in accordance with ASME-16. Tank shall be hot-dip galvanized after fabrication to produce not less than 51 grams of zinc coating per square meter of single-side surface.

Tank accessories shall include red-lined gage-glass complete with glass protectors and shutoff valves, air charger and drainer, and manual vent.

2.2.4 Dielectric Connections

Dissimilar pipe metals shall be electrically insulated from each other by couplings, unions, or flanges commercially manufactured for that purpose and rated for the service pressure and temperature.

2.2.5 Expansion Vibration Isolation Joints

Single or multiple arch-flanged expansion vibration isolation joints shall be constructed of steel-ring reinforced chloroprene-impregnated cloth materials. Joint shall be designed to absorb the movement of the pipe sections in which installed with no detrimental effect on pipe or connected equipment. Flanges shall be backed with ferrous-metal backing rings. Control rod assemblies shall be provided to restrict joint movement. All nonmetallic exterior surfaces of the joint shall be coated with chlorosulphinated polyethylene. Grommets shall be provided in limit bolt hole to absorb noise transmitted through the bolts.

Joints shall be suitable for continuous-duty working temperature of at least 121 degrees C.

Arches shall be filled with soft chloroprene.

Joint, single-arch, movement limitations and size-related, pressure characteristics shall conform to Tables I and II of FSA-01.

2.2.6 Flexible Pipe

Flexible pipe vibration and pipe-noise eliminators shall be constructed of wire-reinforced, rubber-impregnated cloth and cord materials and shall be flanged. Flanges shall be backed with ferrous-metal backing rings. Service pressure-rating shall be minimum 1.5 times actual service. Surge pressure shall be at 82 degrees C.

Flexible pipe vibration and pipe noise eliminators shall be constructed of wire-reinforced chloroprene-impregnated cloth and cord materials and shall be flanged. Flanges shall be backed with ferrous-metal backing rings. Nonmetallic exterior surfaces of the flexible pipe shall be coated with an acid- and oxidation-resistant chlorosulphinated polyethylene. Flexible pipe shall be rated for continuous duty at 896 kilopascal and 121 degrees C.

Unit pipe lengths, face-to-face, shall be not less than the following:

INSIDE DIAMETER (DN	UNIT PIPE LENGTH
To 65, inclusive	305 millimeter
80 to 100, inclusive	450 millimeter
125 to 300, inclusive	600 millimeter

INSIDE DIAMETER (DN UNIT PIPE LENGTH

2.2.7 Flexible Metallic Pipe

Flexible pipe shall be the bellows-type with wire braid cover and shall be designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Working pressure minimum rating shall be 345 kilopascal at 149 degrees C.

Minimum burst pressure shall be four times working pressure at 149 degrees C. Bellows material shall be AISI Type 316L corrosion-resistant steel. Braid shall be AISI 300 series corrosion-resistant steel wire.

Threaded end connections shall be hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A 312/A 312M.

Flanged end connection rating and materials shall conform to specifications for system primary-pressure rating.

2.2.8 Metallic Expansion Joints

Expansion joints shall be metallic-bellows-type, conforming to MS MIL-E-17813.

Expansion joints shall be Type I (corrugated bellows, unreinforced), Class 1 (single bellows, expansion joint).

Joints shall be designed and constructed to absorb all of the movements of the pipe sections in which installed, with no detrimental effect on pipe or supporting structure.

Joints shall be rated, designed, and constructed for pressures to 862 kilopascal and temperatures to 260 degrees C.

Joints shall have a designed bursting strength in excess of four times their rated pressure.

Joints shall be capable of withstanding a hydrostatic test of 1.5 times their rated pressure while held at their uncompressed length without leakage or distortion that may adversely affect their life cycle.

Life expectancy shall be not less than 10,000 cycles.

Movement capability of each joint shall exceed calculated movement of piping by 100 percent.

Bellows and internal sleeve material shall be AISI Type 304, 304L, or 321 corrosion-resistant steel.

End connections shall require no field preparation other than cleaning.

Butt weld end preparation of expansion joints shall conform to the same

codes and standards requirements as applicable to the piping system materials at the indicated joint location.

Flanges of flanged-end expansion joints shall conform to the same codes and standard requirements as are applicable to companion flanges specified for the given piping system at the indicated joint location.

Joints, DN65 and smaller, shall have internal guides and limit stops.

Joints, DN80 and larger, shall be provided with removable external covers, internal sleeves, and purging connection. Sleeves shall be sized to accommodate lateral clearance required, with minimum reduction of flow area, and with oversized bellows where necessary. When a sleeve requires a gasket as part of a locking arrangement, the gasket shall be provided by the manufacturer. Joints without purging connection may be provided; however, these shall be removed from the line prior to, or not installed until, cleaning operations are complete.

Cylindrical end portion of the reinforced bellows element shall be provided with a thrust sleeve of sufficient thickness to bring that portion within applicable code-allowable stress. Sleeve shall provide 360 degrees support for the element and end-reinforcing ring.

Expansion joints shall have four, equidistant, permanent tram points clearly marked on each joint end. Points shall be located to prevent obliteration during installation. Distance between tram points indicating installed lengths shall be included in shop drawings. Overall dimension after joint installation shall be subject to approval.

Each expansion joint shall have adjustable clamps or yokes provided at quarter points, straddling the bellows. Overall joint length shall be set by the manufacturer to maintain joints in manufacturer's recommended position during installation.

Each joint shall be permanently and legibly marked with the manufacturer's name or trademark and serial number; the size, series, or catalog number; bellows material; and directional-flow arrow.

2.2.9 Hose Faucets

Hose faucets shall be constructed with 15 millimeter (1/2-inch) male inlet threads, hexagon shoulder, and 20 millimeter (3/4-inch) hose connection, conforming to ANSI A112.18.1M. Hose-coupling screw threads shall conform to ASME B1.21M.

Vandalproof, atmospheric-type vacuum breaker shall be provided on discharge.

2.2.10 Orifice Unions

Orifice unions shall be nonferrous type, with gasketed corrosion-resistant steel orifice. Flanged unions shall have the orifice size stamped on a tab of the orifice. Screwed unions shall have the orifice size stamped on the coupling nut.

2.2.11 Pressure Gages

Pressure gages shall conform to ANSI B40.1 and to requirements specified herein. Pressure gages shall be Type I, (for air, steam, and water) Class 1 (pressure). Pressure-gage size shall be 90 millimeter nominal diameter. Case shall be corrosion-resistant steel, conforming to any of the AISI 300 series of ASTM A 6/A 6M, with an ASM No. 4 standard commercial polish or better. Gages shall be equipped with adjustable red marking pointer and damper-screw adjustment in inlet connection. Service-pressure reading shall be at midpoint of gage range. All gages shall be equipped with gage isolators.

2.2.12 Sight-Flow Indicators

Sight-flow indicators for pressure service on 80 millimeter and smaller shall be constructed of bronze with specially treated single- or double-glass sight windows and shall have a bronze, nylon, or tetrafluoroethylene rotating flow indicator mounted on an AISI Type 304 corrosion-resistant steel shaft. Body may have screwed or flanged end. Assembly shall be pressure- and temperature-rated for the applied service. Flapper flow-type indicators are not acceptable.

2.2.13 Sleeve Couplings

Sleeve couplings for plain-end pipe shall consist of one steel middle ring, two steel followers, two chloroprene or Buna-N elastomer gaskets, and the necessary steel bolts and nuts.

2.2.14 Thermometers

Thermometers shall conform to ASTM E 1. Thermometers shall be industrial pattern Type I, except red Organic-liquid-filled, Class 3 (well-threaded and seal-welded). Thermometers installed 1800 millimeter or higher above the floor shall have an adjustable angle body. Scale shall be not less than 180 millimeter long. Case face shall be manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Thermometer range shall be 120 degrees C. Thermometers shall be provided with nonferrous separable wells. Lagging extension to accommodate insulation thickness shall be provided.

2.2.15 Pump Suction Strainers

Strainer body shall be cast iron, rated for not less than 172 kilopascal at 38 degrees C (25 psig at 100 degrees F), with flanges conforming to ASME B16.1, Class 125. Strainer construction shall be such that there is a machined surface joint between body and basket that is normal to the centerline of the basket.

Minimum ratio of open area of each basket to pipe area shall be 3 to 1. Basket shall be AISI 300 series corrosion-resistant steel wire mesh with perforated backing.

Mesh shall be capable of retaining all particles larger than 1,000 micrometer, with a pressure drop across the strainer body of not more than

5 kilopascal when the basket is two-thirds dirty at maximum system flow rate. Reducing fittings from strainer-flange size to pipe size shall be provided.

A differential-pressure gage fitted with a two-way brass cock shall be provided across the strainer.

Manual air vent cocks shall be provided in cap of each strainer.

2.2.16 Line Strainers, Water Service

Strainers shall be Y-type with removable basket. Strainers in sizes DN50 and smaller shall have screwed ends. In sizes DN65 and larger, strainers shall have flanged ends. Body working-pressure rating shall exceed maximum service pressure of system in which installed by at least 50 percent. Body shall have cast-in arrows to indicate direction of flow. All strainer bodies fitted with screwed screen retainers shall have straight threads and shall be gasketed with nonferrous metal. Strainer bodies DN65 and larger, fitted with bolted-on screen retainers, shall have offset blowdown holes. All strainers larger than DN65 shall be fitted with manufacturer's standard ball-type blowdown valve. Body material shall be cast bronze conforming to ASTM B 62 cast iron conforming to Class 30 ASTM A 278M. Where system material is nonferrous, metal strainer body material shall be nonferrous metal.

Minimum free-hole area of strainer element shall be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens shall have perforations not to exceed 1.14 millimeter. Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 304 corrosion-resistant steel.

2.3 VALVES

2.3.1 Ball and Butterfly Valves

Ball valves shall conform to MSS SP-72. Valves shall be Style 1A and shall be rated for service at not less than 1207 kilopascal at 93 degrees C. Valve bodies in sizes DN50 and smaller shall be screwed-end connection-type constructed of Class A copper alloy. Valve bodies in sizes DN65 and larger shall be flanged-end connection type, constructed of Class D material. Balls and stems of valves DN50 and smaller shall be manufacturer's standard with hard chrome plating finish. Balls and stems of valves DN65 and larger shall be manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome plating. Balls of valves DN150 and larger may be Class D with 900 Brinell hard chrome plating. Valves shall be suitable for flow from either direction and shall seal equally tight in either direction. Valves with ball seals held in place by spring washers are not acceptable. All valves shall have adjustable packing glands. Seats and seals shall be tetrafluoroethylene.

Butterfly valves shall conform to MSS SP-67. Valves shall be wafer type for mounting between specified flanges and shall be rated for 1034 kilopascal shutoff and nonshock working pressure. Bodies shall be cast

ferrous metal conforming to ASTM A 126, Class B, and to ASME B16.1 for body wall thickness. Seats and seals shall be of the resilient elastomer type designed for field removal and replacement.

2.3.2 Drain, Vent, and Gage Cocks

Drain, vent, and gage cocks shall be T-head or lever handle, ground key type, with washer and screw, constructed of polished ASTM B 62 bronze, and rated 862 kilopascal wsp. End connections shall be rated for specified service.

Pump vent cocks, and where spray control is required, shall be UL umbrella-hood type, constructed of manufacturer's standard polished brass. Cocks shall be 15 millimeter male, end threaded, and rated at not less than 862 kilopascal AT 107 degrees C.

2.3.3 Gate Valves (GAV)

Gate valves DN50 and smaller shall conform to MSS SP-72. Valves located in equipment rooms, factory-assembled equipment, and where indicated shall be union-ring bonnet, screwed-end type. Packing shall be made of non-asbestos type materials. Valves shall be rising stem type.

Gate valves DN65 and larger, shall be Type I, (wedge disk, tapered seats, steam rated); Class I (862 kilopascal steam-working pressure at 178 degrees C saturation); and 1379 kilopascal, wog (nonshock), conforming to MSS SP-70 and to requirements specified herein. Valves shall be flanged, with bronze trim and outside screw and yoke (OS&Y) construction. Packing shall be made of non-asbestos type materials.

2.3.4 Globe and Angle Valves (GLV-ANV)

Globe and angle valves DN50 and smaller, shall be 862 kilopascal conforming to MSS SP-72 and to requirements specified herein. Valves located in equipment rooms, factory-assembled equipment, and where indicated shall be union-ring bonnet, screwed-end type. Disc shall be free to swivel on the stem in all valve sizes. Composition seating-surface disc construction may be substituted for all metal-disc construction. Packing shall be made of non-asbestos type materials. Disk and packing shall be suitable for pipe service installed.

Globe and angle valves DN65 and larger, shall be cast iron with bronze trim. Valve bodies shall be cast iron conforming to ASTM A 126, Class A, as specified for Class 1 valves under MSS SP-70. Valve ends shall be flanged in conformance with ASME B16.1. Valve construction shall be outside screw and yoke (OS&Y) type. Packing shall be made of non-asbestos type materials.

2.3.5 Standard Check Valves (SCV)

Standard check valves in sizes DN50 and smaller shall be 862 kilopascal swing check conforming to MSS SP-72, except as otherwise specified. Lift checks (lift check horizontal) and 862 kilopascal, conforming to MSS SP-72, shall be provided where indicated. Swing-check pins shall be nonferrous

and suitably hard for the service. Discs shall be composition type. Swing-check angle of closure shall be manufacturer's standard unless a specific angle is needed.

Check valves in sizes DN65 and larger shall be cast iron, bronze trim, swing type. Valve bodies shall be cast iron, conforming to ASTM A 126, Class A. Valve ends shall be flanged in conformance with ASME B16.1. Swing-check pin shall be AISI Type 304 or approved equal corrosion-resistant steel. Angle of closure shall be manufacturer's standard unless a specific angle is needed. Valves shall have bolted and gasketed covers.

Check valves shall be provided with lever-weighted, positive-closure devices and valve ends shall be push-on or flanged.

2.3.6 Nonslam Check Valves (NSV)

Check valves at pump discharges in sizes DN50 and larger shall be nonslam or silent-check type. Valve disc or plate shall close before line flow can reverse to eliminate slam and water-hammer due to check-valve closure. Valve shall be rated for 1379 kilopascal maximum, nonshock pressure at 66 degrees C in sizes to DN300. Valves shall be fitted with flanges conforming to ASME B16.1. Valve body may be cast iron, conforming to ASTM A 278M, Class 40 or equivalent strength ductile iron. Disks shall be manufacturer's standard bronze, aluminum bronze, or corrosion-resistant steel. Pins, springs, and miscellaneous trim shall be manufacturer's standard corrosion-resistant steel. Disk and shaft seals shall be Buna-N elastomer tetrafluoroethylene.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Bituminous Coating

Bituminous coating shall be a solvent cutback, heavybodied material to produce not less than a 0.30 millimeter dry-film thickness in one coat, and shall be as recommended by the manufacturer to be compatible with factory-applied coating and rubber joints.

For previously coal-tar coated and uncoated ferrous surfaces underground, bituminous coating shall be solvent cutback coal-tar type, conforming to MS MIL-C-18480.

2.4.2 Bolting

Flange and general purpose bolting shall be hex-head and shall conform to ASTM F 568, Class 4.8 or above (bolts, for flanged joints in piping systems where one or both flanges are cast iron). Heavy hex-nuts shall conform to ASTM A 563M. Square-head bolts and nuts are not acceptable. Threads shall be coarse-thread series.

2.4.3 Elastomer Calk

Polysulfide- or polyurethane-base elastomer calking material shall be two-component type, conforming to ASTM C 920.

2.4.4 Escutcheons

Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Metals and finish shall conform to ASME A112.19.2M.

Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. All escutcheons shall have provisions consisting of internal spring-tension devices or setscrews for maintaining a fixed position against a surface.

2.4.5 Flashing

Sheet lead shall conform to ASTM B 749, Grade B intended for use in laboratories and shops in general application.

Sheet copper shall conform to ASTM B 370 and shall be of not less than 4.88 kilogram per square meter weight.

2.4.6 Flange Gaskets

Compressed non-asbestos sheet, conforming to ASTM F 104, Type 7-P1161A, coated on both sides with graphite or similar lubricant, with nitrile composition, binder rated to 399 degrees C.

2.4.7 Grout

Shrink-resistant grout shall be a premixed and packaged metallic-aggregate, mortar-grouting compound conforming to ASTM C 404 and ASTM C 476.

Shrink-resistant grout shall be a combination of premeasured and packaged epoxy polyamide or amine resins and selected aggregate mortar grouting compound conforming to the following requirements:

Tensile strength	ASTM C 190	13.100 Megapascal, minimum
Compressive strength	ASTM C 109/C 109M	96.527 Megapascal, minimum
Shrinkage, linear		0.003 mm per millimeter, maximum
Water absorption	ASTM C 67	0.1 percent, maximum
Bond strength to steel in shear minimum		6.895 Megapascal, minimum

2.4.8 Pipe Thread Compounds

Tetrafluoroethylene tape not less than 0.05 to 0.08 millimeter thick shall be used in potable and process water and in chemical systems for pipe sizes to and including DN25. Tetrafluoroethylene dispersions and other suitable compounds may be used for all other applications upon approval; however, no lead-containing compounds may be used in potable water systems.

2.5 SUPPORTING ELEMENTS

All necessary piping systems and equipment supporting elements shall be provided, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable, or constant supports. All supporting elements shall be suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.

Supporting elements shall conform to requirements of ASME B31.3, FS FF-S-325, MSS SP-58, and MSS SP-69 except as noted.

Attachments welded to pipe shall be made of materials identical to that of pipe or materials accepted as permissible raw materials by referenced code or standard specification.

Supporting elements exposed to weather shall be hot-dip galvanized. Materials shall be of such a nature that their apparent and latent-strength characteristics are not reduced due to galvanizing process. Supporting elements in contact with copper tubing shall be electroplated with copper.

Type designations specified herein are based on MSS SP-58 and MSS SP-69. Masonry anchor group-, type-, and style-combination designations shall be in accordance with FS FF-S-325. Support elements, except for supplementary steel, shall be cataloged, load rated, commercially manufactured products.

2.5.1 Building Structure Attachments

2.5.1.1 Anchor Devices, Concrete and Masonry

Anchor devices shall conform to FS FF-S-325 for the following types:

Group I - shield, expansion (lead, bolt and stud anchors)

Group II - shield, expansion (bolt anchors)

Type 2 - machine bolt expansion shield anchors

Class 2 - open-end expansion shield anchors

Style 1 - single-end expansion shield anchors

Style 2 - double-end expansion shield anchors

Group III - shield, expansion (self-drilling

tubular expansion shell bolt anchors)

Cast-in, floor mounted, equipment anchor devices shall provide adjustable positions.

Masonry anchor devices shall be built-in.

Powder-actuated anchoring devices shall not be used to support any mechanical systems components.

2.5.1.2 Beam Clamps

Beam clamps shall be center-loading Type 30.

When it is not possible to use center-loading beam clamps, eccentric-loading beam clamps, Type 20 may be used for piping sizes DN50 and less and for piping sizes DN50 through DN250 provided two counterbalancing clamps are used per point of pipe support. Where more than one rod is used per point of pipe support, rod diameter shall be determined in accordance with referenced standards.

2.5.1.3 Inserts, Concrete

Concrete inserts shall be Type 18. When applied to piping in sizes DN50 and larger and where otherwise required by imposed loads, a 305 millimeter length of 13 millimeter reinforcing rod shall be inserted and wired through wing slots. Proprietary-type continuous inserts may be submitted for approval.

2.5.2 Horizontal Pipe Attachments

2.5.2.1 Single Pipes

Piping in sizes to and including DN50 shall be supported by Type 6 solid malleable iron pipe rings, except that split-band-type rings may be used in sizes up to DN25.

Piping in sizes through DN200 inclusive shall be supported by Type 3 attachments.

Type 1 and Type 6 assemblies shall be used on vapor-sealed insulated piping and shall have an inside diameter larger than pipe being supported to provide adequate clearance during pipe movement.

Where thermal movement of a point in a piping system DN100 and larger would cause a hanger rod to deflect more than 4 degrees from the vertical or where a horizontal point movement exceeds 13 millimeter, Type 44 through 47 pipe rolls shall be used.

Type 40 shields shall be used on all insulated piping. Area of the supporting surface shall be such that compression deformation of insulated surfaces does not occur. Longitudinal and transverse shield edges shall be rolled away from the insulation.

Insulated piping without vapor barrier on roll supports shall be provided with Type 39a saddles for pipe sizes to DN300.

Type 39a and 39b saddles shall be used for pipe guiding.

Spring supports shall be as indicated.

2.5.2.2 Parallel Pipes

Trapeze hangers fabricated from approved structural steel shapes, with U-bolts, shall be used in congested areas and where multiple pipe runs occur. Structural steel shapes shall be of commercially available, proprietary design, rolled steel.

2.5.3 Vertical Pipe Attachments

Vertical pipe attachments shall be Type 8.

Shop drawing data shall include complete fabrication and attachment details of any spring supports.

2.5.4 Hanger Rods and Fixtures

Only circular cross section rod hangers may be used to connect building structure attachments to pipe support devices. Pipe, straps, or bars of equivalent strength shall be used for hangers only where approved.

Turnbuckles, swing eyes, and clevises shall be provided as required by support system to accommodate temperature change, pipe accessibility, and adjustment for load and pitch. Rod couplings are not acceptable.

2.5.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, such supplementary steel shall be designed and fabricated in accordance with AISC S328.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

Certificates shall be submitted for pipes, valves and specialties showing conformance with test requirements as contained in the reference standards contained in this section. Certificates shall verify Surface Resistance, Shear and Tensile Strengths, Temperature Ratings, Bending Tests, Flattening Tests and Transverse Guided Weld Bend Tests.

Test reports for Hydrostatic Tests, Air Tests, Valve-Operating Tests, Drainage Tests, Pneumatic Tests, Non-Destructive Electric Tests and System Operation Tests shall be provied by the Contractor, in compliance with refereced standards contained within this section.

Piping systems shall be fabricated and installed in accordance with ASME B31.3, MSS SP-69, and AWS-02.

Installation Drawings shall be submitted for pipes, valves and specialties. Drawings shall include the manufacturer's design and construction calculations, forces required to obtain rated axial, lateral, or angular

movements, installation criteria, anchor and guide requirements for equipment, and equipment room layout and design. Drawing shall specifically advise on procedures to be followed and provisions required to protect expansion joints during specified hydrostatic testing operations.

Connections between steel piping and copper piping shall be electrically isolated from each other with dielectric couplings (or unions) rated for the service.

Final connections to equipment shall be made with unions or flanges provided every 30480 millimeter of straight run. Unions shall be provided in the line downstream of screwed- and welded-end valves.

All pipe ends shall be reamed before joint connections are made.

Screwed joints shall be made up with specified joint compound and not more than three threads shall show after joint is made up.

Joint compounds shall be applied to the male thread only and care shall be exercised to prevent compound from reaching the unthreaded interior of the pipe.

Screwed unions, welded unions, or bolted flanges shall be provided wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

Piping systems shall be securely supported with due allowance for thrust forces, thermal expansion and contraction, and shall not be subjected to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.

Field welded joints shall conform to the requirements of the AWS-02, ASME B31.3, and ASME-17.

Piping systems butt weld joints shall be made with backing rings. Backing ring materials shall be compatible with materials being joined. Joint configuration shall conform to ASME B16.25.

All necessary precautions shall be taken during installation of flexible pipe and hose including flushing and purging with water, steam, and compressed air to preclude bellows failure due to pipe line debris lodged in bellows. Installation shall conform to manufacturer's instructions.

3.2 VALVES

Valves shall be provided in piping mains and all branches and at equipment where indicated and as specified.

Valves shall be provided to permit isolation of branch piping and each equipment item from the balance of the system.

Riser and downcomer drains above piping shutoff valves in piping DN65 and larger shall be provided. Shutoff valve body shall be tapped and fitted with a DN15 plugged globe valve.

Valves unavoidably located in furred or other normally inaccessible places shall be provided with adequately sized access panels approved for the location.

3.3 SUPPORTING ELEMENTS INSTALLATION

Supporting elements shall be provided in accordance with the referenced codes and standards.

Piping shall be supported from building structure. No piping shall be supported from roof deck or from other pipe.

Piping shall run parallel with the lines of the building. Piping and components shall be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there shall be no less than DN15 of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the building.

Piping support elements shall be installed at intervals specified hereinafter, at locations not more than 900 millimeter from the ends of each runout, and not over 300 millimeter from each change in direction of piping.

Load rating for all pipe-hanger supports shall be based on insulated weight of lines filled with water and forces imposed. Deflection per span shall not exceed slope gradient of pipe. Supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, the allowable span shall be reduced proportionately:

PIPE SIZE (DN) MILLIMETE	ROD SIZE MILLIMETE	STEEL PIPE MILLIMETE	COPPER PIPE MILLIMETER
25 and smaller	10	2500	1850
32 to 40	10	3050	2500
50	10	3700	3050
65 to 90	13	3700	3700
100 to 125	16	5000	4300
150	20	5000	5000

Vibration isolation supports shall be provided where needed. Refer to Section 15072, "Vibration Isolation for Air Conditioning Equipment," where A/C equipment and piping is installed.

Vertical risers shall be supported independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and

at intervals to accommodate system range of thermal conditions. Risers shall be guided for lateral stability. For risers subject to expansion, only one rigid support shall be provided at a point approximately one-third down from the top. Clamps shall be placed under fittings unless otherwise specified. Carbon-steel pipe shall be supported at each floor and at not more than 4572 millimeter intervals for pipe DN50 and smaller and at not more than 6096 millimeterintervals for pipe DN65 and larger.

3.4 PENETRATIONS

Effective sound stopping and adequate operating clearance shall be provided to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces shall include space above ceilings where no special acoustic treatment of ceiling is provided. Penetrations shall be finished to be compatible with surface being penetrated.

Sound stopping and vapor-barrier sealing of pipe shafts and large floor and wall openings shall be accomplished by packing to high density with properly supported fibrous-glass insulation or, where ambient or surface temperatures do not exceed 49 degrees C, by foaming-in-place with self-extinguishing, 0.9 kilogram density polyurethane foam to a depth not less than 152 millimeter. Foam shall be finished with a rasp. Vapor barrier shall be not less than 3 millimeter thick vinyl coating applied to visible and accessible surfaces. Where high temperatures and fire stopping are a consideration, only mineral wool shall be used and openings shall also be covered with 1.6 millimeter sheet metal.

3.5 SLEEVES

Sleeves shall be provided where piping passes through roofs, masonry, concrete walls and floors.

Sleeves passing through steel decks shall be continuously welded to the deck.

Sleeves that extend through floors, roofs, load bearing walls, and fire barriers shall be continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. All other sleeves shall be formed by molded linear polyethylene liners or similar materials that are removable. Diameter of sleeves shall be large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide a minimum 10 millimeter clearance. Sleeve size shall accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and the generation of noise.

Space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration shall be packed solid with a mineral fiber conforming to FS HH-I-558, Form B, Type 1 (flexible blanket), Class 8, (233 to 538 degrees C (451 to 1000 degrees F)). This packing shall be provided wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other

locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration shall be filled with an elastomer calk to a depth of 13 millimeter. All surfaces to be calked shall be oil- and grease-free.

Exterior wall sleeves shall be calked watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed metal components.

Sleeve height above roof surface shall be a minimum of 305 and a maximum of 457 millimeter.

3.6 ESCUTCHEONS

Escutcheons shall be provided at all penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, escutcheons shall be provided on both sides of the partition. Where suspended ceilings are installed, plates shall be provided at the underside only of such ceilings. For insulated pipes, the plates shall be large enough to fit around the insulation. Escutcheons shall be chrome-plated in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Escutcheons shall be firmly attached with setscrews.

3.7 FLASHINGS

Flashings shall be provided at penetrations of building boundaries by mechanical systems and related work.

3.8 UNDERGROUND PIPING INSTALLATION

Prior to being lowered into a trench, all piping shall be cleaned, visually inspected for apparent defects, and tapped with a hammer to audibly detect hidden defects.

Suspect cast-ferrous piping shall be further inspected by painting with kerosene on external surfaces to reveal cracks.

Defective materials found shall be distinctly marked using a road-traffic quality yellow paint; defective material shall be promptly removed from the site.

After conduit has been inspected, and not less than 48 hours prior to being lowered into a trench, all external surfaces of cast ferrous conduit shall be coated with a compatible bituminous coating for protection against brackish ground water. Application shall be single coat, in accordance with the manufacturer's instructions, to result in a dry-film thickness of not less than 0.30 millimeter.

Excavations shall be dry and clear of extraneous materials when pipe is being laid.

Cutting of piping shall be by wheel cutters or other machines designed specifically for that purpose. Electric-arc and oxyacetylene cutting will not be permitted.

Laying of pipe shall begin at the low point of a system. When in final acceptance position, it shall be true to the grades and alignment indicated, with unbroken continuity of invert. Blocking and wedging will not be permitted.

Bell or grooved ends of piping shall point upstream.

Changes in direction shall be made with long sweep fittings.

Necessary socket clamping, piers, bases, anchors, and thrust blocking shall be provided. Rods, clamps, and bolting shall be protected with a coating of bitumen.

Underground piping below supported or suspended slabs shall be supported from the slab with a minimum of two supports per length of pipe. Supports shall be protected with a coating of bitumen.

On excavations that occur near and below building footings, the backfilling material shall consist of 13800 kilopascal cured compressive-strength concrete poured or pressure-grouted up to the level of the footing.

Vertical downspouts; soil, waste, and vent stacks; water risers; and similar work shall be properly supported on approved piers at the base and provided with approved structural supports attached to building construction.

Cleanout shall be provided.

3.9 DISINFECTION

Water piping, including all valves, fittings, and other devices, shall be disinfected with a solution of chlorine and water. Solution shall contain not less than 50 parts per million (ppm) of available chlorine. Solution shall be held for a period of not less than 8 hours, after which the solution shall contain not less than 10 ppm of available chlorine or the piping shall be redisinfected. After successful sterilization, the piping shall be thoroughly flushed before placing into service. Flushing shall be complete when the flush water contains less than 0.5 ppm of available chlorine. Water for disinfected will be furnished by the Government. Contractor shall be responsible for approved disposal of contaminated flush water.

3.10 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Test data shall be legible and of good quality.

-- End of Section --

SECTION 15055

WELDING MECHANICAL

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.1	(1995) Power Piping
ASME B31.3	(1996) Chemical Plant and Petroleum Refinery Piping
ASME B31.5	(1992; Errata 1993) Refrigeration Piping
ASME-14	(1995) Boiler and Pressure Vessel Code; Section V, Nondestructive Examination
ASME-16	(1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME-17	(1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

BUILDING OFFICIALS & CODE ADMINISTRATORS (BOCA)

BOCA-01	(1995) The BOCA International Plumbing Code

NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS (NBBPVI)

NBBPVI-23	(1995) National Board Inspection Code

PIPE FABRICATION INSTITUTE (PFI)

PFI ES 1	(1992) Internal Machining and Solid Machined Backing Rings for Circumferential Butt Welds
PFI ES 21	(1992) Internal Machining and Fit-up of GTAW Root Pass Circumferential Butt Welds
PFI ES 3	(1981; Rev 1994) Fabricating Tolerances
PFI ES 31	(1992) Standard for Protection of Ends of Fabricated Piping Assemblies

PFI ES 35	(1993) Nonsymmetrical Bevels and Joint Configurations for Butt Welds
PFI ES 7	(1994) Minimum Length and Spacing for Welded Nozzles
PFI TB1	(1988) Pressure Temperature Ratings of Seamless Pipe Used in Power Plant Piping Systems

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for Welding Equipment and Welding Rods and Accessories in accordance with paragraph entitled, "Welding Equipment," of this section.

SD-04 Samples

Welder's Pre-Qualification Samples shall be submitted prior to start.

SD-06 Test Reports

Test reports shall be submitted for Radiographs.

SD-07 Certificates

Certificates for the following shall be submitted in accordance with paragraph entitled, "Quality Assurance," of this section.

Certified Welding Procedure Specifications (WPS)
Certified Brazing Procedure Specifications (BPS)
Certified Procedure Qualification Records (PQR)
Certified Welder Performance Qualifications (WPQ)
Certified Brazer Performance Qualifications (BPQ)

1.3 QUALITY ASSURANCE

Within fifteen days after receipt of Notice to Proceed, the Contractor shall submit for approval to the Contracting Officer Certified Welding Procedure Specifications (WPS), Certified Brazing Procedure Specifications (BPS) and Certified Procedure Qualification Records. (PQR)

1.3.1 Personnel Qualifications

This specification contains the minimum requirements for qualifying welding procedures, welders, and welding operators for making and inspecting welds

in mechanical fabrications of carbon steel, low alloy steel, extra-high-strength quenched and tempered low alloy steels, and austenitic stainless steel materials.

Welder's Pre-Qualification Samples shall be submitted by qualified welding operators performing work on contract prior to start. Only after acceptance of samples, will qualified welding operator be permitted to begin work.

1.3.2 Pressure Vessels Qualification

Qualification documents WPS, PQR and WPQ shall be in accordance with ASME-17.

1.3.3 Piping Qualifications

1.3.3.1 High Pressure Piping

Qualification documents for 860 kilopascal (125 psig) or above, (WPS, PQR and WPQ) shall be in accordance with ASME-17.

1.3.3.2 Low Pressure Piping

Refrigeration Piping: Qualification documents for below 860 kilopascal (125 psig), WPS, PQR and WPQ for "Refrigeration Piping" shall be in accordance with ASME B31.5.

Plumbing: Plumbing work shall be performed by a state licensed plumber.

Other Low Pressure Piping: Qualification documents, WPS PQR and WPQ shall be in accordance with ASME-17.

1.4 WELDING EQUIPMENT

Manufacturer's catalog data shall be provided for Welding Equipment and Welding Rods and Accessories. Equipment shall meet referenced standards contained in this section.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 CONSTRUCTION

3.1.1 Pressure Vessels

3.1.1.1 New Construction

Contractor shall meet the fabrication, welding/brazing and inspection requirements of the ASME-16.

3.1.1.2 Repairs to Existing Pressure Vessels

Code Stamped Vessels: Contractor shall meet the fabrication, welding/brazing and inspection requirements of NBBPVI-23.

Non-Code Vessels: Contractor shall meet the fabrication, welding/brazing and inspection requirements of NBBPVI-23 with the following exception:

a. It is not necessary that a National Board Code Inspector inspect the work.

b. National Board ("R" Stamp) Code stamping is not required.

3.1.2 Piping

3.1.2.1 High Pressure (860 kilopascal or Above)

Other High Pressure Piping: Other high pressure piping systems shall be fabricated, assembled and welded/brazed in accordance with ASME B31.3, and Power Piping Codes, PFI ES 1, PFI ES 3, PFI ES 7, PFI ES 21, PFI ES 31, PFI ES 35, and PFI TB1, of the Piping Fabrication Institute's companion code requirements.

3.1.2.2 Low Pressure (Below 860 kilopascal)

Refrigeration Piping: Piping systems shall be fabricated, assembled and welded/brazed/soldered in accordance with the ASME B31.5.

Plumbing: Plumbing systems shall be fabricated, assembled and welded/brazed/soldered in accordance with BOCA-01.

Other Low Pressure Piping: Other low pressure piping systems shall be fabricated, assembled and welded/brazed/soldered in accordance with the ASME B31.1.

3.2 HEAT INPUT REQUIREMENTS

3.2.1 Preheat

Welding shall not be done at ambient temperature below 0 degrees C, or when the surfaces are wet or exposed to rain, snow, or high wind. Temperature of the metals in the area where the welding is to be done shall be not less than 10 degrees C. When the ambient conditions are such that the normal temperature of the base metal is below 10 degrees C, the area surrounding the joint shall be preheated to provide a base metal temperature of 38 degrees C for a distance of at least 75 millimeter in all directions from the joint to be welded. Preheat shall be in accordance with ASME-16 and ASME-14.

3.2.2 Interpass

In a multipass weld, the interpass temperature is the temperature of the weld metal before the next pass is started. Interpass requirements shall be in accordance with ASME-16.

3.2.3 Postweld

Weldments shall not be given a postweld heat treatment unless noted in the

applicable NASA approved code qualified/certified welding documentation, WPS, PQR and WPQ.

3.3 INSPECTION/NONDESTRUCTIVE TESTING (NDT)

3.3.1 General

Fabrication/Erection inspection shall be performed prior to assembly, during assembly, during welding and after welding to ensure that materials and workmanship meet the requirements of the contract documents.

Each specified radiograph shall, as a minimum, have the following additional information permanently included in the image:

Agency Weld No. (including repair cycle no.)

Agency drawing No.

Agency View No.

Agency Contract No.

Final interpretation and acceptance of all Radiographs of welded joints, with the exception of code stamped pressure vessel welds, will be by the Contracting Officer.

Final acceptance of all welded/brazed joints shall be by the Contracting Officer.

Prior to the Contracting Officer's inspection, all slag and scale shall be removed from all welds. Procedure employed shall not produce notches in either the weld metal or adjacent base metal.

Unacceptable welds shall be immediately repaired and made ready for Government reinspection at no additional cost to the Government.

After weld joints have been satisfactorily completed by the Contractor and accepted by the Contracting Officer, the joint area shall be cleaned to a bright, unpitted, and unscarred surface and then protected in accordance with the contract documents.

3.3.2 Pressure Vessels

3.3.2.1 Test Method

All nondestructive testing shall be performed in accordance with the requirements of ASME-14.

3.3.2.2 Acceptance Requirements

Acceptance requirements shall be in accordance with ASME-14.

3.3.3 Piping

3.3.3.1 Test Method

NDT (Nondestructive Testing) of all piping systems, except plumbing systems, shall be performed in accordance with the requirements of ASME-14.

3.3.3.2 Acceptance Requirements

High Pressure (860 kilopascal or above):

a. Steam piping systems shall meet the requirements of ASME B31.1.

b. Other high pressure piping systems shall meet the requirements of ASME B31.3.

Low Pressure (Below 860 kilopascal):

a. Refrigeration piping systems shall meet the requirements of ASME B31.5.

b. Plumbing piping systems shall meet the requirements of BOCA-01.

c. Other low pressure piping systems shall meet the requirements of ASME B31.1.

3.4 PROTECTION OF ADJACENT MATERIALS

Contractor shall sufficiently protect machinery, materials, floor, etc., adjacent to the welding/brazing operations to prevent any damage from these operations.

-- End of Section --

SECTION 15072

VIBRATION ISOLATION FOR AIR CONDITIONING EQUIPMENT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S2.40	(1984; R 1990) Mechanical Vibration of Rotating and Reciprocating Machinery - Requirements for Measuring Vibration Severity
ANSI S3.29	(1983; R 1990) Evaluation of Human Exposure to Vibration in Buildings, Guide to

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-05	(1995) Handbook, HVAC Applications (SI Edition)

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB-01	(1991) Procedural Standards for Testing-Adjusting-Balancing of Environmental Systems
NEBB-02	(1994) Procedural Standards for Measuring Sound and Vibration

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section to the extent applicable.

Section 15050, "Basic Mechanical Materials and Methods," applies to work specified in this section to the extent applicable.

All vibration-control apparatus shall be the product of a single manufacturing source, where possible. Human exposure levels should be considered using ANSI S3.29 and NEBB-02.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330,

"Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation Drawings and Outline Drawings shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-03 Product Data

Equipment and Performance Data shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

Manufacturer's catalog data shall be submitted for the following items:

Mountings
Bases
Isolators
Floor-Mounted Piping
Vertical Piping

SD-06 Test Reports

Test reports shall be submitted for deflection tests in accordance with the paragraph entitled, "Type of Vibration-Isolation Provisions," of this section. Reports shall include the following information:

Type of Isolator
Type of Base
Allowable Deflection
Measured Deflection

PART 2 PRODUCTS

2.1 TYPE OF VIBRATION-ISOLATION PROVISIONS

Design for vibration isolation using NEBB-01 andASHRAE-05, Chapter 42, as applicable to the following sections.

Test reports for deflection tests shall be submitted for each Type of Isolator and each Type of Base, and meet referenced standards contained within this section. Test reports shall also include Allowable Deflection and Measured Deflection also meeting referenced standards within this section.

2.1.1 Materials

Rubber shall be natural rubber. Elastomer shall be chloroprene. Shore A durometer measurement of both materials shall range between 40 and 60.

Inorganic materials such as precompressed, high-density, fibrous glass

encased in a resilient moisture-impervious membrane may be used in lieu of specified natural rubber and elastomers. Where this substitution is made, specified deflections shall be modified by the manufacturing source to accommodate physical characteristics of inorganic materials and to provide equal or better vibration isolation.

Weather-exposed metal vibration-isolator parts shall be corrosion protected. Springs shall be chloroprene coated.

2.1.2 Mountings

Mountings shall be:

Type B: Double rubber-in-shear with molded-in steel reinforcement in top and bottom. Maximum deflections up to 12.7 millimeter are allowed.

Type D: Partially housed type, containing one or more vertically restrained springs with at least 12.7 millimeterclearance maintained around springs, with adjustable limit stops, 6.3 millimeter thick Type A base elastomer pads, and accessories.

Type E: Pendulum-suspension configuration with free-standing stable spring with resilient horizontal and vertical restraints to allow maximum movements of 6.3 millimeter in each direction, 6.3 millimeter thick Type A base elastomer pads.

[ype F: Combination spring and rubber-in-shear steel framed for hanger-rod mounting. Minimum total static deflection shall be 25 millimeter.

Type G: Air spring with body constructed of reinforced elastomer specifically suitable for application environment. Air spring shall be selected to provide a natural frequency equal to 127 millimeter of deflection of conventional specified steel springs. Facilities shall be provided for dead-level adjustment and height-control of supported equipment.

2.1.3 Bases

Bases shall be:

Type R: Rails, [connected] [disconnected] mill-rolled structural steel, of sufficient dimension to preclude deflection at midpoint of unsupported span in excess of 1/1,440th of the span between isolators, power transmission, component misalignment, and any overhung weight.

Height of steel members shall be sufficient to provide stiffness required to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Height of steel member shall not result in member deflection at midpoint of unsupported span of more than 1/1,440th of the span between isolators. Minimum height shall be 127 millimeter.

Configuration of inertia bases shall be rectangular to accommodate equipment supported.

Minimum thickness of inertia base, in addition to providing suitable mass, shall be sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Minimum thickness shall be sufficient to result in base deflection at midpoint of unsupported span of not more than 1/1,440th of the span between isolators. Minimum thickness, the preceding requirements not withstanding, shall be 8 percent of the longest base dimension.

Pumps with flexible couplings shall have inertia bases not less than 200 millimeter thick.

Minimum mass of concrete inertia block shall be equal in weight to supported equipment.

2.2 VIBRATION-ISOLATION SYSTEMS APPLICATION

Vibration isolation design peNEBB-01, ASHRAE-05, Chapter 42, and ANSI S2.40.

2.2.1 Low-Pressure AHU Locations

Vibration-isolation provisions apply to floor-mounted Air Moving and Conditioning Association Class A packaged central-station units.

TYPE EQUIPMEN	BASEMENT BELOW-GRADE PROVISIONS	ON GRADE 6096 MM FLOOR-SPAN PROVISIONS	ON GRADE 9144 MM FLOOR-SPAN PROVISIONS	ON GRADE 12192 MM FLOOR-SPAN PROVISIONS*
Through 3728 watt	B-U-8.9	C-U-25	C-U-25	C-U-25
5592 watt and over 250 to 500 rpm	B-U-8.9	C-U-44.5	C-U-44.5	C-U-44.5
500 rpm	B-U-8.9	C-U-25	C-U-38	

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

2.2.2 Medium- and High-Pressure AHU Locations

Vibration-isolation provisions apply to floor-mounted Air Moving and Conditioning Association Classes B and C packaged central-station units.

TYPE EQUIPMEN	BASEMENT BELOW-GRADE PROVISIONS	ON GRADE 6096 MM FLOOR-SPAN PROVISIONS	ON GRADE 9144 MM FLOOR-SPAN PROVISIONS	ON GRADE 12192 MM FLOOR-SPAN PROVISIONS*
Through 14.9 kilowatt 250 to 300 rpm	B-U-8.9	C-U-63	C-U-63	C-U-89
300 to 500 rpm	B-U-8.9	C-U-44.5	C-U-44.5	C-U-63
500 rpm and over	B-U-8.9	C-U-25	C-U-25	C-U-44.5
Over 14.9 kilowatt 250 to 300 rpm	B-U-8.9	C-U-63	C-CIB-89	C-CIB-89
300 to 500 rpm	B-U-8.9	C-U-63	C-CIB-63	C-CIB-89
500 rpm and over	B-U-8.9	C-U-25	C-CIB-44.5	C-CIB-63

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

2.2.3 Air-Moving Device Locations

Vibration-isolation provisions apply to free-standing fans of any pressure rating, located in factory-] fabricated central-station units.

TYPE EQUIPMEN	BASEMENT BELOW-GRADE PROVISIONS	ON GRADE 6096 MM FLOOR-SPAN PROVISIONS	ON GRADE 9144 MM FLOOR-SPAN PROVISIONS	ON GRADE 12192 MM FLOOR-SPAN PROVISIONS*
Through 14.9 kilowatt 200 to 300 rpm	B-U-8.9	C-S-63	C-S-63	C-S-89
300 to 500 rpm	B-U-8.9	C-S-44.5	C-S-44.5	C-S-63
500 rpm and over	B-U-8.9	C-S-250	C-S-38	C-S-44.5
Over 14.9				

TYPE EQUIPMEN	BASEMENT BELOW-GRADE PROVISIONS	ON GRADE 6096 MM FLOOR-SPAN PROVISIONS	ON GRADE 9144 MM FLOOR-SPAN PROVISIONS	ON GRADE 12192 MM FLOOR-SPAN PROVISIONS*
kilowatt 250 to 300 rpm	B-U-8.9	C-S-69.9	C-CIB-89	C-CIB-127
300 to 500 rpm	B-U-8.9	C-S-44.5	C-CIB-63	C-CIB-89
500 rpm and over	B-U-8.9	C-S-25	C-CIB-44.5	C-CIB-63

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN MILLIMETER

2.3 PIPE AND DUCT VIBRATION ISOLATION

Type G: Isolators shall be devices with in-series contained steel springs and preformed fibrous-glass or chloroprene-elastomer elements for connecting to building-structure attachments. Devices shall be loaded by supported system during operating conditions to produce a minimum spring and elastomer static deflection of 25 millimeter and 10 millimeter, respectively.

Type H: Isolators shall be devices with contained chloroprene-elastomer elements for connecting to building-structure attachments. Devices shall be loaded by supported system during operating conditions to produce a minimum elastomer static deflection of 10 millimeter.

Type J: Isolators shall be devices with elastomers mounted on floor-supported columns or directly on the floor. Devices shall be loaded by supported system during operating conditions to produce a minimum elastomer static deflection of 10 millimeter.

2.3.1 Vertical Piping

Type L: Isolators shall be pipe base-support devices with one or more contained steel springs. Devices shall be loaded by supported system during operating conditions to produce a minimum static deflection of 25 millimeter. Devices shall be equipped with precompression and vertical-limit features, as well as a minimum 6.4 millimeter thick elastomer sound pad and isolation washers, for mounting to floor.

Type M: Isolators shall be elastomer mounted baseplate and riser pipe-guide devices. Elastomer elements shall be contained double acting, and elastomers under rated load shall have a minimum static deflection of 10 millimeter. Isolator shall be sized to accommodate thermal insulation within the stationary guide ring.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed in accordance with manufacturer's recommendations.

Rails, structural steel bases, and concrete inertia blocks shall be raised not less than 25 millimeter above the floor and shall be level when equipment supported is under operating load.

-- End of Section --

SECTION 15083

DUCT INSULATION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 527/A 527M	(1990) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM C 1071	(1991) Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM C 1136	(1992) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 534	(1994) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 552	(1991) Standard Specification for Cellular Glass Thermal Insulation
ASTM C 553	(1992) Standard Specification for Mineral Fiber Blanket and Felt Insulation (Industrial Type)
ASTM C 592	(1980) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C 795	(1992) Standard Specification for Wicking-Type Thermal Insulation for Use Over Austenitic Stainless Steel
ASTM C 916	(1985; R 1990) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM D 579	(1990) Standard Specification for Greige Woven Glass Fabrics

ASTM E 84	(1995) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Standard Test Methods for Water Vapor Transmission of Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 220	(1992) Standard Types of Building Construction
NFPA 255	(1990) Standard Method of Test of Surface Burning Characteristics of Building Materials
NFPA 90A	(1996) Standard for the Installation of Air Conditioning and Ventilating Systems

1.2 SYSTEM DESCRIPTION

Section 15003, "General Mechanical Provisions," Section 15815, "Low Pressure Ductwork," and Section 15818, "Medium/High Pressure Ductwork," apply to work specified in this section.

1.3 PERFORMANCE REQUIREMENTS

Thermal-insulation system materials shall be noncombustible, as defined by NFPA 220. Adhesives, coatings, sealants, facings, jackets, and thermal-insulation materials, except cellular elastomers, shall have a flame-spread classification (FSC) of 25 and a smoke-developed classification (SDC) of 50. Flame-contributed classification (FCC) shall be as specified for the application. These maximum values shall be determined in accordance with ASTM E 84 and NFPA 255. Adhesives, coatings, and sealants shall be nonflammable in their wet state.

Adhesives, coatings, and sealants shall have published or certified temperature ratings suitable for the entire range of working temperatures normal for the surfaces to which they are to be applied.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation Drawings shall be submitted for duct insulation systems in accordance with paragraph entitled, "Installation," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Adhesives
Coatings
Thermal-Insulation Materials
Jacketing Materials

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following.

2.1.1 Adhesives

2.1.1.1 Cloth

Adhesives for adhering, sizing, and finishing open-weave glass cloth shall be pigmented polyvinyl acetate emulsion and shall conform to the requirements of ASTM C 916, Class 1, Grade A.

2.1.1.2 Adhesive Vapor Barrier

Adhesives for attaching laps of vapor-barrier materials and presized glass cloth and for attaching insulation to itself, to metal, and to various other substrates, shall be the solvent-base synthetic-rubber type and shall conform to the requirements of ASTM C 916, Class 2, Grade A, for attaching fibrous-glass insulation to metal surfaces. Solvents shall be nonflammable.

2.1.1.3 Cellular Elastomer

Adhesive for cellular elastomer insulation shall be a solvent cutback chloroprene elastomer conforming to ASTM C 916, and shall be a type approved by the manufacturer of the cellular elastomer for the intended use.

2.1.2 Coatings

2.1.2.1 Outdoor Vapor-Barrier Finishing

Coatings for outdoor vapor-barrier and weather-barrier finishing of insulation shall comply with manufacturer's recommendation for material compatibility, service life, and environment.

2.1.2.2 Indoor Vapor-Barrier Finishing

Coatings for indoor vapor-barrier finishing of insulation surfaces shall be pigmented resin and solvent compound and shall conform to ASTM C 1136.

2.1.2.3 Outdoor and Indoor Nonvapor-Barrier Finishing

Coatings for outdoor and indoor nonvapor-barrier finishing of insulation surfaces shall be pigmented polymer emulsion recommended by the insulation-material manufacturer for the surface to be coated and shall be applied to the specified dry-film thickness.

2.1.2.4 Cellular Elastomer Insulation

Finish coating for cellular elastomer insulation shall be a polyvinylchloride lacquer approved by the manufacturer of the cellular elastomer for the intended use.

2.1.2.5 Coating Color

Coating color shall be white.

2.1.3 Insulation

Insulation conductances shall be maximum values, as tested at any point, not an average. Insulation conductance found by test to exceed the stipulated maximum shall either be replaced or augmented by an additional thickness to bring it to the required maximum conductance.

Insulation materials requirements for exterior applications are acceptable for interior applications.

Thermal-Insulation Materials shall meet referenced standards within this section.

2.1.3.1 Exterior Insulation

Cellular glass insulation shall be rigid closed cell material complying with ASTM C 552. Minimum insulation thickness shall be 50 millimeter.

2.1.3.2 Interior Insulation

Mineral fiber shall conform to ASTM C 592, shall be suitable for surface temperatures up to 188 degrees C, and shall be not less than 64.1 kilogram per cubic meter density, unless otherwise specified. Thermal conductivity shall be not greater than 37.5 milliwatt per meter per degrees K at 66 degrees C (338.8 degrees K), unless otherwise specified.

2.1.3.3 Rigid Boards

Rigid boards shall be Form A, blocks and boards, Class 1, for use at temperatures up to 204 degrees C, nonloadbearing, minimum 50 kilograms per cubic meter density. Thermal conductivity shall be not greater than 34.6 milliwatt per meter per degree K at 24 degrees C (297.1 degrees K).

2.1.3.4 Flexible Blankets

Flexible blankets shall be Type 1, Class B, blankets and felts, flexible, resilient for use at temperatures up to 204 degrees C, minimum 16.0 kilogram per cubic meter density. Thermal conductivity shall be not

greater than 38.9 milliwatt per meter per degree K at 24 degrees C (297.1 degrees K). Insulation shall conform to ASTM C 553.

2.1.3.5 Cellular Elastomer

Cellular elastomer shall conform to ASTM C 534, except that the water-vapor permeability shall not exceed 0.44 kilogram per pascal per second per meter pressure-differential for 25 millimeter thickness.

2.1.4 Jacketing

Jacketing Materials shall meet referenced standards within this section.

2.1.4.1 Composite Jacketing

Jacketing shall be a 3-ply laminate of 560 kilogram per cubic meter white-bleached kraft bonded to not less than 0.03 millimeter thick aluminum foil and reinforced with glass fiber. Fire-resistance classification shall be as follows:

	FOIL EXPOSE	KRAFT EXPOSED
FSC	5	25
FCC	0	10
SDC	0	15

Water-vapor permeance rating of the composite shall be 1.15 nanogram per pascal per second per square meter pressure-differential determined in accordance with ASTM E 96.

2.1.4.2 Sheetmetal Jacketing

Sheetmetal jacketing shall be minimum 0.55 millimeter galvanized steel in conformance with ASTM A 527/A 527M, having lock-forming corner bead and joint capability.

2.1.4.3 Glass Cloth

Glass cloth shall be plain weave conforming to ASTM D 579, Style 141, and shall weigh not less than 250 gram per square meter before sizing. Cloth shall be factory-applied wherever possible.

Glass reinforcing cloth shall be a leno weave, 26-end and 12-pick thread conservation, with a warp-and-fill tensile strength in kilonewton per meter of width of 7.9 and 5.3, respectively, and with a weight not less than 50 gram per square meter. Style 191 leno-weave glass cloth conforming to ASTM D 579 may be provided.

2.1.4.4 Vapor Barrier Material

Vapor barrier material shall conform to ASTM C 1136, Type I, low vapor transmission, high puncture resistance for use on insulation for piping,

ducts, and equipment, and as indicated.

PART 3 EXECUTION

3.1 INSTALLATION OF INSULATION SYSTEMS

Contours on exposed work shall be smooth and continuous. Cemented laps, flaps, bands, and tapes shall be smoothly and securely pasted down. Adhesives shall be applied on a 100-percent coverage basis. Departure from these requirements shall be a basis for rejection.

Joints shall be tight, with insulation lengths tightly butted against each other. Where lengths are cut, cuts shall be smooth and square and without breakage of end surfaces. Where insulation terminates, ends shall be neatly tapered and effectively sealed or finished. Longitudinal seams of exposed insulation shall be directed away from normal view.

Surfaces shall be clean and free of all oil and grease before insulation adhesives or mastics are applied. Solvent cleaning required to bring metal surfaces to such condition shall be provided.

Installation Drawings for duct insulation systems shall be in accordance with the adhesive manufacturer's recommended instructions for application.

3.2 SYSTEM TYPES

3.2.1 Type T-11, Flexible Mineral Fiber with Jacket

Sheet metal ducts shall be covered with mineral-fiber duct insulation with factory-attached vapor-barrier jacket. Vapor seal shall be maintained. Jacket overlap shall be not less than 50 millimeter.

Insulation shall be adhered to sheet metal surfaces with vapor-barrier adhesive.

Insulation on all rectangular ducting with side- or bottom-surface dimensions over 750 millimeter shall, in addition to being adhered with adhesive, be impaled on pins secured to the duct surface and then locked by means of flush pin caps. Pins shall be clipped flush with face of cap. Pins shall be 300 millimeter on center placed not more than 50 millimeter from duct edges, and there shall be not less than two rows of pins per surface. Pins shall be sealed with outdoor vapor-barrier coating and vapor-barrier duct tape.

When insulation is in place, total thickness shall be reduced by not more than 13 millimeter, and no condensation shall appear on any surface.

Jackets, jacket flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacketing bands for butt joints shall be not less than 100 millimeter wide. In lieu of jacketing bands, pressure-sensitive vapor-barrier tape not less than 75 millimeter wide shall be used to seal horizontal and transverse seams.

Duct insulation shall be rigid-board 50 kilogram per cubic meter density

where penetrations through sleeves or prepared openings occur.

Duct insulation at fire dampers shall be provided.

Duct insulation terminating at insulated or uninsulated sheet metal and equipment surfaces, supports, damper fittings, walls, and similar penetration and construction points shall be sealed with outdoor vapor-barrier coating and, where lengths exceeding 600 millimeter are involved, flashed with glass-cloth tape and sheet metal trimming. Glass-cloth tape shall be in two layers with not less than 75 millimeter of overlap imbedded in not less than 1.6 millimeter dry-film thickness of outdoor vapor-barrier coating.

3.2.2 Type T-13, Rigid Mineral Fiber with Jacket

Sheet metal ducts shall be covered with insulation with factory-applied vapor barrier and finished with field-applied glass-cloth jacket. Vapor seal shall be maintained. Jacket overlap shall be not less than 50 millimeter.

Insulation shall be adhered to sheet metal surfaces with vapor-barrier adhesive.

Insulation on sheet metal with side- or bottom-surface dimensions over 750 millimeter, in addition to being adhered with adhesive, shall be impaled on pins secured to the duct surface and then locked by means of flush pin caps clipped flush with face of cap. Pins shall be 300 millimeter on center placed not more than 50 millimeter from duct edges, and there shall be not less than two rows of pins per surface. Pins shall be sealed with outdoor vapor-barrier coating and vapor-barrier duct tape. Pinned area and other surfaces shall be level with adjoining insulated surface. Edges shall be square and straight without scallops; where necessary, areas shall be leveled with a mixture of finish insulating cement and nonvapor-barrier adhesive diluted with three parts water.

Vapor-barrier jackets, jacket flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacketing bands for butt joints shall be not less than 100 millimeter wide.

Duct insulation at fire dampers shall be provided.

Insulation shall be brought tightly against raised-flange standing seams and sealed with vapor-barrier coating. A 75 millimeter wide strip of the insulation of adequate thickness to give 13 millimeter covering over flange shall be provided. Strip shall be routed out to accommodate the still-exposed portion of the seam or flange and shall be cemented in place over the seam or flange by use of vapor-barrier coating material.

Duct insulation terminating at insulated and uninsulated sheet-metal and equipment surfaces, supports, damper fittings, access doors, walls, and similar penetration and construction points shall be sealed with outdoor vapor-barrier coating. Where lengths exceeding 600 millimeter are involved, insulation shall be flashed with glass-cloth tape and sheet-metal trimming. Glass-cloth tape shall provide not less than 75 millimeter

overlap, shall be in two layers, and shall be embedded in not less than 1.6 millimeter dry-film thickness of outdoor vapor-barrier coating. Sheet metal trimming shall be installed after glass-cloth jacket is in place.

Glass-cloth jacketing shall be applied over the insulation outer corner sheet-metal angles and securely cemented in place with nonvapor-barrier adhesive. Corner angles shall be not less than 0.04 millimeter galvanized sheet metal with leg dimensions equal to thickness of insulation. Glass cloth embedded in the adhesive shall be pulled tight and wrinkle-free and shall lap seams not less than 100 millimeter. The entire outer surface shall be given a flood coat of nonvapor-barrier adhesive while the first coat is still wet.

Insulation shall be finished with not less than 0.152 millimeter dry-film thickness of nonvapor-barrier coating suitable for painting.

3.2.3 Type T-15, Rigid Mineral Fiber

This insulation system consists of 25 millimeter thick mineral fiber, without jacket, placed between concealed hot and cold ducts to prevent cold-duct heat gain.

3.2.4 Type T-16, Plenums

Installation methods and materials are the same, except as follows:

No glass-cloth jacket is required.

Plenum surfaces shall be made airtight.

Mineral-fiber insulation with a vapor-barrier jacket not less than 25 millimeter thick shall be applied to walls and ceilings where the opposite side is exposed to nonconditioned spaces. Ceilings that separate plenum space from connected occupied space need no vapor-barrier jacket. Insulation with vapor-barrier jacket, as required, shall be applied before installation of piping, ducting, electrical conduit, ceiling suspension system, and other equipment. All air-leakage paths and vapor-barrier penetrations shall be sealed with vapor-barrier jacket.

3.2.5 Type T-18, Cellular Elastomer

Surfaces shall be covered with 13 millimeter cellular-elastomer sheet insulation. Vapor seal shall be maintained. Insulation shall be cemented into continuous material with a solvent cut-back chloroprene adhesive recommended by the manufacturer for the specific purpose. Adhesive shall be applied to both of the surfaces to be joined to a minimum thickness of 0.25 millimeter wet or 3.5 meter square per liter of undiluted adhesive.

Duct stiffeners shall be covered with cellular elastomer insulation strips.

Surfaces exposed to weather, to view, or to ultraviolet light shall be finished with a 0.051 millimeter minimum dry-film thickness of a polyvinylchloride lacquer recommended by the manufacturer and applied in

not less than two coats.

3.2.6 Acoustic Duct-Lining

Acoustic duct-lining shall be provided where indicated. Duct sizes indicated shall be interpreted to mean clear air space.

Acoustic duct-lining shall be fibrous glass conforming to ASTM C 1071. Material shall be 25 millimeter thick unless otherwise indicated, and the density of the insulation, including surface coating or facing, shall be not less than 24.0 kilogram per cubic meter nor greater than 56 kilogram per cubic meter. Liner composition shall be uniform density, graduated density, or dual density and deeply impregnated with chloroprene on the surface exposed to airstream. Acoustic liner shall conform to the fire-hazard requirements of NFPA 90A. The airstream side of the liner shall be capable of withstanding air velocities of 20 meter per second without delamination or erosion. Sound-absorption coefficient shall be not less than indicated below.

Octave band	2ND	3RD	4TH	5TH	6TH	7TH
Midfrequency (kilohertz)	.125	.250	.500	1	2	4
Sound-absorption coefficient	0.25	0.48	0.67	0.88	0.89	0.83

Lining shall be applied in cut-to-size pieces attached to the interior of the duct with fire-resistant adhesive conforming to ASTM C 916, Class 2, for attaching fibrous-glass insulation to metal surfaces. Top and bottom pieces shall lap the side pieces and, in addition, shall be secured with pins and speed washers or cup-head pins 300 millimeter on center, maximum and within 50 millimeter of each edge. Pins and washers shall be flush with the surface of the duct-liner, and breaks and punctures of the duct-liner coating shall be sealed with fire-resistant adhesive conforming to ASTM C 916, Class 1. Exposed edges of the coated liner at the duct ends and at other joints where the lining will be subject to erosion shall be coated with a heavy brush-coat of fire-resistant adhesive and where necessary with metal nosing to prevent delamination of the glass fibers. Duct liner may also be applied to flat sheet metal with fire-resistant adhesive, ASTM C 916, Class 2, prior to forming duct through the sheet metal brake. The lining at the top and bottom surfaces of the duct shall be additionally secured by pins or adhered clips as specified for cut-to-size pieces.

Preformed round duct liner designed for insertion in round ducts shall be used in the sizes commercially available. Duct-liner sections shall be furnished with not less than 50 millimeter wide ship-lap joints. Joints shall be in accordance with the manufacturer's instructions. Fire-resistant adhesive shall be used to field-coat joints, when recommended by the manufacturer of the liner, to prevent delamination or erosion at the joints. Tubular sections of the duct liner shall fit the metal duct snugly and without gaps between duct-liner sections. Requirements specified previously for acoustic duct-lining shall apply to

preformed round duct liner.

3.2.7 Cellular Glass

Sheetmetal surfaces covered with cellular glass shall be cleaned and coated with adhesive or mastic recommended by the insulation manufacturer. In addition, the insulation shall be impaled on pins secured to the duct surface and locked by means of flush pin caps clipped flush with face of cap.

Pins shall be 300 millimeter on center placed not more than 50 millimeter from the duct edges, and there shall be not less than two rows of pins per surface. Pins shall be sealed with exterior vapor-barrier coatings and duct tape. Pinned areas and other surfaces shall be level with adjoining insulated surface. Edges shall be square and straight, without scallops.

Exterior surface of the insulation shall be coated with mastic to thickness recommended by the manufacturer.

For glass cloth exterior coverings, the cloth shall be applied while the mastic is still wet. After installing the cloth, the entire exterior surface shall be given a flood coat of mastic recommended by the manufacturer.

For sheetmetal exterior, the installation shall be completed using interlocking seams and corner beads.

-- End of Section --

SECTION 15085

PIPING INSULATION

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 209M	(1995) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C 1136	(1992) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C 534	(1994) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 552	(1991) Standard Specification for Cellular Glass Thermal Insulation
ASTM C 592	(1980) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C 795	(1992) Standard Specification for Wicking-Type Thermal Insulation for Use Over Austenitic Stainless Steel
ASTM C 916	(1985; R 1990) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C 920	(1995) Standard Specification for Elastomeric Joint Sealants
ASTM C 921	(1989) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM D 1927	(1981; R 1988) Rigid Poly (Vinyl Chloride) Plastic Sheet
ASTM D 579	(1990) Standard Specification for Greige Woven Glass Fabrics

ASTM E 84	(1995) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 96	(1995) Standard Test Methods for Water Vapor Transmission of Materials

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 220	(1992) Standard Types of Building Construction
NFPA 255	(1990) Standard Method of Test of Surface Burning Characteristics of Building Materials

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE AMS 3779/1A	(1990) Tape Adhesive, Pressure Sensitive Thermal Radiation Resistant, Aluminum Foil/Glass Cloth
SAE AMS 3779A	(1990) Tape Adhesive, Pressure Sensitive Thermal Radiation Resistant

1.2 SYSTEM DESCRIPTION

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

1.3 PERFORMANCE REQUIREMENTS

Thermal-insulation system materials shall be noncombustible, as defined by NFPA 220. Adhesives, coatings, sealants, facings, jackets, and thermal-insulation materials, except cellular elastomers, shall have a flame-spread classification (FSC) of 25, and a smoke-developed classification (SDC) of 50. These maximum values shall be determined in accordance with ASTM E 84 and NFPA 255. Coatings and sealants shall be nonflammable in their wet state.

Adhesives, coatings, and sealants shall have published or certified temperature ratings suitable for the entire range of working temperatures normal for the surfaces to which they are to be applied.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation Drawings for pipe insulation shall be submitted in

accordance with paragraph entitled, "Installation," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Adhesives
Coatings
Insulating Cement
Insulation Materials
Jacketing
Tape

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following.

2.1.1 Adhesives

2.1.1.1 Cloth Adhesives

Adhesives for adhering, sizing, and finishing lagging cloth, canvas, and open-weave glass cloth shall be a pigmented polyvinyl acetate emulsion and shall conform to the requirements of ASTM C 916, Class 1, Grade A.

2.1.1.2 Vapor-Barrier Material Adhesives

Adhesives for attaching laps of vapor-barrier materials and presized glass cloth and for attaching insulation to itself, to metal, and to various other substrates, shall be solvent-base, synthetic-rubber type and shall conform to the requirements of ASTM C 916, Class 2, Grade A, for attaching fibrous-glass insulation to metal surfaces. Solvent shall be nonflammable.

2.1.1.3 Cellular Elastomer Insulation Adhesive

Adhesive for cellular elastomer insulation shall be a solvent cutback chloroprene elastomer conforming to ASTM C 916, and shall be of a type approved by the manufacturer of the cellular elastomer for the intended use.

2.1.2 Coatings

2.1.2.1 Outdoor Vapor-Barrier Finishing

Coatings for outdoor vapor-barrier finishing of insulation surfaces such as fittings and elbows shall be a nonasphaltic, hydrocarbon polymer, solvent-base mastic containing a blend of nonflammable solvents. Coatings

shall conform to the requirements of ASTM C 1136 and ASTM C 921.

2.1.2.2 Indoor Vapor-Barrier Finishing

Coatings for indoor vapor-barrier finishing of insulation surfaces shall be a pigmented resin and solvent compound and shall conform to ASTM C 1136, Type II.

2.1.2.3 Outdoor and Indoor Nonvapor-Barrier Finishing

Coatings for outdoor and indoor nonvapor-barrier finishing of insulation surfaces shall be pigmented polymer-emulsion type recommended by the insulation material manufacturer for the surface to be coated and shall be applied to specified dry-film thickness.

2.1.2.4 Cellular-Elastomer Insulation Coating

Finish coating for cellular-elastomer insulation shall be a polyvinylchloride lacquer approved by the manufacturer of the cellular elastomer.

2.1.2.5 Coating Color

Coating color shall be white.

2.1.3 Calking

Calking used with specified insulation materials shall be an elastomeric joint sealant in accordance with ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.4 Corner Angles

Corner angle piping insulation shall be nominal 0.41 millimeter aluminum 25 by 25 millimeter with factory applied kraft backing. Aluminum shall be in accordance with ASTM B 209M, Alloy 3003.

2.1.5 Insulation Materials

Insulation conductances shall be maximum values, as tested at any point, not an average. Insulation conductance found by test to exceed the specified maximum shall either be replaced or augmented by an additional thickness to bring it to the required maximum conductance and a complete finishing system.

2.1.5.1 Mineral Fiber

Mineral fiber shall conform to ASTM C 592,
shall be suitable for surface temperatures up to 188 degrees C (461 degrees K), and shall be of not less than 64.1 kilograms per cubic meter density. Thermal conductivity shall be not greater than0.037 watt per meter per degree Kelvin at 66 degrees C (339 degrees K) mean.

2.1.5.2 Pipe Barrel

Pipe barrel insulation shall be Form D, sleeving, pipe, and the tube covering, Type III, molded, Class 12, for use at temperatures up to and including 232 degrees C (505 degrees K).

2.1.5.3 Pipe Fittings

Pipe fitting insulation shall be Form E, molded pipe fitting covering, Class 16, for use at temperatures up to and including 232 degrees C (505 degrees K).

2.1.5.4 Flexible Blankets

Flexible blankets shall be Form B, blankets and felts, flexible, Class 6, resilient for use at temperatures up to and including 177 degrees C (450 degrees K) minimum 16 kilogram per cubic meter density. Thermal conductivity shall be not greater than 1.53 watt per meter per degree K at 24 degrees C (279 degrees K) mean.

2.1.5.5 Cellular Elastomer

Cellular elastomer shall conform to ASTM C 534, except that the water-vapor permeability shall not exceed 0.44 nanogram per meter per second per pascal mercury pressure difference for 25 millimeter thickness.

2.1.5.6 Cellular Glass

Cellular glass shall conform to ASTM C 552, Type II, pipe covering. Substitutions for this material shall not be permitted.

2.1.6 Jacketing

2.1.6.1 Glass Cloth Jackets

Glass cloth shall be plain-weave glass cloth conforming to ASTM D 579, Style 141 and shall weigh not less than 0.25 kilogram/square meter before sizing. Cloth shall be factory applied wherever possible.

Glass reinforcing cloth shall be a leno weave, 26-end and 12-pick thread conservation, with a warp and fill tensile strength of 7.9 and 5.3 kilonewton per meter of width, respectively, and with a weight of not less than 0.51 kilogram per square meter. At the Contractor's option, Style 191 leno-weave glass cloth conforming to ASTM D 579 may be provided.

2.1.6.2 PVC Jackets

Polyvinylchloride (PVC) shall be a 0.25 millimeter thick, factory-premolded, one-piece fitting or pipe-barrel sheeting vapor-barrier jacketing. Material shall be self-extinguishing, and shall conform to ASTM D 1927, Composition A polyvinylchloride, Type II, high-impact strength, moderate chemical resistance. Permeability rating shall be 0.574 nanogram per pascal per second per square meter of mercury pressure difference, determined in accordance with ASTM E 96. Vapor-barrier joint adhesive shall be the manufacturer's standard solvent-weld type.

Vapor barrier shall conform to ASTM C 1136, Type I, low-vapor transmission, high-puncture resistance for use on insulation for piping, ducts, and equipment.

2.1.6.3 3-Ply Laminate

Jacketing shall be a 3-ply laminate of 1.7 kilogram per square meter white-bleached kraft, bonded to not less than 0.018 millimeter thick aluminum foil and reinforced with glass fiber.

Water-vapor permeance rating of the composite shall be 1.15 nanogram per pascal per second per square meter pressure differential, determined in accordance with ASTM E 96.

2.1.7 Tape

Glass lagging shall be a knitted elastic cloth specifically suitable for continuous spiral wrapping of insulated pipe bends and fittings and shall produce a smooth, tight, wrinkle-free surface. Tape shall conform to requirements of SAE AMS 3779A, SAE AMS 3779/1A, ASTM D 579, and ASTM C 921, and shall weigh not less than 0.339 kilogram per square meter.

2.2 PIPING SYSTEMS

Insulation thickness and pipe sizes are in millimeter. Pipe size is inclusive dimensionally, and includes pipe nominal pipe size (NPS) and tubing outside diameter.

2.2.1 Dual-Temperature (Hot- and Chilled-) Water Piping

Insulation shall be mineral fiber with vapor barrier jacket, Type T-1. Thickness shall be not less than that given in the following list. Aboveground pipes, valve bodies, fittings, unions, and flanges shall be insulated.

PIPE SIZE (MILLIMETER	INSULATION THICKNESS (MILLIMETER)
Up to 32	25
32 to 75	40
75 and larger	50

2.2.2 Hot-Water

Insulation shall be mineral fiber with glass cloth jacket, Type T-2. Thickness shall be not less than that given in the following list. Aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces shall be insulated.

PIPE SIZE (MILLIMETER	INSULATION THICKNESS (MILLIMETER)
Up to 100	25
100 to 250	40

2.2.3 Cold-Water and Condensate-Drain Piping

Aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces shall be insulated

Insulation shall be 10 millimeter mineral fiber with glass cloth jacket, Type T-2.

Cold-water piping insulation shall be flexible unicellular-elastomeric thermal insulation, Type T-3. Pipe insulation thickness shall be 15 millimeter per calculation. Expanded, closed-cell pipe insulation shall be used only aboveground, not for underground piping.

2.2.4 Refrigerant Suction Piping

Insulation shall be cellular-elastomer, Type T-3. Thickness shall be nominal 20 millimeter. Surfaces, including valve, fittings, unions, and flanges, shall be insulated.

2.2.5 Cooling-Tower Circulating Water Piping

Insulation shall be cellular-elastomer, Type T-3. Thickness shall be not less than that given in the following list. Aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces shall be insulated.

PIPE SIZE (MILLIMETER	INSULATION THICKNESS (MILLIMETER)
Up to 50	15
50 to 150	20
150 and larger	25

Thickness inside buildings shall be 10 millimeter for all pipe sizes.

Insulation shall be mineral fiber with aluminum jacket, Type T-6. Thickness shall be not less than that indicated. Aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces shall be insulated.

PART 3 EXECUTION

3.1 INSTALLATION OF INSULATION SYSTEMS

Contours on exposed work shall be smooth and continuous. Cemented laps, flaps, bands, and tapes shall be smoothly and securely pasted down. Adhesives shall be applied on a full-coverage basis.

Insulation shall be applied only to system or component surfaces that have been tested and approved.

Joints shall be tight with insulation lengths tightly butted against each other. Where lengths are cut, cuts shall be smooth and square and without breakage of end surfaces. Where insulation terminates, ends shall be neatly tapered and effectively sealed, or finished as specified. Longitudinal seams of exposed insulation shall be directed away from normal view.

Materials shall be applied in conformance with the recommendations of the manufacturer.

Surfaces shall be clean and free of oil and grease before insulation adhesives or mastics are applied. Solvent cleaning required to bring metal surfaces to such condition shall be provided.

Installation Drawings for pipe insulation shall be in accordance with the adhesive manufacturer's written instructions for installation.

3.2 SYSTEM TYPES

3.2.1 Type T-1, Mineral Fiber with Vapor-Barrier Jacket

Piping shall be covered with mineral-fiber pipe insulation with factory-and field-attached vapor-barrier jacket. Vapor seal shall be maintained. Jackets, jacket laps, flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacket overlap shall be not less than 40 millimeter. Jacketing bands for butt joints shall be 75 millimeter wide.

Exposed-to-view fittings and valve bodies shall be covered with preformed mineral-fiber pipe-fitting insulation of the same thickness as the pipe-barrel insulation. Fitting insulation shall be temporarily secured in place with light cord ties. A 1.52 millimeter coating of white indoor vapor-barrier coating shall be applied and, while still wet, wrapped with glass lagging tape with 50 percent overlap, and shall be smoothly blended into the adjacent jacketing. Additional coating shall be applied as needed and rubber-gloved to smooth fillet or contour coating, then allowed to fully cure before the finish coating is applied. On-the-job fabricated insulation for concealed fittings and special configurations shall be built up from mineral fiber and a special mastic consisting of a mixture of insulating cement and lagging adhesive diluted with 3 parts water. Where standard vapor-barrier jacketing cannot be used, the surfaces shall be made vapor tight by using coating and glass lagging cloth or tape as previously specified.

In lieu of materials and methods previously specified, fittings may be wrapped with a twine-secured, mineral-wool blanket to the required thickness and covered with premolded polyvinylchloride jackets. Seams shall be made vapor tight with a double bead of manufacturer's standard

vapor-barrier adhesive applied in accordance with the manufacturer's instructions. All jacket ends shall be held in place with AISI 300 series corrosion-resistant steel straps, 0.381 millimeter thick by 15 millimeter wide.

Pipe insulation shall be set into an outdoor vapor-barrier coating for a minimum of 150 millimeter at maximum 3500-millimeter spacing and the ends of the insulation sealed to the jacketing with the same material to provide an effective vapor-barrier stop.

Staples shall not be used in applying insulation. Vapor-barrier materials shall be continuous over all surfaces, including areas inside pipe sleeves, hangers, and other concealments.

Piping insulation at hangers shall consist of 208 kilogram per cubic meter density, fibrous-glass inserts or expanded, rigid, closed-cell, polyvinylchloride. Junctions shall be sealed with vapor-barrier jacket where required, glass-cloth mesh tape, and vapor-barrier coating.

White-bleached kraft paper side of the jacketing shall be on the side exposed to view.

Exposed-to-view insulation shall be finished with not less than a 0.152-millimeter dry-film thickness of nonvapor-barrier coating suitable for painting.

3.2.2 Type T-2, Mineral Fiber with Glass Cloth Jacket

Piping shall be covered with a mineral-fiber, pipe insulation with factory-attached, presized, white, glass cloth. Jackets, jacket laps, flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacket overlap shall be not less than 40 millimeter. Jacketing bands for butt joints shall be 75 millimeter wide.

Exposed-to-view fittings shall be covered with preformed mineral-fiber fitting insulation of the same thickness as the pipe insulation and temporarily secured in place with light cord ties. Impregnated glass lagging tape shall be installed with indoor vapor-barrier on 50 percent overlap basis and the tape shall be blended smoothly into the adjacent jacketing. Additional coating shall be applied as needed, and rubber gloved to a smooth contour. Ends of insulation shall be taped to the pipe at valves DN50 and smaller. On-the-job fabricated insulation for concealed fittings and special configurations shall be built up from mineral fiber and a mixture of insulating cement and lagging adhesive, diluted with 3 parts water. Surfaces shall be finished with glass cloth or tape lagging.

Valves 65 millimeter and larger and all flanges shall be covered with preformed insulation of the same thickness as the adjacent insulation.

Exposed-to-view insulation shall be finished with a minimum 0.152-millimeter dry-film thickness of nonvapor-barrier coating suitable for painting.

In lieu of materials and methods specified above, fittings may be wrapped

with a twine-secured, mineral-wool blanket to the required thickness and covered with premolded polyvinylchloride jackets. All jacket ends shall be held in place with ANSI 300 series corrosion-resistant steel straps, 0.381 millimeter thick by 15 millimeter wide. Fitting insulation shall be thermally equivalent to pipe-barrel insulation to preclude surface temperatures detrimental to polyvinylchloride.

3.2.3 Type T-3, Cellular Elastomer

Piping-system surfaces shall be covered with flexible cellular-elastomer sheet or preformed insulation. Vapor seal shall be maintained. Insulation shall be cemented into continuous material with a solvent cutback chloroprene adhesive recommended by the manufacturer for the specific purpose. Adhesive shall be applied to both of the surfaces on a 100-percent coverage basis to a minimum thickness of 0.254 millimeter wet or approximately 4 square meter per liter of undiluted adhesive.

Hot-water, cold-water, and condensate drain pipes shall be insulated to the extent shown with nominal 15 millimeter thick, fire retardant (FR), cellular elastomer, preformed pipe insulation. Joints shall be sealed with adhesive.

At pipe hangers or supports where the insulation rests on the pipe hanger strap, the insulation shall be cut with a brass cork borer and a No. 3 superior grade cork inserted. Seams shall be sealed with approved adhesive. Sweat fitting shall be insulated with miter-cut pieces of cellular elastomer insulation of the same nominal pipe size and thickness as the insulation on the adjacent piping or tubing. Miter-cut pieces shall be joined with approved adhesive. Covers shall be slit and snapped over the fitting, and joints shall be sealed with approved adhesive.

Screwed fittings shall be insulated with sleeve-type covers formed from miter-cut pieces of cellular elastomer thermal insulation having an inside diameter large enough to overlap adjacent pipe insulation. Pipe insulation shall be butted against fittings. Overlap shall be not less than 25 millimeter. Adhesive shall be used to join cover pieces and cement the cover to the pipe insulation.

Surfaces exposed to view or ultraviolet light shall be finished with a 0.051 millimeter minimum dry-film thickness application of a polyvinylchloride lacquer recommended by the manufacturer, and applied in not less than two coats.

3.2.4 Type T-4, Cellular Glass with Vapor-Barrier Jacket

Piping shall be covered with cellular glass insulation and factory- and field-attached vapor-barrier jacket. Vapor seal shall be maintained. Jackets, jacket laps, flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacket overlap shall be not less than 40 millimeter . Jacket bands for butt joints shall be not less than 75 millimeter wide. Insulation shall be continuous through hangers. Insulation shall be bedded in an outdoor vapor-barrier coating applied to all piping surfaces.

Flanges, unions, valves, anchors, and fittings shall be insulated with factory premolded or prefabricated or field fabricated segments of insulation of the same material and thickness as the adjoining pipe insulation. When segments of insulation are used, elbows shall be provided with not less than three segments. For other fittings and valves, segments shall be cut to the required curvature or nesting size.

Segments of the insulation shall be secured in place with twine or copper wire. After the insulation segments are firmly in place, a vapor-barrier coating shall be applied over the insulation in two coats with glass tape imbedded between coats. First coat shall be tinted, the second shall be white to ensure application two coats. Coating shall be applied to a total dry-film thickness of 1.6 millimeter minimum. Glass tape seams shall overlap not less than 25 millimeter and the tape end not less than 100 millimeter.

In lieu of materials and methods specified above, fittings may be wrapped with 10 millimeter thick, vapor-barrier, adhesive-coated strips of cellular elastomer insulation. Insulation shall be under tension, compressed to 25 percent of original thickness, and wrapped until overall thickness is equal to adjacent insulation. Cellular elastomer shall be secured in place with twine and sealed with vapor-barrier coating applied to produce not less than 1.6 millimeter dry-film thickness. Fittings shall then be covered with premolded polyvinylchloride jackets. Seams shall be made vapor-tight with a double bead of manufacturer's standard vapor-barrier adhesive applied in accordance with the manufacturer's instructions. Jacket ends shall be held in place with AISI 300 series corrosion-resistant steel straps, 0.381 millimeter thick by 15 millimeter wide.

Anchors secured directly to piping shall be insulated, to prevent condensation, for not less than 150 millimeter from the surface of the pipe insulation.

White-bleached kraft paper side of jacketing shall be on the side exposed to view. Exposed-to-view insulation shall be finished with not less than a 0.152 millimeter dry-film thickness of nonvapor-barrier coating suitable for painting.

3.2.5 Type T-5, Calcium Silicate with Glass Cloth Jacket (Piping)

Piping shall be covered with a calcium-silicate pipe insulation with factory attached and presized, white, glass cloth. Jackets shall be field applied when required. Jackets, jacket laps, flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacket overlap shall be not less than 40 millimeter. Jacketing bands for butt joints shall be 100 millimeter wide. Fittings shall be fabricated from segmented pipe barrel sections bedded in general purpose insulating cement and wired in place. Voids shall be filled with general purpose insulating cement with not less than 6 millimeter thick, final coating. Glass lagging tape shall be impregnated with lagging adhesive, wrapped with a 50-percent overlap, and be blended smoothly into adjacent jacketing. Additional adhesive shall be applied as needed and rubber-gloved to a smooth contour.

3.2.6 Type T-7, Calcium Silicate with Glass Cloth Jacket (Surfaces)

Surfaces shall be covered with insulation block bedded in an insulating cement and covered with glass cloth jacketing.

Surfaces shall be cleaned with a chlorinated solvent. General purpose insulating cement shall be mixed with 3 parts water to 1 part nonvapor-barrier adhesive to bring to application consistency. Block shall be set into bedding and joints and spaces shall be filled with a bedding mix and wrapped with galvanized chicken wire mesh well laced into an envelope. A 10 millimeter thick coating of bedding mix jacket shall be troweled on with nonvapor-barrier adhesive and glass cloth. Surfaces shall be finished with not less than a 0.152 millimeter dry-film thickness of nonvapor-barrier coating.

At the Contractor's option, aluminum sheet jacketing may be used in lieu of glass cloth.

3.2.7 Type T-9, Cellular Elastomer

Pump surfaces shall be solvent cleaned. Not less than 25 millimeter of general purpose insulating cement shall be applied, mixed with nonvapor-barrier adhesive diluted with 3 parts water, to achieve smooth surface and configuration contours. After all water has been removed, surfaces shall be covered with 13 millimeter thick cellular elastomer insulation attached and joined into a continuous sheet with an outdoor vapor-barrier coating recommended by the insulation manufacturer for the specific purpose. Coating shall be applied to both of the surfaces on a 100-percent coverage basis with a minimum thickness of 0.254 millimeter wet, or approximately 3.7 square meter per liter of undiluted coating. Coating shall be blended into the adjacent flange insulation and the joint covered with a band of cellular elastomer equal to the flange assembly width. Same coating shall be used to seal insulation to the casing at penetrations and terminations. Pumps shall be insulated in a manner that will permit insulation to be removed to repair or replace pumps.

Insulation shall be finished with a 0.051 millimeter minimum dry-film application of a polyvinylchloride lacquer coating recommended by the manufacturer and applied in not less than two coats.

3.2.8 Type T-10, Mineral-Fiber Fill

Voids surrounding pipe shall be packed with mineral-fiber fill.

3.2.9 Type T-17, Calcium Silicate Weatherproof Jacket

Piping system surfaces shall be covered with calcium silicate insulation. Fittings and valve bodies shall be covered with preformed insulation of the same material and thickness as the adjoining pipe insulation.

-- End of Section --

SECTION 15102

PLUMBING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 1010	(1994) Drinking Fountain and Self Contained, Mechanically Refrigerated Drinking Water Coolers

AMERICAN GAS ASSOCIATION (AGA)

AGA Z21.22	(1986; 6th Ed) Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A112.18.1M	(1996) Plumbing Fixture Fittings
ANSI A112.19.1M	(1987) Enameled Cast Iron Plumbing Fixtures
ANSI A112.19.2M	(1982) Vitreous China Plumbing Fixtures
ANSI A112.19.3M	(1987) Stainless Steel Plumbing Fixtures (Designed for Residential Use)
ANSI A112.19.5	(1979) Trim for Water-Closet Bowls, Tanks, and Urinals (Dimensional Standards)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 126	(1995) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 197M	(1987; R 1992) Standard Specification for Cupola Malleable Iron (Metric)
ASTM A 53	(1996) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 536	(1994) Standard Specification for Ductile Iron Castings

ASTM A 563M	(1996) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A 74	(1994) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM B 306	(1995) Copper Drainage Tube (DWV)
ASTM B 370	(1992) Standard Specifications for Copper Sheet and Strip for Building Construction
ASTM B 584	(1996) Standard Specification for Copper Alloy Sand Castings for General Applications
ASTM B 88M	(1995) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM C 109/C 109M	(1995) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C 1107	(1991; Rev A) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink)
ASTM C 190	(1985) Standard Test Method for Tensile Strength of Hydraulic Cement Mortars
ASTM C 547	(1995) Mineral Fiber Preformed Pipe Insulation
ASTM C 564	(1995) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 592	(1980) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM C 67	(1994) Standard Test Methods of Sampling and Testing Brick and Structural Clay Tile
ASTM C 920	(1995) Standard Specification for Elastomeric Joint Sealants
ASTM D 2665	(1994; Rev A) Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM F 568	(1995) Standard Specification for Carbon

	and Alloy Steel Externally Threaded Metric Fasteners

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.21.1M	(1991) Floor Drains
ASME A112.6.1M	(1979) Supports for Off the Floor Plumbing Fixtures for Public Use
ASME B1.20.7	(1966; R 1983) Hose Coupling Screw Threads (Inch)
ASME B1.21M	(1978; R 1991) Metric Screw Threads - MJ Profile
ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.12	(1991) Cast-Iron Threaded Drainage Fittings
ASME B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(1992) Cast Copper Alloy Solder Joint Drainage Fittings-DWV
ASME B16.26	(1988) Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(1992) Malleable-Iron Threaded Fittings, Classes 150 and 300
ASME B31.1	(1995) Power Piping
ASME-17	(1995) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Specification for Filler Metals for Brazing
AWS-02	(1990) Welding Handbook; Eighth Ed; Vol Two - Welding Process
AWS-03	(1990; 8th Ed) Welding Handbook, Volumes 1 thru 5

AMERICAN WATERWORKS ASSOCIATION (AWWA)

AWWA C200	(1991) Steel Water Pipe 6 In. (150 mm) and Larger

AWWA C203	(1991) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
AWWA C206	(1991) Field Welding of Steel Water Pipe
AWWA C207	(1994) Standard for Steel Pipe Flanges for Waterworks Service-Sizes 4 In. Through 144 In.
AWWA C500	(1993) Gate Valves for Water and Sewerage Systems
AWWA C510	(1992) Double Check Valve Backflow-Prevention Assembly (Second Edition)
AWWA C511	(1992) Reduced Pressure Principle Backflow-Prevention Assembly (First Edition)
AWWA C606	(1987) Grooved and Shouldered Joints
AWWA C651	(1992) Disinfecting Water Mains

FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH (FCCHR)

FCCHR-01	(1988; 8th Ed) Manual of Cross-Connection Control

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825	(1990; Supple I, II & III) Approval Guide

FEDERAL SPECIFICATIONS (FS)

FS FF-S-325	(Int Amd 3) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(1993) Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69	(1996) Pipe Hangers and Supports - Selection and Application
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201 (1983) Water Hammer Arrestors Standard

SOUTHERN BUILDING CODE CONGRESS INTERNATIONAL (SBCCI)

SBCCI-02 (1994) Standard Plumbing Cod

1.2 DESIGN REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Plumbing systems shall be provided and shall include the water supply system, the waste and vent system, and all required plumbing fixtures and fittings. Plumbing fixtures and fittings shall be selected in accordance with the water conservation guidelines as described in SBCCI-02, Appendix J.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Detail Drawings shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

Installation Drawings shall be submitted for piping systems in accordance with paragraph entitled, "Pipe Installation," of this section.

SD-06 Test Reports

Test Reports shall be submitted for hydrostatic pressure tests in accordance with paragraph entitled, "Tests," of this section.

1.4 GENERAL REQUIREMENTS

Detail Drawings shall be submitted for plumbing systems including spring-support data.

Material, Equipment, and Fixture Lists shall be submitted for plumbing systems.

PART 2 PRODUCTS

2.1 WATER SUPPLY SYSTEM COMPONENTS

2.1.1 Pipe and Fittings

2.1.1.1 Copper Pipe

Above ground copper tubing shall conform to ASTM B 88M, Type B, hard-drawn for horizontal and exposed vertical lines.

Underground copper tubing shall conform to ASTM B 88M, Type A, seamless. No joints shall be permitted in underground copper piping unless specifically approved. Fittings for connection to corporation cocks shall be cast bronze, flared type, conforming to ASME B16.26. Underground joints shall be brazed.

Fittings and unions shall be 1034 kilopascal working steam pressure (wsp), wrought-copper solder joint conforming to ASME B16.22.

Solder shall be 95-5 tin-antimony, alloy Sb5, conforming to AWS-02. Brazing rod shall be classification BCP-5, conforming to AWS A5.8.

Copper tubing systems may be installed using mechanical pipe couplings of a bolted type with a central cavity design pressure responsive gasket. Copper pipe and fittings are to be grooved in accordance with the coupling manufacturers specifications.

2.1.1.2 Ductile Iron Cement Lined (Below Grade)

Pipe and Fittings 100 Millimeters and Larger

Ductile Iron

a. ANSI-A21.51
b. ANSI-A21.4 for cement lining
c. Protective coating outside: Acceptable bitumastic or coat tar enamel
d. Thickness ANSI Class 53 and pressure Class 150
e. Joints: Mechanical or "push-on" type complying with ANSI A-21.1..
f. Polyethylene encasement: 8 mil tube, sized to accommodate the pipe, comply with ANSI A21.5.
g. Test Pressure 1379 KPa
h. Fittings: Ductile iron ANSI A21.1 short body fittings:
    1) Cement lining ANSI A21.4
    2) Class 250

2.1.1.3 Galvanized Carbon Steel Pipe

Pipe size DN15 through DN80 and where indicated shall be in accordance with AWWA C200, Schedule 40 seamless galvanized steel conforming to ASTM A 53, Type S (seamless).

Fittings DN50 and under shall be 1034 kilopascal wsp banded galvanized malleable iron screwed, conforming to ASTM A 197M and ASME B16.3.

Unions DN50 and under shall be 2068 kilopascal wsp female, screwed, galvanized malleable iron with brass-to-iron seat and ground joint.

Fittings DN65 and over shall be 862 kilopascal wsp cast-iron flanges and flanged fittings, conforming to ASTM A 126, Class A and ASME B16.1.

Steel flanges shall conform to AWWA C207.

Field welding of steel pipe shall be as specified in AWWA C206.

Contractor has the option of using 1034 kilopascal wsp banded galvanized malleable iron screwed fittings, conforming to ASTM A 197M and ASME B16.3.

Grooved fittings may be used in lieu of threaded, flanged, or welded fittings. Fittings shall be cast ductile iron in accordance with ASTM A 536. Grooves shall conform to AWWA C606. Galvanized coating damaged by grooving process shall be repaired using approved ASTM zinc-rich coating.

2.1.2 Valves and Specialties

2.1.2.1 Gate Valves

Valves shall be designed for a minimum of 1034 kilopascal. Valves shall have screw joints. Valves smaller than DN80 shall be all brass and shall conform to MSS SP-80, Type I. Valves DN80 shall be iron-body, brass-mounted, conforming to AWWA C500.

2.1.2.2 Vacuum and Relief Valves

Vacuum and relief valves shall be size and type to relieve pressure and prevent the formation of a vacuum. Valves shall automatically remove air from the lines when the lines are being filled and admit air into the lines when water is being withdrawn in excess of the inflow.

2.1.2.3 Hose Faucets

Hose faucets shall be constructed with 15 millimeter male inlet threads, hexagon shoulder, and 20 millimeter hose connection, conforming to ANSI A112.18.1M. Hose-coupling screw threads shall conform to ASME B1.20.7 and ASME B1.21M.

2.1.2.4 Globe Valves

Valves shall be 862 kilopascal, bronze body, conforming to MSS SP-80. Disk shall be free to swivel on the stem. Composition seating surface disk construction may be substituted for all-metal disk construction. Packing shall be a woven non-asbestos material, impregnated with not less than 25 percent, by weight, tetrafluoroethylene resin.

2.1.2.5 Check Valves

Standard check valves in sizes DN50 and smaller shall be 862 kilopascal swing check conforming to MSS SP-80.

Check valves in sizes DN65 and larger shall be cast iron, bronze trim, swing type. Valve bodies shall be cast iron, conforming to ASTM A 126, Class A. Valve ends shall be flanged in conformance with ASME B16.1. Swing-check pin shall be AISI Type 304 corrosion-resistant steel. Valves shall have bolted and gasketed covers.

Grooved end check valves may be used provided that the manufacturer certifies to the performance requirements of MSS SP-80.

2.1.2.6 Backflow Prevention Devices

Backflow prevention devices shall conform to AWWA C510 and AWWA C511.

Devices DN50 ips and smaller with moving components defined in AWWA C511, shall be constructed of nonferrous metals. Nonmetal components of such devices shall be rated for the applicable service temperature.

Bodies of devices DN65 and larger shall be corrosion-resistant ferrous material or bronze, with flanged connections. Metallic operating components and trim shall be nonferrous. Nonmetallic parts shall be rated for the applicable service temperature.

External surfaces of devices used in conjunction with equipment with polished or chrome-plated surfaces shall be similarly finished.

External surfaces of devices may be rough castings where these devices are used outside of the building or in equipment rooms. Devices shall be protected from freezing and shall be installed, tested, and used in strict conformance with the manufacturer's instructions.

Air gaps shall be at least two times the supply pipe diameter, but not less than 25 millimeter, as measured vertically, from the flood rim of the supplied device. There shall be no provision for a temporary bypass line around the air gap.

Type DC backflow devices or assemblies are used for low degree of hazard nonpollutants or contaminants. This device shall conform to AWWA C510 and FCCHR-01 standard. This unit shall be installed a minimum of 450 millimeter above the ground or flood level. When installed in a pit, a drain must be provided. This assembly device must be furnished with tightly closing shutoff resilient seated valves on each end and be fitted with properly located test cocks. Outside locations shall include protection against freezing. Critical facility potable water systems and DN65 and larger shall have dual-parallel installation which should be installed in accessible locations. When DC backflow assemblies are used on fire suppression water systems, the shutoff valves must be OS&Y resilient seated gate valves.

Reduced pressure principle devices shall conform to AWWA C511 and FCCHR-01. This unit shall be installed a minimum of 450 millimeter above ground or flood level. This unit shall include tightly closing shut-off valves on each end and be fitted with properly located test cocks. Indoor installations shall include an airgap-equipped drain adequate for relief valve discharge. Outside installations shall include protection against

freezing. Critical water supplies shall have dual-parallel installations which should be installed in accessible locations.

2.1.2.7 Service Stops

Service stops shall be waterworks ground-key type, oval flow way, T-handle, without drain. Pipe connections shall be suitable for the type of service pipe used. Parts shall be cast red brass having a nominal composition of 85 percent copper, 5 percent tin, 5 percent lead, and 5 percent zinc, with female ips connections designed for a minimum pressure of 1379 kilopascal.

2.1.2.8 Water-Hammer Arresters

Water-hammer arresters shall be commercially manufactured products consisting of bellows arranged to absorb the energy of pressure waves generated by valve closure in a line in which water is flowing. Arresters shall be nonferrous construction, shall be rated as to capacity, and shall be certified in accordance with PDI WH 201.

2.1.2.9 Wall Hydrants

Wall hydrants shall have brass wall-boxes with nozzles and detachable T-handles and shall be provided with vandalproof type BAT vacuum breakers. Exterior surfaces shall be chrome-plated.

2.1.3 Storage-Type Water Heaters

Storage-type water heaters shall be electric type. Electric water heaters shall be UL listed.

Water heaters shall be commercially available models. Model selected shall be of the energy efficient type insulated to an R value of at least 1.8 square meter Celsius per watt (10 square foot Fahrenheit per Btu).

Temperature- and pressure-relief valves shall conform to AGA Z21.22. Type I, combination pressure- and temperature-relief valves shall be installed when the heat input is less than 30 kilowatt and when the storage is less than 454 liter. Vacuum-relief valves shall be installed on each cold-water branch connection on the bottom of the water heaters at an elevation above the top of the heater. Vacuum relief valve shall be designed to prevent water heater damage from a reverse flow vacuum.

2.1.4 Plumbing Fixtures and Trim

Vitreous-china and enameled cast-iron plumbing fixtures shall be white, and shall be the product of the same manufacturer.

Exposed traps and double-cone supply tubes for fixtures and equipment shall be connected to rough-piping at the wall, unless otherwise specified in the contract documents. Floor and wall plates shall be as specified herein or as covered by the outfit numbers. Exposed-to-view fixture trimmings, fittings, and fasteners shall be chromium-plated or nickel-plated brass with polished, bright surfaces.

Supplies and wastes for lavatories shall be to wall, except as otherwise indicated on the construction drawings. Sleeves are not required at penetrations.

Rubber compression type connections shall not be acceptable. Brass ferrule type fittings shall be required.

2.1.4.1 Fixture Supports

Wall-hung fixtures shall be supported by ferrous-metal carriers suited to the particular installation conditions. Carriers may be combination type with adjustable fittings. Water closets shall be floor mounted. Lavatories shall be supported from the wall by wall-carriers with concealed arms.

2.1.4.2 Lavatories

Lavatories and fittings shall conform to ANSI A112.19.2M.

Type L-S lavatories shall be Type V, slab type, Class 4, wall hung, 508 by 457 millimeter. Inside opening shall be substantially rectangular.

Supply fittings shall conform to applicable requirements for faucets in ANSI A112.19.2M.

Supply fitting shall be a 100 millimeter, centerset type with a vandalproof aerator.

Supply fitting spout angle and length over the bowl shall provide a water-free back ledge. Horizontal distance from the centerline of the spoutless aerator to the centerline of the supply piping shall be not less than 111 millimeter, and the vertical distance between the centerline of the spout, less aerator, and the fitting base shall be not less than DN65. Supply fittings with handles capable of being turned 360 degrees shall not be acceptable.

Supply piping shall be chrome-plated brass and threaded in accordance with the requirements of ANSI A112.19.2M.

Drain fittings shall conform to ANSI A112.19.2M, strainer drain, but with perforated removable strainer and DN32 tailpiece. Adjustable P-trap, with cleanout, shall be Type I.

2.1.4.3 Service Sinks

Service sinks and fittings shall conform to ANSI A112.19.1M, ANSI A112.19.2M, and ANSI A112.19.3M.

Type SS-T service sinks shall be single bowl, three-side access, floor mounted, terrazzo, with four-side cap-tiling flange, and fabricated from Class 302, annealed corrosion-resistant steel. Fixtures shall be 914 by 600 millimeter overall and 300 millimeter high. Supply fittings shall be a DN250 spout, chrome-plated, single, compression, with vacuum breaker and 4-foot hose with holding bracket. Drain fittings shall be 80 millimeter.

2.1.4.4 Water Closets

Water closet, Type WC-1, shall be office and industrial type, elongated bowl with flush valve, siphon, jet, and floor outlet, in conformance with ANSI A112.19.5, constructed for quiet operation. Seat shall be elongated, open-front, solid-molded, high-impact, polystyrene, white, with check hinge, less cover. Flush valve shall be exposed flushometer, large diaphragm and large piston, side oscillating handle with vacuum breaker and screwdriver stop, constructed for quiet operation.

2.1.4.5 Wheelchair Electric Water Cooler

ARI 1010, wall-mounted bubbler style with ASME A112.6.1M wall hanger, air-cooled condensing unit, 18 liter per hour minimum capacity, stainless steel splash receptor, and all stainless steel cabinet, with 675 millimeter clearance from front bottom of unit to floor and 900 millimeter maximum spout height above floor. Bubblers shall also be controlled by push levers, by push bars, or touch pads one on each side or one on front and both sides of the cabinet. CFC refrigerants are not allowed.

2.2 SANITARY DRAIN, WASTE, AND VENT SYSTEM (DWV)

2.2.1 DWV Piping

2.2.1.1 Cast-Iron

Soil pipe drain, waste, and vent bell-and-spigot type shall conform to ASTM A 74. Joints shall be calked and leaded in lines where necessary to provide proper leaktight support and alignment. Joints may be elastomeric compression conforming to ASTM C 564. Hubless joints may be used. Pipe class shall be standard weight CISP-DWV.

2.2.1.2 Copper

Pipe shall be type DWV copper drainage tube conforming to ASTM B 306, with wrought copper drainage fittings conforming to ASTM B 584 and ASME B16.23.

2.2.1.3 Polyvinylchloride (PVC)

Polyvinylchloride drain, waste, and vent piping-system materials shall be manufactured from Type I normal impact resins in conformance with ASTM D 2665 and with ASME B16.12. Pipe and fittings shall be white and specifically suited for joining socket interfaces into a homogeneous mass by solvent-cement welding.

Fittings shall be molded to produce upon insertion of pipe an interference fit at two-thirds depth of socket. No thread cutting shall be permitted.

2.2.2 Sanitary Drain Waste and Vent Fixtures

2.2.2.1 Floor Drains (FD)

Floor drains shall be complete with traps, and bottom outlets.

Floor drains located in slabs on earth shall have hub outlets.

Floor drains shall have integral seepage pans and weepholes.

Ferrous floor-drain surfaces, except the top of grates, shall be given a heavy coating of coal-tar enamel. Coating shall be applied either at the factory or in the field before installation and before any rusting has occurred.

Type FD-1 floor drains shall conform to ASME A112.21.1M and as indicated. Adjustable collar strainer and fasteners shall be nickel-bronze. Exposed-to-view surfaces shall be satin polished, except in mechanical rooms. Strainer holes shall be square. Strainer diameter shall be nominal 125 millimeter Strainer and body shall be capable of sustaining specified platen load of not less than 8900 newton with not more than 1.6 millimeter deflection with load applied within 5 seconds. Strainer-free area shall be not less than 4516 millimeter square.

2.2.2.2 Cleanouts (CO)

Cleanouts shall be effectively gastight and watertight, sized to provide quick and easy access for plug removal and rodding tools in their specific location. Cleanouts shall be aesthetically located with respect to tile patterns, masonry bond, and alignment.

Cleanouts in ceramic-tile and resilient-tile flooring and wall finish shall be rectangular.

No cleanout plug shall terminate in or above a finished floor or wall surface except in stack bases and where indicated on the construction drawings.

Cleanouts shall have cast-brass raised-head plugs. Not less than two tools for each size and type of plug shall be delivered to the Contracting Officer.

Cleanouts set outside of the building and all cleanouts in building floors shall have adjustable housings.

Cast-iron bodies shall be coated with manufacturer's standard material.

Type CO-2 shall be cast-iron body and setscrew-adjustable housing with deep-set tractor-type polished nickel-brass or nickel-bronze scoriated cover. Construction shall be heavy duty, suitable for AASHTO H-10 loading.

2.3 SUPPORTING ELEMENTS

Necessary piping-system components and miscellaneous supporting elements shall be provided, including, but not limited to, building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; and variable and constant supports. Supporting elements shall be suitable for stresses imposed by systems pressures and temperatures, and natural and

other external forces.

Supporting elements shall be in accordance with FM P7825 and be UL listed and shall conform to ASME B31.1, MSS SP-58, MSS SP-69, and requirements specified herein.

Types of devices specified herein are defined in referenced MSS standards.

2.3.1 Building Structure Attachments

2.3.1.1 Anchor Devices, Concrete and Masonry

Anchor devices shall conform to requirements of FS FF-S-325, Group II, Type 2, Class 2, Styles 2.

Anchor devices for cast-in floor-mounted equipment shall provide for adjustable positions.

Masonry anchor devices shall be built-in.

Powder-actuated anchoring devices shall not be used to support any mechanical-system components.

2.3.1.2 Beam Clamps

Beam clamps shall be center-loading Types D21, 28, 29, and 30, UL listed, cataloged and load-rated, commercially manufactured products.

2.3.1.3 C-Clamps

C-clamps shall not be used.

2.3.2 Horizontal Pipe Attachments

2.3.2.1 Single Pipes

Piping in sizes through DN50 ips shall be supported by Type 6 solid malleable-iron pipe rings, except that split-band rings shall be used in sizes up to DN25 ips.

Type 1 and 6 assemblies shall be used on vapor-sealed insulated piping and shall have an inside diameter 1-ips larger than the pipe being supported, to provide adequate clearance during pipe movement.

Type 40 shields shall be used on insulated piping. Area of the supporting surface shall be such that compression deformation of insulated surfaces does not occur. Longitudinal and transverse shield edges shall be rolled away from the insulation.

Type 38 saddles shall be used for pipe guiding.

Spring supports shall be provided.

2.3.2.2 Parallel Pipes

Trapeze hangers fabricated from approved, structural-steel shapes, with U-bolts shall be used in congested areas and where multiple pipe runs occur. Structural-steel shapes shall conform to supplementary steel requirements, or the support shall be a commercially available, proprietary design, rolled steel.

2.3.3 Vertical Single Pipe Attachments

Vertical pipe attachments shall be Type 8.

2.3.4 Hanger Rods

Only circular cross-section rod hangers shall be used to connect building-structure attachments to pipe supports. Pipe, straps, or bars of equivalent strength shall be used for hangers only where approved.

2.3.5 Copper Tubing and Pipe Supports

Metal surfaces in contact with copper tubing or pipe shall be plastic-coated.

Support surfaces shall have large contact areas to prevent point loading with consequent cutting. Minimum direct-contact areas shall be equal to commercially available Type I hangers.

2.4 INSULATION

Hot-water-piping insulation shall be fiberglass with factory-applied jacket conforming to ASTM C 547.

Composite UL-listed jacket and insulation shall have a Fire-Hazard Classification of flame-spread 25, smoke-developed 50. Wall penetrations shall be sleeved with foamed, flexible insulation, continuous through the sleeve.

Potable hot- and cold-water lines shall be insulated to the extent shown with standard nominal 19 millimeter foamed, flexible insulation. Insulation shall be slipped onto the pipe prior to making up fittings. Butt joints shall be sealed with adhesive as recommended by the insulation manufacturer. Outdoor insulation shall be coated with an ultraviolet light protective coating recommended by the insulation manufacturer.

For pipe hangers and supports where the insulation rests on the 32 millimeter strap of the adjustable clevis pipe hanger, the insulation shall be cut with a brass cork-borer and a number 15 superior grade cork shall be inserted. Seams shall be sealed with suitable adhesive. Cork shall be centered on the strap. Length of the cork shall be modified to suit the insulation thickness.

Fitting shall be insulated with miter-cut pieces of pipe insulation of the same size as applied to the adjacent pipe. Miter-cut pieces shall be joined with adhesive, the covers slit, snapped over the fittings, and the joints sealed with adhesive.

After the piping system has been installed, tested, and placed in satisfactory operation, the hanger load nut above the clevis shall be firmly tightened to ensure proper hanger performance. A nipple shall be placed over the 13 millimeter diameter clevis bolt as a spacer to ensure that the lower U-strap will not move in on the bolt and deform or compress the insulation.

2.5 MISCELLANEOUS MATERIALS

2.5.1 Bituminous Coating

Bituminous coating shall be a solvent cutback, heavybodied material to produce not less than a 0.3 millimeter dry-film thickness in one coat, and shall be recommended by the manufacturer as compatible with factory-applied coating and rubber joints.

For previously coal-tar coated and uncoated ferrous surfaces underground, bituminous coating shall be solvent cutback coal-tar type, conforming to AWWA C203.

2.5.2 Bolting

Flange and general purpose bolting shall be hex-head and shall conform to ASTM F 568, Class 4.8 or above bolts, for flanged joints in piping systems where one or both flanges are cast iron. Heavy hex-nuts shall conform to ASTM A 563M. Square-head bolts and nuts shall not be acceptable. Threads shall be coarse-thread series.

2.5.3 Elastomer Calk

Polyurethane-base elastomer calking material shall be two-component type, conforming to ASTM C 920.

2.5.4 Escutcheons

Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Metals and finish shall conform to ANSI A112.19.1M, ANSI A112.19.2M, and ANSI A112.19.3M.

Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. Escutcheons shall have provisions consisting of internal spring-tension devices or setscrews for maintaining a fixed position against a surface.

2.5.5 Flashing

Sheet copper shall conform to ASTM B 370 and shall weigh not less than 4.8 kilogram per square meter.

2.5.6 Grout

Shrink-resistant grout shall be a premixed and packaged metallic-aggregate,

mortar-grouting compound conforming to ASTM C 1107.

Shrink-resistant grout shall be a combination of premeasured and packaged epoxy polyamide and selected aggregate mortar grouting compound with a tensile strength of 13100 kilopascal, minimum in accordance with ASTM C 190 ; and a compressive strength of 96.53 Megapascal, minimum in accordance with ASTM C 109/C 109M. Linear shrinkage shall be 0.003 millimeter per millimeter with water absorption of 0.1 percent in accordance with ASTM C 67. Bond strength to steel in shear shall be 6895 kilopascal, minimum.

PART 3 EXECUTION

3.1 EXCAVATION AND BACKFILL

Excavation and backfill operations shall performed in accordance with Section 02315, "Excavation and Fill."

3.2 PIPE INSTALLATION

Installation drawings shall be submitted and piping systems shall be fabricated and installed in accordance with ASME B31.1 and MSS SP-69.

Final connections to equipment shall be made with unions or flanges. A union or flange shall be provided every 30480 millimeter of straight run. Unions shall be provided in the line downstream of screwed- and welded-end valves.

Metallic pipe ends shall be reamed before joint connections are made.

Pipe ends shall be reamed before joint connections are made.

Screwed joints shall be made up with tetrafluoroethylene joint compound or tape and not more than three threads shall show after the joint is made up.

Connections between copper and steel pipe or equipment shall be made using dielectric unions having 1207 kilopascal minimum pressure.

Cutting of metallic piping shall be by wheel cutters or other machines designed specifically for that purpose. Electric-arc and oxyacetylene cutting shall not be permitted.

Plastic pipe shall be cut square with pipe. Burrs shall be removed by smoothing edges.

Schedule 40 plastic pipe shall not be threaded.

Joint compounds shall be applied to the male thread only and care shall be exercised to prevent compound from reaching the unthreaded interior of the pipe.

Screwed unions, welded unions, or bolted flanges shall be provided wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

Piping systems shall be securely supported with due allowance for thrust forces and thermal expansion and contraction, and shall not be subjected to mechanical, chemical, vibration, or other damage as specified in ASME B31.1.

Field welded joints shall conform to the requirements of the AWS-03, ASME B31.1, and ASME-17.

3.3 VALVES

Valves shall be provided in piping mains, on branches, and at equipment locations.

Valves shall be provided to permit isolation of branch piping and each equipment item from the balance of the system.

Valves unavoidably located in furred or other normally inaccessible places shall be provided with adequately sized access panels approved for the location.

3.4 SUPPORTING ELEMENTS INSTALLATION

Supporting elements shall be provided as indicated.

Piping shall be supported from building structure only. Piping shall not be supported from roof deck or from other pipe.

Piping shall run parallel with the lines of the building. Piping and components shall be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there shall be no less than 13 millimeter of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the building.

Piping support elements shall be installed at intervals not more than 914 millimeter from the ends of each runout, and not over 300 millimeter from each change in direction of piping.

Load rating for pipe-hanger supports shall be based on insulated weight of lines filled with water and forces imposed. Deflection per span shall not exceed slope gradient of pipe. Supports shall be in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, the allowable span shall be reduced proportionately:

PIPE SIZE (DN) MILLIMETE	ROD SIZE MILLIMETE	STEEL PIPE MILLIMETE	COPPER PIPE MILLIMETER
25 and smaller	10	2500	1830
32 to 40	10	3050	2500
50	10	3700	3050

PIPE SIZE (DN) MILLIMETE	ROD SIZE MILLIMETE	STEEL PIPE MILLIMETE	COPPER PIPE MILLIMETER
65 to 90	15	3700	3700
100 to 125	18	3700	3700
150	22	3700	3700
200	25	3700	3700

Vibration isolation supports shall be provided.

All PVC piping shall be supported at intervals of no more than 1219 millimeter and CPVC support spacing at no more than 910 millimeter.

Vertical risers shall be supported independently of connected piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Risers shall be guided for lateral stability. For risers subject to expansion, only one rigid support shall be provided at a point approximately one-third down from the top. Clamps shall be placed under fittings.

3.5 PENETRATIONS

Effective sound stopping and adequate operating clearance shall be provided to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces shall include space above ceilings where no special acoustic treatment of ceiling is provided. Penetrations shall be finished to be compatible with surface being penetrated.

3.6 SLEEVES

Sleeves shall be provided where piping passes through roofs, masonry or concrete walls, and floors.

Sleeves passing through steel decks shall be continuously welded or brazed to the deck.

Sleeves that extend through floors, roofs, load bearing walls, and fire barriers shall be continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. Other sleeves shall be formed by molded linear polyethylene liners or similar materials which are removable. Diameter of sleeves shall be large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide a minimum 10 millimeter clearance. Sleeve size shall accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and the generation of noise.

Space between a pipe, bare or insulated, and the inside of a pipe sleeve or

a construction surface penetration shall be packed solid with a mineral fiber conforming to ASTM C 592. This packing shall be provided wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration shall be filled with an elastomer calk to a depth of 13 millimeter. Surfaces to be calked shall be oil-and grease-free.

Exterior wall sleeves shall be calked watertight with mechanically expandable chloroprene inserts with mastic-sealed metal components.

3.7 ESCUTCHEONS

Escutcheons shall be provided at penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, escutcheons shall be provided on both sides of the partition. Where suspended ceilings are installed, plates shall be provided at the underside only of such ceilings. For insulated pipes, the plates shall be large enough to fit around the insulation. Escutcheons shall be chrome-plated in occupied spaces and of size sufficient to effectively conceal openings in building construction. Escutcheons shall be firmly attached with setscrews.

3.8 FLASHINGS

Flashings shall be provided at penetrations of building boundaries by mechanical systems and related work.

3.9 UNDERGROUND PIPING INSTALLATION

Prior to being lowered into a trench, piping shall be cleaned, visually and audibly inspected for apparent defects.

Suspect cast-ferrous piping shall be further inspected by painting with kerosene on external surfaces to reveal cracks.

Defective materials found shall be distinctly marked using a road-traffic quality yellow paint. Defective material shall be promptly removed from the site.

After conduit has been inspected, and not less than 48 hours prior to being lowered into a trench, external surfaces of cast ferrous conduit shall be coated with a compatible bituminous coating for protection against brackish ground water. Application shall be single coat, in accordance with the manufacturer's instructions, to result in a dry-film thickness of not less than 0.3 millimeter.

Excavations shall be dry and clear of extraneous materials when pipe is being laid.

Laying of pipe shall begin at the low point of a system. When in final

acceptance position, it shall be true to the grades and alignment, with unbroken continuity of invert. Blocking and wedging shall not be permitted.

Bell or grooved ends of piping shall point upstream, unless otherwise approved.

Changes in direction shall be made with long sweep fittings unless otherwise approved.

On excavations that occur near and below building footings, the backfilling material shall consist of 14 Megapascal cured compressive-strength concrete poured or pressure grouted up to the level of the footing.

Vertical downspouts and similar work shall be properly supported on approved piers at the base and provided with approved structural supports attached to building construction.

When PVC pipe is installed in a trench, single conductor No. 14 AWG wire with Type TW insulation shall be installed above the pipe, not less than 300 millimeter below grade, to facilitate pipe location.

3.10 TESTS

Test reports shall be submitted in accordance with referenced standards in this section.

Plumbing systems shall be tested to prove tightness of piping and connections and proper operation of equipment and fixtures.

Hydrostatic tests shall be performed by completely filling the piping system with water and eliminating accumulation of air so that any leakage will be immediately apparent. Pressure shall be maintained until pipe under test has been examined, but in no case for less than 1 hour.

Hot- and cold-water piping shall be tested hydrostatically 1.5 times, under 862 kilopascal pressure for not less than 8 hours with no loss of pressure. Leaks shall be eliminated by replacing the pipe or fitting in question at no additional cost to the Government. Underground hot- and cold-water piping shall be tested before backfilling.

Drainage and venting piping shall be tested before the fixtures are installed. Underground soil and waste piping shall be tested before backfilling. Testing shall be applied to the system in its entirety.

When the entire system is tested, openings in the pipes shall be tightly closed except the highest opening, and the system shall be filled with water to the point of overflow.

When the system is tested in sections, each opening except the highest opening of the section under test shall be tightly plugged, and each section shall be filled with water and tested with at least a 30 kilopascal of water. In testing successive sections, at least the upper 3050 millimeter of the next preceding section shall be tested so that each joint or pipe except the uppermost 3000 millimeter of the system has been

submitted to a test of at least a 30 kilopascal of water. Water shall be kept in the system or in the portion under test for at least 2 hours before the inspection starts. System shall be proved tight at all joints.

3.11 DISINFECTION

Water piping, including valves, fittings, and other devices, shall be disinfected with a solution of chlorine and water, and tested according to AWWA C651. Solution shall contain not less than 50 parts per million (ppm) of available chlorine. Solution shall be held for a period of not less than 8 hours, after which time the solution shall contain not less than 10 ppm of available chlorine or the piping shall be disinfected again. After successful disinfection, the piping shall be flushed before placing into service. Water for disinfection will be furnished by the Government, but disposal shall be the responsibility of the Contractor.

3.12 PLUMBING FIXTURES

Materials, equipment, and fixtures shall be installed in accordance with the manufacturer's recommendations. Fixtures and equipment shall be installed to comply with water conservation policy.

Fixtures shall be clean and free of deleterious material before being installed. Before connecting to water, waste, vent, or trap service, the fixture lines shall be blown out with compressed air. During the progress of construction, open ends of fixtures shall be protected at all times to prevent the admission of foreign matter.

3.13 INSULATION

After tests have been completed and surfaces cleaned, insulation shall be installed on hot-water piping except for chrome-plated brass pipe and other hot-water-exposed supplies to fixtures.

Thickness shall be not less than 19 millimeter for piping DN25 or less and 25 millimeter for piping larger than DN25.

Valves and fittings shall be insulated with segments of insulation of the same material and thickness as the adjoining pipe insulation.

3.14 ADJUSTING

Automatic control devices shall be adjusted for proper operation.

Autoflush controls shall be tested to ensure correct adjustment sensitivity.

-- End of Section --

SECTION 15106

FERROUS PIPE AND FITTINGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 105/A 105M	(1996) Standard Specification for Forgings, Carbon Steel, for Piping Components
ASTM A 106	(1997; Rev A) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 181/A 181M	(1995; Rev B) Standard Specification for Forgings, Carbon Steel, for General-Purpose Piping
ASTM A 193/A 193M	(1997; Rev A) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194/A 194M	(1997) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A 234/A 234M	(1997) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 53	(1996) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.11	(1996) Forged Steel Fittings, Socket-Welding and Threaded
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings

ASME B36.10M	(1985) Welded and Seamless Wrought Steel Pipe

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation Drawings for steel piping shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Piping for High-Pressure Compressed-Air Systems
Fittings
Unions
Flanges
Gaskets
Bolting

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Installation Drawings for steel piping shall be in accordance with the manufacturer's recommendations and in accordance with Section 15050, "Basic Mechanical Materials and Methods."

PART 2 PRODUCTS

2.1 PIPING FOR HIGH-PRESSURE COMPRESSED-AIR SYSTEMS

2.1.1 Type BCS-2,000 (15 megapascal Service)

Pipe or tube(DN6 through DN80): Schedule 40, seamless black carbon steel, conforming to ASTM A 106, Grade B, or ASTM A 53, Grade B, Type S, and ASME B36.10M

Fittings (DN6 through DN40): 15 megapascal wog, forged carbon steel, socket weld, conforming to ASTM A 105/A 105M and ASME B16.11

Fittings (DN50 through DN80): Schedule 40, long radius, butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB, and ASME B16.9

Flanges (DN25 through DN80): 6200 kilopascal, forged carbon steel, welding

neck, with raised face and concentric serrated finish, conforming to ASTM A 105/A 105M or ASTM A 181/A 181M, Class 60, and ASME B16.5

Gaskets: Spiral wound, non-asbestos-fiber-filled, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1

Bolting: Alloy-steel bolt studs conforming to ASTM A 193/A 193M, Grade B7, and semifinished heavy hex-nuts, conforming to ASTM A 194/A 194M, Grade 2H

2.1.2 Type BCS-6,000 (41368-kilopascal Service)

Pipe or tube (DN15 through DN80): XXS, seamless, black carbon steel, conforming to ASTM A 106, Grade B, or ASTM A 53, Grade B, Type S and ASME B36.10M

Fittings (DN15 through DN40): 41.3 megapascal wog, forged carbon steel, socket weld, conforming to ASTM A 105/A 105M and ASME B16.11

Fittings (DN50 through DN80): XXS, long-radius, butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB, ASME B16.9, and ASME B36.10M

Flanges (DN50 through DN80): 17.2 megapascal, forged carbon steel, welding neck with raised face and concentric serrated finish, conforming to ASTM A 105/A 105M and ASME B16.5

Gaskets: Spiral-wound, non-asbestos-filled, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1

Bolting: Alloy steel bolt studs conforming to ASTM A 193/A 193M, Grade B7, and semifinished heavy hex-nuts, conforming to ASTM A 194/A 194M, Grade 2H

PART 3 EXECUTION

3.1 GENERAL

Pipe shall be installed in accordance with manufacturer's recommendations and in accordance with Section 15050, "Basic Mechanical Materials and Methods."

-- End of Section --

SECTION 15107

PLASTIC PIPE AND FITTINGS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1784	(1992) Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	(1994) Standard Specification for Poly (Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2235	(1993; Rev A) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D 2241	(1994) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
ASTM D 2466	(1994; Rev A) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2564	(1993) Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2661	(1994; Rev A) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40, Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2680	(1993) Standard Specification for Acrylonitrile-Butadene-Styrene (ABS) Composite Sewer Piping
ASTM D 2751	(1993) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings

ASTM D 2855	(1993) Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fitting

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation Drawings for plastic piping systems shall be in accordance with paragraph entitled, "Installation," of this section.

SD-03 Product Data

Manufacturer's Catalog Data shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-07 Certificates

Certificates shall be submitted for Potable Water Systems Materials in accordance with paragraph entitled, "General Requirements," of this section.

Seal of approval of an approved testing laboratory acceptable to public health officials.

1.4 GENERAL REQUIREMENTS

Manufacturer's Catalog Data shall be submitted for plastic pipe and fittings, for each size and type.

PART 2 PRODUCTS

2.1 POLYVINYLCHLORIDE (PVC) PIPE

PVC pipe shall be in accordance with ASTM D 1785.

2.1.1 Schedule Pipe (PVC)

Pipe shall be Schedule 40.

Material shall be PVC Class 12454-B in accordance with ASTM D 1784.

2.1.2 SDR-PR Nonthreaded Pipe (PVC)

Nonthreaded standard dimension ratio/pressure rated (SDR-PR) pipe shall be in accordance with ASTM D 2241.

Pipe shall have SDR of 35.

Material shall be PVC Class 12454-B.

2.1.3 Fittings (PVC)

2.1.3.1 Socket-Type, Schedule 40

Material shall be PVC in accordance with ASTM D 2466.

2.1.4 Cement and Lubricant

Solvent cement for pipe and fittings shall be in accordance with ASTM D 2564. Thread lubricant shall be in accordance with the pipe manufacturer's recommendations.

2.2 ACRYLONITRILE-BUTADIENE-STYRENE (ABS) PIPE

2.2.1 Drain, Waste, and Vent Pipe

Drain, waste, and vent pipe shall be in accordance with ASTM D 2661.

2.2.2 Sewer Pipe

Sewer pipe shall be in accordance with ASTM D 2751.

2.2.3 Composite Sewer Piping

Composite sewer piping shall be in accordance with ASTM D 2680.

2.2.4 Fittings (ABS)

2.2.4.1 Drain, Waste, and Vent Fittings

Drain, waste, and vent fittings shall be in accordance with ASTM D 2661.

2.2.4.2 Sewer Pipe Fittings

Sewer pipe fittings shall be in accordance with ASTM D 2751.

2.2.5 Cement and Lubricant

Solvent cement for pipe and fittings shall be in accordance with ASTM D 2235.

Thread lubricant shall be in accordance with the pipe manufacturer's instructions.

PART 3 EXECUTION

3.1 PIPE LAYOUT

Installation shall present a neat, orderly appearance. Openings or passageways shall not be blocked.

Piping shall be kept free from contact with structure or installed items to prevent noise transmission.

3.2 INSTALLATION

Installation drawings shall be submitted.

Plastic piping shall be installed in accordance with the manufacturer's installation instructions.

3.2.1 Vertical Piping

All other piping shall be supported at intervals of not more than 1200 millimeter.

Piping shall be secured at sufficiently close intervals to keep pipe in alignment and to support weight of pipe and contents.

Supports shall be installed at each floor.

Piping shall be secured in position by approved stakes or braces when piping is to stand free, or when no structural element is available for providing stability during construction.

3.2.2 Horizontal Piping, Suspended

All piping shall be supported at intervals in accordance with the manufacturer's instructions and in no case not more than 900 millimeter.

Hangers shall be installed at ends of runs or branches and at each change of direction or alignment.

3.2.3 Horizontal Piping, Underground

Piping shall be laid on a firm bed for the entire trench length, except where otherwise supported.

Partial backfilling and cradling shall be employed to secure piping during backfilling operations.

Piping laid on grade shall be firmly braced prior to embedment in concrete.

3.2.4 Cutting

Cuts shall be made square with pipe and burrs shall be removed by smoothing edges.

3.2.5 Joints

Joints shall be solvent cemented in accordance with ASTM D 2855.

Junction with other materials shall be the type of adapter and technique as recommended by the pipe manufacturer.

-- End of Section --

SECTION 15110

VALVES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 105/A 105M	(1996) Standard Specification for Forgings, Carbon Steel, for Piping Components
ASTM A 106	(1997; Rev A) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 126	(1995) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 182/A 182M	(1997; Rev C) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 216/A 216M	(1993) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM B 148	(1997) Standard Specification for Aluminum-Bronze Sand Castings
ASTM B 164	(1993) Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire
ASTM B 61	(1993) Standard Specification for Steam or Valve Bronze Castings
ASTM B 62	(1993) Standard Specification for Composition Bronze or Ounce Metal Castings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.34	(1996) Valves - Flanged, Threaded and

Welding End

AMERICAN WELDING SOCIETY (AWS)

AWS A5.13	(1989) Specification for Solid Surfacing Welding Rods and Electrodes

FEDERAL SPECIFICATIONS (FS)

FS WW-V-35	(Rev C) Valve, Ball

INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA RP60.9	(1981) Piping Guide for Control Centers

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-67	(1995) Butterfly Valves
MSS SP-70	(1990) Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	(1997) Bronze Gate, Globe, Angle and Check Valves
MSS SP-86	(1987; R 1992) Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuator

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings shall be submitted for the following in accordance with pargraph entitled, "General Requirements," of this section.

Valves
Accessories

Installation drawings for valves shall be in accordance with the paragraph entitled, "Installation," of this section.

SD-07 Certificates

Listing of Product Installation shall be submitted in accordance with pargraph entitled, "General Requirements," of this section.

Certificates shall be submitted for the following items showing

conformance to the referenced standards contained in this section.

Gate Valves
Globe and Angle Valves
Check Valves
Cone-Plug Balancing Valve
Eccentric Plug Valves
Ball Valves
Dial Cocks
Diaphragm Control and Instrument Valves

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Section 15055, "Welding Mechanical," applies to work specified in this section.

Fabrication Drawings shall be submitted for each type of Valves and Accessories used, meeting referenced standards contained within this section.

Listing of Product Installation shall be submitted for valve assemblies indicating at least five installed units, similar to those proposed for use, that have been in successful service for a minimum of five years.

PART 2 PRODUCTS

2.1 COMPONENTS

2.1.1 Dial Cocks

Dial cocks in sizes DN65 and smaller with pointer and etched position dial shall be rated 1100 kilopascal working steam pressure (wsp) and shall be of manufacturer's standard all-brass construction.

2.1.2 Diaphragm Control and Instrument Valves (DCIV)

Diaphragm control and instrument valves in sizes DN8 and DN10 shall have a forged-brass body with reinforced tetrafluoroethylene diaphragm, and an AISI 300 series corrosion-resistant steel spring with round phenolic handle. Handle shall be fitted with disks color-coded in accordance with ISA RP60.9.

2.2 FABRICATION

2.2.1 Gate Valves

2.2.1.1 2500 kPa

Valves shall be rated 2100 kilopascal working steam pressure (wsp) and shall conform to ASME B16.34.

Body end connections shall be flanged for all valves larger than DN50, unless butt weld ends are specified. Screwed weld shall be used for sizes DN50 and under to suit specified piping system end connection and maintenance requirements, or be welded. Flange faces shall have concentric serrated finish.

Body to bonnet connection shall be gasketed-bolted type for valves DN50 and under and gasketed-bolted type for valves larger than DN50. Bonnet shall be outside screw and yoke (OS&Y) type, rising stem.

Body and bonnet assembly shall be cast steel. Cast steel shall conform to ASTM A 216/A 216M, Grade WCB.

Valves shall have a full port.

Trim shall include hard-surfaced solid wedge disc and hard-surfaced seats. Stem shall be rising and backseating type.

Trim materials and hard-surfaced substrates shall conform to ASTM A 182/A 182M, Grade F6.

Hard surfacing alloy shall conform to AWS A5.13, Class RNiCr-B.

Packing shall be wire-reinforced, fiber braid impregnated with a corrosion-inhibiting lubricant specifically suitable for service with stem material provided.

Valve wheels shall be malleable iron.

Integral bypass globe valves shall be provided around valves larger than DN150. Bypass valves shall be factory installed and shall be socket welded end, conforming to the same requirements as the main valve, except that in all cases valve seat and plug disk shall be hard surfaced and seat shall be removable, replaceable type. Piping connections shall be pressure tubing, conforming to Schedule 80 ASTM A 106, Grade B, and without change of direction fittings, i.e., bent. Connection shall be to valve bosses located to perform specified function. Valves with integral bypass shall be shipped bolted to crates in a manner that will preclude damage to bypass assembly.

Integral drain valve assembly shall be factory installed. Connection to main valve body shall be welded. Drain valve shall be trimmed with manufacturer's standard hardened corrosion-resistant steel. Piping shall be pressure tubing conforming to ASTM A 106, Grade B. Drain discharge shall be capped; threaded closure assembly shall be made with tetrafluoroethylene tape.

2.2.1.2 1100 kPa

Valves shall be rated 1100 kilopascal (wsp) and shall conform to ASME B16.34.

Body end connections shall be flanged for all valves larger than DN50 unless butt weld ends are specified. Screwed or socket weld shall be used for sizes DN50 and under to suit specified piping system end connection and

maintenance requirements. Flange faces shall have concentric serrated finish.

Body to bonnet connection shall be gasketed-bolted type for valvesDN50 and under and gasketed-bolted type for valves larger than DN50. Bonnet shall be OS&Y type, rising stem.

Body and bonnet assembly shall be forged carbon steel. Cast steel shall conform to ASTM A 216/A 216M, Grade WCB. Forged carbon steel shall conform to ASTM A 105/A 105M.

Valves shall have a full port.

Trim for valves larger than DN50 shall include one-piece flexible-wedge disk and hard-surfaced seats. Trim for valves DN50 and under shall include one-piece flexible wedge disk and hardened seats. Hardened components shall have Brinell hardness of not less than 500. Stem shall be rising and backseating type.

Trim materials and hard-surfaced substrates shall conform to ASTM A 182/A 182M, Grade F6.

Hard-surfacing alloy shall conform to AWS A5.13, Class RNiCr-B.

Packing shall be wire reinforced, fiber braid impregnated with 30 percent tetrafluoroethylene.

Valve wheels shall be malleable iron.

Integral bypass globe valves shall be provided around valves larger than DN150. Bypass valves shall be factory installed and shall be butt welded end, conforming to the same requirements as the main valve except that in all cases, valve seat and disk shall be hard-surfaced and seat shall be removable, replaceable type. Piping connections shall be pressure tubing, conforming to Schedule 80 ASTM A 106, Grade B, and without change of direction fittings; i.e., bent. Connection shall be to valve bosses located to perform specified function. Valves with integral bypass shall be shipped bolted to crates in a manner that will preclude damage to bypass assembly.

Integral drain valve assembly shall be factory. Main valve boss shall be factory drilled. Connection to main valve body shall be welded. Drain valve shall be trimmed with manufacturer's standard hardened corrosion-resistant steel. Piping shall be pressure tubing conforming to ASTM A 106, Grade B. Drain discharge shall be capped, and threaded closure assembly shall be made with tetrafluoroethylene tape. All necessary handling and shipping care shall be provided.

2.2.1.3 900 kPa

Valves shall be rated 900 kilopascal (wsp) and shall conform to MSS SP-80 and MSS SP-86 wedge disc, rising stem, inside screw, 900 kilopascal for sizes DN50 and under and to MSS SP-70 for sizes over DN50.

Body end connections shall be flanged for all valves larger than DN50 and shall be screwed in sizes DN50 and under to suit specified piping system end connection and maintenance requirements.

Valves, in sizes DN50 and under, shall be union-bonnet type. Cast iron shall conform to ASTM A 126, Class B.

Stem shall be rising and backseating type.

Packing shall be fiber braid impregnated with 30 percent tetrafluoroethylene.

Valve wheels shall be malleable iron.

For condensate service, screwed-end gate valves shall be 1100 kilopascal, wsp-rated, forged steel, conforming to ASME B16.34, except that trim shall be manufacturer's standard corrosion-resistant steel.

Integral bypass globe valves shall be provided around valves larger than DN150. Main valve body taps shall be factory installed. Bypass valves shall be globe type, factory installed, and shall be socket welded end conforming to ASME B16.34, except that in all cases, valve seat and plug disk shall be hard-surfaced and seats shall be removable replaceable type. Piping connections shall be pressure tubing, conforming to Schedule 80 ASTM A 106, Grade B, and without change of direction fittings; i.e., bent, and shall include a socket welded end 20700 kilopascal, forged steel union with corrosion-resistant steel insert. Connection shall be to valve bosses located to perform specified function. Valves with integral bypass shall be shipped bolted to crates in a manner that will preclude damage to bypass assembly.

Integral drain valves shall be provided. Main valve boss penetration shall be factory finished, and drain assembly shall be factory installed. Drain valve shall be gate type. Piping shall be pressure tubing conforming to ASTM A 106, Grade B. Drain discharge shall be plugged, and threaded closure assembly shall be made with tetrafluoroethylene tape.

2.2.2 Globe and Angle Valves

2.2.2.1 2500 kPa

Valves shall be rated 2100 kilopascal (wsp) and shall conform to ASME B16.34.

Body end connections shall be flanged for all valves larger than DN50, unless butt weld ends are specified. Screwed weld shall be used for sizes DN50 and under to suit specified piping system end connection and maintenance requirements. Flange faces shall have concentric serrated finish.

Body to bonnet connection shall be gasketed-bolted type for valves DN50 and under; gasketed-bolted type for valves larger than DN50; and for valves DN10 and under, assembly shall be screwed type. Bonnet shall be OS&Y type, except that valves DN10 and under shall be inside screw type.

Body and bonnet assembly shall be cast steel. Cast steel shall conform to ASTM A 216/A 216M, Grade WCB.

Trim shall include hard-surfaced plug disk and hard-surfaced seats. Stem shall be rising and backseating type.

Trim materials and hard surface substrates shall conform to ASTM A 182/A 182M, Grade F6.

Hard-surfacing alloy shall conform to AWS A5.13, Class RNiCr-B.

Packing shall be wire reinforced, fiber braid impregnated with 30 percent tetrafluoroethylene.

Valve wheels shall be malleable iron.

Integral drain valves shall be provided. Main valve boss penetration shall be factory finished and drain assembly shall be factory installed. Connection to main valve body shall be welded. Drain valve shall be trimmed with manufacturer's standard hardened corrosion-resistant steel. Piping shall be pressure tubing, conforming to ASTM A 106, Grade B. Drain discharge shall be plugged, and threaded closure assembly shall be made with tetrafluoroethylene tape.

2.2.2.2 1100 kPa

Valves shall be rated 1100 kilopascal working steam pressure (wsp) and shall conform to ASME B16.34.

Body end connections shall be flanged for all valves larger than DN50, unless butt weld ends are indicated. Screwed weld shall be used for sizes DN50 and under to suit specified piping system end connection and maintenance requirements. Flange faces shall have concentric serrated finish.

Body to bonnet connection shall be gasketed-bolted type for valves DN50 and under; gasketed-bolted type for valves larger than DN50; and for valves DN10 and under, assembly shall be screwed type. Bonnet shall be OS&Y type, except that valves DN10 and under shall be inside screw type.

Body and bonnet assembly shall be cast steel. Cast steel shall conform to ASTM A 216/A 216M, Grade WCB.

Trim for valves larger than DN50 and for all sizes of valves in bypass service shall include hard-surfaced, solid plug disk and hard-surfaced seats. Plug material in valves DN50 and under shall be as specified for valves larger than DN50. Stem shall be rising and backseating type.

Trim materials and hard surface substrates shall conform to ASTM A 182/A 182M, Grade F6.

Hard-surfacing alloy shall conform to AWS A5.13, Class RNiCr-B.

Packing shall be wire reinforced, fiber braid impregnated with 30 percent

tetrafluoroethylene.

Valve wheels shall be cast iron.

Integral, drain-valves assembly shall be factory installed. Main valve boss shall be factory drilled. Connection to main valve body shall be welded. Drain valve shall be trimmed with manufacturer's standard hardened corrosion-resistant steel. Piping shall be pressure tubing conforming to ASTM A 106, Grade B. Drain discharge shall be plugged. Threaded closure assembly shall be made with tetrafluoroethylene tape.

2.2.2.3 900 kPa

Valves shall be rated 900 kilopascal (wsp) and shall conform to MSS SP-80, MSS SP-86.0

Body end connections shall be flanged for all valves larger than DN50 and shall be screwed for sizes DN50and under.

Valves DN50 and under in size shall be union bonnet type.

Cast iron shall conform to ASTM A 126, Class B.

Stem shall be rising and backseating type.

Composition seating surface disc construction may be substituted for metal plug disc connection.

Pressure regulating station bypass valves shall be 1100 kilopascal.

Packing shall be fiber braid impregnated with 30 percent tetrafluoroethylene.

Valve wheels shall be cast iron.

Integral drain valves shall be provided. Main valve boss penetration shall be factory finished and drain assembly shall be factory installed. Drain valve shall be gate type. Piping shall be pressure tubing conforming to ASTM A 106, Grade B. Drain discharge shall be capped, and threaded closure assembly shall be made with tetrafluoroethylene tape. All necessary handling and shipping care shall be provided.

2.2.2.4 Type A Rated 41400 kPa WOG

Valves shall be Y-body globe type rated 17300 kilopascal wsp and 41400 kilopascal wog with seal-guided disc, hard-surfaced integral hard-surfaced body backseating, loose backseat, swing-eye gland bolts, and malleable-iron, impact-type, valve wheels and handles.

Body and bonnet assembly shall be forged corrosion-resistant steel conforming to ASTM A 182/A 182M, Grade F 316.

Trim shall conform to ASTM A 182/A 182M, Grade F 316.

Bronze stem bushing shall conform to ASTM B 148, C95300, heat treated or as approved.

Valves shall have a full port.

Valve body shall have butt weld ends except that valves DN40 iron pipe size (ips) and smaller shall be socket weld end type.

2.2.2.5 Type B Rated 41400 kPa WOG

Valves shall be Y-body type, piston check, rated 17300 kilopascal wsp and 41400 kilopascal wog; seal welded, hard-surfaced, spring-loaded, body guided disk; and hard-surfaced integral.

Body and bonnet assembly shall be forged corrosion-resistant steel conforming to ASTM A 182/A 182M, Grade F 316.

Trim shall conform to ASTM A 182/A 182M, Grade F 316.

Spring shall be corrosion-resistant steel.

Valve body shall have butt weld ends, except that valves DN40 ips and smaller shall be socket-weld end type.

2.2.2.6 Type A 13800 kPa WOG

Valves shall be globe type rated 4200 kilopascal wsp and 13800 kilopascal wog, with union, pressure sealed bonnet OS&Y, hard-surfaced, loose disc, hard surfaced seat, minimum 375 Brinell backseating, loose backseat where required for access, and a malleable iron hand wheel. Body and bonnet assembly shall be forged corrosion-resistant steel conforming to ASTM A 182/A 182M, Grade F 316.

Trim shall conform to ASTM A 182/A 182M, Grade F 316.

Valve body shall have butt weld ends, except that valves DN40 ips and smaller may be socket-weld end type.

2.2.3 Check Valves

2.2.3.1 2500 kPa

Valves shall be rated 2100 kilopascal wsp and shall conform to applicable portions of ASME B16.34.

Valves shall be horizontal swing-check type.

Body end connections shall be flanged for all valves larger than DN50 unless butt weld ends are specified. Screwed weld shall be used for sizes DN50 and under to suit specified piping system end connection and maintenance requirements. Flange faces shall have concentric serrated finish.

Body to cover connection shall be union type.

Body and bonnet assembly shall be cast steel. Cast steel shall conform to ASTM A 216/A 216M, Grade WCB.

Trim materials, including hinge pin, shall be manufacturer's standard corrosion-resistant alloys for the specified service.

2.2.3.2 900 kPa

Valves shall be rated 900 kilopascal wsp and standard horizontal swing type shall conform to MSS SP-80, MSS SP-86,swing check, 900 kilopascal.

Body end connections shall be flanged for all valves larger than and screwed in sizes DN50 and under.

Body to cover connection in sizes larger than DN50shall be gasketed-bolted type, and valve body shall be cast iron, conforming to ASTM A 126, Class B Class 1 Class 1, at 178 degrees C; 1379 kilopascal water, oil and gas (wog), nonshock valves conforming to MSS SP-70. Flanges shall conform to ASME B16.1.

Swing-check pin shall be corrosion-resistant brass. Swing check angle of closure shall be manufacturer's standard, unless a specific angle is indicated.

Valve disk shall be regrindable metal type.

2.2.4 Eccentric Plug Valves (EPV)

Eccentric plug valves in sizes DN50 and smaller shall be constructed of manufacturer's standard bronze materials conforming to ASTM B 61 or ASTM B 62. Valves shall be rated for service at 1207 kilopascal maximum nonshock pressure at 121 degrees C. Valve body shall have screwed ends. Eccentric plug surfaces in contact with flow shall be coated with a 60 to 70 Shore A durometer hardness elastomer, resistant to treated water. Valves used for combination shutoff and balancing service shall be fitted with a memory device or mechanism which shall permit a valve set at a balance point to be operated to the closed position.

2.2.5 Ball Valves (BAV)

Ball valves shall conform to FS WW-V-35. Valves shall be Style 3 (removal required for inspection and repair).

Valves shall be rated for service at not less than 1207 kilopascal at 93 degrees C.

Valve bodies in sizes DN50 and smaller shall be screwed-end-connection type, constructed of Class A copper alloy.

Valve bodies in sizes DN50 and larger shall be flanged-end connection type, constructed of Class D material.

Balls and stems of valves DN50 and smaller shall be manufacturer's standard

Class A copper alloy with 900 Brinell hard-chrome plate finish. Electroless nickel plating is acceptable.

Balls and stems of valves DN65 and larger shall be manufacturer's standard Class C, corrosion-resistant steel alloy with hard-chrome plate. In valves DN150 and larger, balls shall be Class D with 900 Brinell hard-chrome plate. Electroless nickel-plating is acceptable.

Valves shall be suitable for flow from either direction and shall seal equally tight in either direction.

Valves shall have full-pipe-size flow areas.

Valves with ball seals kept in place by spring washers are not acceptable. Valves shall have adjustable packing glands. Seats and seals shall be tetrafluoroethylene.

Valve body construction shall be such that:

Torque from a pipe with a valve installed shall not tend to disassemble the valve by stripping setscrews or loosening body-end inserts or coupling nuts.

2.2.6 Butterfly Valves (BUV)

2.2.6.1 Metal

Butterfly valves shall conform to MSS SP-67.

Butterfly valves shall be wafer type for mounting between specified flanges and shall be rated for 1100 kilopascal shutoff and nonshock working pressure. Body shall be cast-ferrous metal, conforming to requirements of ASTM A 126, Class B, and to ASME B16.1 for body wall thickness.

Face-to-face dimensions shall conform to MSS SP-67.

Valves installed in insulated piping systems shall be provided with extended bonnets placing the operator beyond the specified insulation.

Disk shall be free of external ribs and shall be streamlined. Disk shall be fabricated from nonferrous alloys conforming to ASTM B 148; bronze.

Use of taper pins to secure the valve disc to the shaft is prohibited.

Shafts shall be fabricated from 17-4 PH corrosion-resistant steel conforming to ASTM B 164, and shall be one-piece type. Stub shafts shall extend into the disk hub at least 1-1/2 shaft diameters except for angle disk construction. Connection between the valve shaft and disk shall be designed to transmit shaft torque equivalent to not less than 75 percent of the torsional strength of the minimum required shaft diameter. Minimum shaft diameter for all valves shall be in accordance with the following:

DN-VALVE SIZE (MILLIMETER	SHAFT DIAMETER (MILLIMETER	DN-VALVE SIZE (MILLIMETER	SHAFT DIAMETER (MILLIMETER)
65	11	250	28
80	15	300	32

Seats and seals shall be resilient-elastomer type designed for field removal and replacement. Elastomers shall be Buna-N, formulated for continuous immersion service at 121 degrees C, minimum, and shall be applied at least 10 percent below maximum continuous service temperature. Bonding adhesives shall comply with elastomer temperature requirements and shall have an effective life equal to or greater than the elastomer.

Seals on DN500 and smaller valves shall be designed to use standard split-V packing, dual O-rings, and quad rings.

Seats may be installed in the valve body except that circular cross section O-ring construction is not acceptable.

Seat or disk matting surfaces shall be corrosion-resistant material such as austenitic gray cast iron and bronzes specified for the disk or the materials specified for stems. These materials shall be welded to substrate and ground. Plated or similarly applied surfacing materials are not acceptable.

Bearings shall be permanently lubricated sleeve type of manufacturer's standard corrosion-resistant nylon. Bearings shall be designed for a pressure not exceeding the published design load for the bearing material Operating end of the shaft shall be provided with dual inboard bearings in or beyond the operator.

Padlocking feature shall be provided to make valve tamperproof.

For balancing service, valve operators shall have provision for infinite position locking.

PART 3 EXECUTION

3.1 INSTALLATION

Valves shall be installed in accordance with the manufacturer's recommendations and in accordance with the applicable requirements of Section 15050, "Basic Mechanical Materials and Methods."

-- End of Section --

SECTION 15119

SELF-CONTAINED CONTROL AND RELIEF VALVES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 463/A 463M	(1994) Standard Specification for Steel Sheet, Cold-Rolled, Aluminum-Coated, Type 1 and Type 2
ASTM A 48	(1994; Rev A) Standard Specification for Gray Iron Castings
ASTM B 61	(1993) Standard Specification for Steam or Valve Bronze Castings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME-13	(1995) Boiler and Pressure Vessel Code; Section IV, Rules for Construction of Heating Boilers

INTERNATIONAL STANDARDS ORGANIZATION (ISO)

ISO 4126	(1981) Safety Valves - General Requirements
ISO 5209	(1977) General Purpose Industrial Valves - Marking
ISO 5752	(1982) Metal Valves for Use in Flanged Pipe Systems - Face to Face and Center to Center Dimensions
ISO 7005-2	(1988) Metallic Flanges Part 2: Cast Iron Flanges

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-86	(1987; R 1992) Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following shall e submitted for self-contained control and relief valves in accordance with paragraph entitled, "General Requirements," of this section.

Fabrication Drawings

The following shall e submitted for self-contained control and relief valves in accordance with paragraph entitled, "Installation," of this section.

Installation Drawings

SD-07 Certificates

Listing of Product Installation shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Self-Contained Temperature Control Valves
Self-Contained Temperature-Regulator Valves
Rate-of-Flow Controller
Nonmodulating Float Valve
Water Pressure Regulating Valve
Water Pressure Relief Valve
Pilot-Operated Pressure-Relief Valve
Relief Valves for Electric Water Heaters

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Fabrication Drawings shall be submitted for self-contained control and relief valves, including part numbers and exploded views.

Listing of Product Installation shall be submitted for self-contained control and relief valves, identifying a minimum of five installed units, similar to those proposed for use, that have been in successful service for a minimum period of five years.

PART 2 PRODUCTS

2.1 SELF-CONTAINED TEMPERATURE CONTROL VALVES

Self-contained temperature-control valves shall conform to MSS SP-86 and to the following requirements.

Control valves shall be Type I, Class II (integral temperature-sensing units for very hot water).

Control valves shall be Type II, Class 2, Style A (remote temperature-sensing units for very hot water with a single temperature-sensing control element).

Set-point adjustment shall be mounted on the cabinet of the convector; the control knob shall be accessible on the cabinet surface.

Set-point adjustment and thermostat for finned-tube radiation shall be wall-mounted. Thermostat surfaces shall be nickel-plated brass.

Capillary tubing shall be installed and shall be armored. Remote element shall be not less than 450 millimeter long and contained within a guard.

Valve disks shall be renewable.

2.2 SELF-CONTAINED TEMPERATURE-REGULATOR VALVES

Valve shall be direct-operated, self-contained type. The valve body shall be ASTM B 61, (bronze) and rated not less than 862 kilopascal saturated working steam-pressure. Body end connections shall be screwed. Trim shall be corrosion-resistant AISI Type 300 Series steel. Replaceable seat and plug shall be hardened or faced with a cobalt-chromium-tungsten alloy to produce a surface with resistance to impact, wire-drawing, and with a Brinell hardness of not less than 450. Packed steam valves shall be fitted with tetrafluoroethylene packing and shall be spring-loaded and self-adjusting. Valve shall be single-seated, suitable for dead-end service, and shall be fail-safe. Remote Class I or Class III filled-bulb element shall be mounted in a nonferrous separable socket. Valve shall maintain set-point temperature, plus or minus 15 degrees C, with the set point at or near midpoint of the adjustable element range.

2.3 RATE-OF-FLOW CONTROLLER

Rate-of-flow controller shall be a hydraulically operated, pilot-controlled diaphragm-type globe valve. Pilot control shall be actuated by differential pressure produced across an orifice installed at the inlet. Rate of flow shall be adjusted by varying spring loading on the pilot. Valve body shall be cast iron conforming to ASTM A 48, with 862 kilopascal ASME B16.1, MSS SP-86 and ISO 7005-2 flanges. Valve trim shall be manufacturer's standard bronze or AISI 18-8 corrosion-resistant steel. Orifice plate shall be AISI Type 303 corrosion-resistant steel. Diaphragm and seal material shall be Buna-N. Maximum-service-pressure rating shall be not less than 1207 kilopascal at 82 degrees C.

2.4 NONMODULATING FLOAT VALVE

Nonmodulating float valve shall be pilot-controlled, diaphragm-actuated, spring-loaded, single-seated, hydraulically operated type. Pilot valve shall be mounted on the main valve or remotely mounted within the cooling tower basin. Main valve body shall be cast iron conforming to ASTM A 48 with screwed ends for sizes smaller than DN50 iron pipe size (ips) and flanges conforming to ASME B16.1, MSS SP-86 and ISO 7005-2, for sizes DN50 ips and larger. Pilot valve body shall be brass or bronze. Main and pilot valve trim, including linkage and float, shall be the manufacturer's standard bronze-copper or AISI Type 300 series corrosion-resistant steel. Diaphragm materials and seals shall be Buna-N. Maximum-service-pressure rating shall be not less than 1207 kilopascal at 82 degrees C. Valve operation shall be nonslam.

2.5 WATER PRESSURE-REGULATING VALVE

Pressure-regulating valve shall conform to MSS SP-86 and ISO 5752(ASSE 1003), direct acting.

Pressure-regulating valve shall not stick or allow pressure to build up on the low side. Valve shall be set to maintain a terminal pressure of approximately 35 kilopascal in excess of the static head on the system and shall operate within a 9 Newtons maximum variation regardless of initial pressure fluctuation, and without objectionable noise under any condition of operation.

2.6 WATER PRESSURE-RELIEF VALVE

Pressure-relief valve shall be constructed, labeled, and installed in accordance with ASME-13 ISO 5209 and ISO 4126. Relieving capacity shall be as specified by the referenced publication. Valves shall be of nonferrous construction, complete with test lever.

2.7 PILOT-OPERATED PRESSURE-RELIEF VALVE

Pilot-operated pressure-relief valve shall be hydraulically operated, pilot-controlled modulating, with adjustable set point over the indicated range. Valve body shall be cast iron conforming to ASTM A 48, with 862 kilopascal ASME B16.1, MSS SP-86 and ISO 7005-2 flanges. Valve trim shall be manufacturer's standard brass, bronze, or corrosion-resistant steel. Pilot control shall have AISI Type 303 or 304 corrosion-resistant steel trim. Diaphragm and seal material shall be Buna-N. Maximum service-pressure rating shall be not less than 1207 kilopascal at 82 degrees C.

2.8 RELIEF VALVES FOR ELECTRIC WATER HEATERS

Temperature- and pressure-relief valves shall conform to ASTM A 463/A 463M. Type I (combination pressure- and temperature-relief) valves shall be installed when the heat input is less than 30 kilowatts per hour and when the storage is less than 450 liter. If either or both of the specified conditions will be reached or exceeded, Type II (temperature relief, water rated) or Type III (temperature relief, steam rated) valves shall be installed. Vacuum-relief valves shall be installed on each cold-water branch connection to electric water heaters at an elevation above the top

of the heater. Vacuum relief shall be designed to prevent water heater damage from a reverse flow vacuum.

PART 3 EXECUTION

3.1 INSTALLATION

Installation Drawings shall be submitted for self-contained control and relief valves, and valves shall be installed and specified in accordance with the manufacturer's recommendations, and Section 15050, "Basic Mechanical Materials and Methods."

-- End of Section --

SECTION 15120

PIPING SPECIALTIES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.1.2	(1991) Air Gaps in Plumbing Systems

AMERICAN WATERWORKS ASSOCIATION (AWWA)

AWWA C510	(1992) Double Check Valve Backflow-Prevention Assembly (Second Edition)
AWWA C511	(1992) Reduced Pressure Principle Backflow-Prevention Assembly (First Edition)

PLUMBING AND DRAINAGE INSTITUTE (PDI)

PDI WH 201	(1983) Water Hammer Arrestors Standard

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Backflow Prevention Devices
Water-Hammer Arresters
Wall Hydrants

SD-02 Shop Drawings

Installation drawings shall be submitted for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Plumbing Specialties
Equipment

Detail Drawings shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Backflow Prevention Devices
Water-Hammer Arresters
Wall Hydrants

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Detail Drawings shall be submitted for piping specialties consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents.

Installation drawings shall be submitted for Plumbing Specialties and Equipment in accordance with the manufacturer's recommended instructions and methods.

PART 2 PRODUCTS

2.1 BACKFLOW PREVENTION DEVICES (VACUUM BREAKERS)

Backflow prevention devices, including airgaps, shall conform to the requirements of ASME A112.1.2, AWWA C510 and AWWA C511.

Airgaps conforming to ASME A112.1.2 shall be constructed of metal, ferrous or nonferrous.

Devices DN50 iron pipe size (ips) and smaller with moving components, including devices defined in AWWA C510 and AWWA C511, shall be constructed of nonferrous metals; nonmetal components of such devices shall be rated for the application service temperature.

Bodies for devices DN65 and larger shall be corrosion-resistant ferrous material or bronze, with flanged connections. Metallic operating components and trim shall be nonferrous. Nonmetallic parts shall be rated for the application service temperature.

External surfaces of devices used in conjunction with equipment with polished or chrome-plated surfaces shall be similarly finished.

External surfaces of devices may be rough castings where these devices are used outside of the building or in equipment rooms.

Devices shall be protected from freezing and shall be installed and used in strict conformance with the manufacturer's instructions.

Devices mounted outside of the building shall be vandalproof.

2.1.1 Type BAG

Type BAG backflow prevention device shall be an airgap casting of ferrous or nonferrous metal.

2.1.2 Type BAT

Type BAT backflow prevention device shall be an atmospheric type for nonpressurized service. Operating device, when installed where very low flow may occur, shall be sufficiently sensitive to preclude spillage and slow leakage of water into surrounding area. BAT device shall be used only where no backpressure may occur.

2.1.3 Type BPT

Type BPT backflow prevention device shall be a pressure type suitable for permanent duty under pressure but without possibility of exposure to backpressure. Operating device shall be spring-loaded. Unit shall consist of shutoffs upstream and downstream of vacuum breaker, one or two check valves, vacuum breaker, and test cocks.

2.1.4 Type BDC

Type BDC backflow prevention device shall be a double check-valve pressure unit with shutoffs upstream and downstream of the check valves, and test cocks in the upstream side of the upstream shutoff and on each side of the check-valve internal closing device. Check-valve loading, swing or lift, shall be such that the valve will remain closed against 7 kilopascal differential pressure with the higher pressure on the inlet side of the check valve. Lift type shall be very soft elastomer.

2.1.5 Type BRP

Type BRP reduced-pressure backflow prevention device shall be a standard commercial unit or shall be fabricated from stock parts. A prototype of the device shall be submitted to, and approved by, a test and checkout laboratory. Before acceptance for installation, shop drawings and a certificate of performance test of the operational characteristics shall be submitted to the Contracting Officer. Device shall consist of two or more tight-closing check valves, two shutoff valves, reduced-pressure regulating device, and the necessary appurtenances for testing.

2.2 WATER-HAMMER ARRESTERS

Water-hammer arresters shall be commercially manufactured products consisting of bellows arranged to absorb the energy of pressure waves generated by valve closure in a line in which water is flowing. Arresters shall be nonferrous construction, shall be rated as to capacity, and shall be certified in accordance with PDI WH 201.

2.3 WALL HYDRANTS

Wall hydrants shall have brass wall-boxes with nozzles and detachable T-handles and shall be provided with vandalproof type BAT vacuum breakers. Exterior surfaces shall be chrome-plated.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated and specified in accordance with manufacturer's recommendations.

3.2 WATER-HAMMER ARRESTERS

Water-hammer arresters shall be installed in accordance with the manufacturer's printed instructions and PDI WH 201.

-- End of Section --

SECTION 15135

CENTRIFUGAL PUMPS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA 11	(1990) Load Ratings and Fatigue Life for Roller Bearings
AFBMA 9	(1990) Load Ratings and Fatigue Life for Ball Bearings

INTERNATIONAL STANDARDS ORGANIZATION (ISO)

ISO 2858	(1975) End Suction Centrifugal Pump (Rating 16 Bar) Designation Nominal Duty Point and Dimensions
ISO 5199	(1986) Technical Specifications for Centrifugal Pumps, Class II
ISO 7005-2	(1988) Metallic Flanges Part 2: Cast Iron Flanges

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP 51	(1991; R 1995) Class 150 LW Corrosion Resistant Cast Flanges and Flanged Fittings
MSS SP-86	(1987; R 1992) Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators

1.2 DESIGN REQUIREMENTS

Pumps shall be designed using hydraulic criteria based upon actual model developmental test data. Manufacturer shall certify that pumps have been hydraulically tested at the factory.

Pumps shall be selected at a point within the maximum efficiency for a given impeller casing combination. Deviations within 3 percent of maximum efficiency are permissible, provided the lesser efficiency is not less than the scheduled efficiency.

Pumps having impeller diameters larger than 90 percent of the published maximum diameter of the casing or less than 15 percent larger than the published minimum diameter of the casing will be rejected.

Acceptable maximum impeller diameter calculations shall not be based on percentage of impeller diameter range for a given casing. Shop drawings will be approved only if complete performance curves for all impeller sizes for a given casing are included in the submittal.

Pumps shall be suitable for operation at indicated temperature without vapor binding and without cavitation under any system operating condition. The only acceptable means of rectification of cavitation shall be replacement of entire pump assembly.

Available Net Positive Suction Head (NPSH) shall exceed required NPSH by not less than 0.46 meter.

Pumps of the same duty condition, classification, and accessories, or with specified accessory deviation, shall be identical and the product of one manufacturing source.

Pumps from more than one manufacturing source shall be provided only when a single manufacturing source is unable to meet all specification requirements.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation drawings for centrifugal pumps shall be submitted in accordance with Part 3, "Execution," of this section.

SD-03 Product Data

The following shall be submitted for centrifugal pumps in accordance with pargraph entitled, "General Requirements," of this section.

Equipment and Performance Data
Equipment Foundation Data

SD-05 Design Data

Design Analysis and Calculations shall be submitted for centrifugal pumps in accordance with pargraph entitled, "General

Requirements," of this section.

SD-06 Test Reports

Test reports for pumps shall be submitted on the following tests:

Hydraulic Tests
Efficiency Tests
Vibration
Output Efficiency
Surface Hardness Tests
Deflection Tests

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Base-Mounted Centrifugal Pumps
Line-Mounted Pumps
Accessories

1.4 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Section 15072, "Vibration Isolation for Air Conditioning Equipment," applies to work specified in this section.

Design Analysis and Calculations shall show NPSH (net positive suction head) calculations for centrifugal pumps.

Equipment and Performance Data consisting of pump curves (liter per minute versus total head in millimeter per rpm) shall be provided for each type centrifugal pump.

Equipment Foundation Data shall be submitted for centrifugal pumps.

PART 2 PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS

Certificates for pumps and Accessories shall show conformance with the referenced standards contained in this section.

This specification includes design, construction, installation, and performance features of centrifugal water pumps. Pumps provided shall conform to ISO 5199 and ISO 2858 standards for centrifugal pumps, and to requirements specified herein.

2.1.1 Classification

Class ADS: Axially (horizontally) split-case, single-stage, double-suction, single- or double-volute centrifugal type

Class FES: Radially (vertically) split-case, single-stage, frame-mounted distance piece or back pullout end suction, single- or double-volute centrifugal type

Class CES: Radially (vertically) split-case, single-stage, close-coupled, distance piece end-suction, single- or double-volute centrifugal type

2.1.2 Casing

Pump casings shall be bronze-fitted, seasoned cast iron with a design working pressure of not less than 1275 kilopascal at 38 degrees C. Casings shall be single or double volute with flanged piping connections conforming to ASME B16.1, MSS SP 51, MSS SP-86 and ISO 7005-2, Class 125 psi. Direction of shaft rotation shall be conspicuously indicated. Casing shall have tapped openings for air venting, priming, draining, and suction and discharge gages. A brass or bronze umbrella or vent cock shall be furnished for venting except where automatic air vents are indicated. Drain openings in the volute, intake, or other passages capable of retaining trapped water shall be located in the low point of such passages.

Casing construction shall be such that packing seals may be substituted in the field for mechanical seals without machining.

Packing-box depth shall accommodate six rings of square packing, lantern ring, and throttling bushing.

2.1.3 Distance Piece

A suction end distance piece shall be provided with each end suction pump as a part of the pump or piping system.

2.1.4 Impellers

Impellers shall be enclosed cast bronze or corrosion-resistant steel, machined and polished. Waterways shall be machine- or hand-finished. Impellers shall meet maximum and minimum diameter requirements.

2.1.5 Balancing

Pump impeller assemblies shall be statically and dynamically balanced to within 1/2 percent of W times R squared, where W equals load of the impeller and R equals impeller radius. Correction planes needed for additional mass for balancing shall be determined by using a calibrated and certified balancing machine capable of identifying the magnitude and angular position of any unbalance of the impeller.

Rotating elements shall be statically balanced as a minimum and, where necessary to conform to the requirements of these specifications, shall be dynamically balanced.

Rotating elements shall be dynamically balanced, where indicated.

2.1.6 Wearing Rings

Wearing rings shall be dissimilar bronze composition for nongalling service. Wearing rings shall be provided in every pump case and on all impellers larger than 175 millimeter in diameter.

2.1.7 Shaft

Shafts for convertible packed or mechanical seal service shall be solid sleeveless AISI 400 series corrosion-resistant steel hardened to 425 Brinell in packing area, or sleeved type with AISI 300 series corrosion-resistant steel shaft and AISI 400 series corrosion-resistant steel sleeves hardened to 425 Brinell.

Shafts for packed seal service shall be sleeved and all materials shall be AISI Type 304 corrosion-resistant steel. Surfaces in packing area shall be plasma-spray-coated alumina ceramic with a coefficient of expansion compatible with the substrate. Surface hardness shall be 900 Brinell.

Shafts for mechanical-seal service shall be solid or sleeved and all materials shall be AISI Type 304 or 316 corrosion-resistant steel.

Press-fitted sleeves are not acceptable.

Motor shafts of close-coupled pumps shall be manufacturer's standard AISI 18-8 corrosion-resistant steel and finish.

Surfaces shall have a 406 nanometer surface finish where packing is specified or where a pump must be convertible to packing seals from mechanical seals. Pump shafts to be sealed by mechanical seals only shall have a 815 nanometer surface finish, or better.

End-suction pump shafts shall have an impeller nut that completely encloses shaft end threads and seals tight to the impeller.

Shaft construction shall be substantial to prevent seal or bearing failure due to vibration. Total shaft peak-to-peak dynamic deflection measured by vibrometer at pump-seal face shall not exceed 0.05 millimeter under shutoff-head operating conditions. Flow from DN6 iron pipe size (ips) pipe shall be provided during testing.

Shaft shall be equipped with bronze or nylon water slingers at each bearing and shall be sealed at the casing interface with a bronze throttling bushing.

2.1.8 Packing Seals

Packing shall be soft woven non-asbestos material with not less than 25 percent by weight of tetrafluoroethylene resin. Pump shall be shipped to the site without the packing inserted and shall be packed on site in the presence of the pump or packing manufacturer's representative. At no time during startup or run-in shall the gland drip less water than 80 drops per minute. After a minimum of 40 operating hours and upon permission of the

Contracting Officer, leakage rate may be reduced to 50 drops per minute or to the rate recommended by packing manufacturer.

Gland shall be split-bronze type with AISI 18-8 corrosion-resistant steel eyebolts and pins or studs. Hex-nuts shall be bronze or nongalling corrosion-resistant steel.

Stuffing boxes exposed to below atmospheric pressure at any operating condition, including starting, shall be provided with a water seal. Water seal shall consist of nonferrous lantern ring or a seal cage and required connections to the pump case.

2.1.9 Mechanical Seals

Mechanical seals shall be balanced or unbalanced, as necessary to conform to specified service requirements. Mechanical seals shall be constructed in a manner and of materials particularly suitable for the temperature service range and chemical analysis of water being pumped.

Cooling-water characteristics for seal construction purposes are as follows: makeup total dissolved solids of 200 parts per million (ppm) cycled up to five times, containing not more than 600 ppm of hexavalent chromate, and pH not less than 6.0.

Seal construction shall not require external source cooling for pumped-fluid service temperatures up to 121 degrees C.

Seal pressure rating shall be suitable for maximum system hydraulic conditions.

Materials of construction shall include AISI 300 series corrosion-resistant steel, solid tungsten-carbide rotating-seal face, and Buna-N vinylidene-fluoride-hexafluoropropylene, EPT, or tetrafluoroethylene seals.

Bypass flushing water supply shall be free of iron rust products and other abrasive materials and shall be directed onto face of seal without dead ending. All piping and accessories shall be provided.

Throttling bushing shall have clearances to minimize leakage in case of complete seal failure without restriction of flushing water.

Mechanical seals shall not be subjected to hydrostatic test pressures in excess of the manufacturer's recommendations.

Mechanical-seal manufacturer's representative shall direct on-site seal installation, testing, adjustment, and placing-into-service operations and shall instruct facility personnel as scheduled by the Contracting Officer.

2.1.10 Centrifugal Abrasive-Separators

Pump seals shall be flushed with pump discharge water cleansed by centrifugal force in a cyclone abrasive-separator. Separator shall be constructed of AISI Type 316 corrosion-resistant steel. Underflow shall be piped to waste.

2.1.11 Bearings and Lubrication

Bearings shall be heavy-duty ball or roller type with full provisions for the mechanical and hydraulic radial and thrust loads imposed by any normal service condition. Bearings shall be manufactured from vacuum-degassed or processed-alloy steel. Thrust-bearing endplay shall not exceed 0.127 millimeter. Thrust bearings shall be secured to the shaft by threaded collar and locknut. Double-row ball or roller bearings shall be self-aligning. Bearings shall have an L-10 rated life of not less than 30,000 hours or an average life of 150,000 hours in accordance with AFBMA 9 or AFBMA 11. Shop drawings shall bear manufacturer's certification of bearing life.

Bearings shall be heavy-duty ball or roller type with full provisions for the mechanical and hydraulic radial and thrust loads imposed by any normal service condition. Bearings shall be manufactured from vacuum-degassed or processed-alloy steel. Bearings shall have an L-10 rated life of not less than 30,000 hours or an average life of 150,000 hours in accordance with AFBMA 9 or AFBMA 11. Shop drawings shall bear manufacturer's certification of bearing life.

Bearings shall be grease lubricated and shall be provided with grease supply and relief fittings located at bottom of bearings.

Bearing housings shall be cast iron, self-aligning on metal-to-metal surfaces and shall totally enclose bearings.

2.1.12 Flexible Coupling

Pump shaft shall be connected to the motor shaft through a flexible coupling. Flexible member shall be a tire shape in shear, or a solid-mass serrated-edge disk shape made of chloroprene materials and retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration, or end thrust.

All couplings in intermittent on/off service shall have couplings selected on the basis of a 2.0 service factor. Other service factors shall be in accordance with the manufacturer's instructions.

2.1.13 Bedplate

Pump and driver shall be mounted on a common bedplate, hollow cast iron, multiribbed for maximum rigidity, with adequate number of grout holes and grout air vents, and with drip rim and drain tapping.

Contractor shall submit for approval, when specified, a fabricated steel base constructed of a rolled structural-steel perimeter frame, reinforced and cross-braced internally with pipe or rolled structural members, capped with 6 millimeter steel plate, and provided with adequate grout holes, grout air vents, drip rim, and drain tapping. Formed or bent steel bedplates are not acceptable.

2.1.14 Motors

Pump motors shall be checked for current direction of rotation only after pumps have been primed and approved by the manufacturer's representative and the Contracting Officer.

Motors shall be permanently tagged as quiet.

2.1.15 Special Requirements

Plugged or valved casing drains which may require ips red-brass pipe shall be brought out beyond periphery of casing to facilitate drainage. Volute plugs at flanges shall be assembled with tetrafluoroethylene tape.

Pump casing and pump motor shall be mounted on a single pedestal and shall not require a bedplate. Pump casing drain shall be plugged.

Pump casing with threaded inlet and outlet connections shall be furnished.

Pump casing and impeller wear rings shall be furnished.

Pump motor shall be an extended-shaft type with special heavy-duty thrust and radial bearings to accommodate motor and pump thrust loads. Impeller shall be mounted directly on the motor-shaft extension.

Pump seals shall be packed type.

Pump seals shall be packed type or have the manufacturer's standard mechanical seals for the specified service.

2.2 LINE-MOUNTED PUMPS

Pump shall be the capacity indicated.

Design, construction balancing, and vibration-isolation provisions shall conform to ISO 5199 and ISO 2858 standards specifically for quiet waterside operation.

Pump casing and seal shall be suitable for operation at pressures up to 862 kilopascal at temperatures to 121 degrees C.

Pump casing shall be cast iron.

Pump shall be single-stage, single-suction centrifugal-type, bronze, fitted with mechanical seal. Pump shaft shall be AISI 300 series corrosion-resistant steel or the manufacturer's standard alloy steel with nonferrous-metal-protected wetted surfaces. Coupling shall be elastomer-in-shear or four-spring type. Mechanical seal shall be designed for service with makeup water normal to the site and for 300 ppm of hexavalent chromate in the recirculating system. Pump bearings shall be oil-lubricated sleeve type, with oil reservoirs for extended periods of service without requiring added lubricant.

Motor shall have oil-lubricated sleeve bearings with oil reservoirs for extended periods of service, without requiring added lubricant, and shall

be resiliently mounted.

PART 3 EXECUTION

3.1 PUMP PROTECTION

Before any pump is operated, sumps and piping systems shall be cleaned to remove all particles larger than 1,000 micrometer or larger than one-half of the smallest pump axial or radial clearance, whichever is smaller. Permanent and temporary pipeline strainers shall be in place and shall be cleaned frequently to prevent cavitation. Temporary strainers shall not be removed until after system acceptance, unless otherwise approved.

Mechanical-seal flushing water shall be provided with centrifugal separator or 10-micrometer filter element where loose rust may be present at startup.

3.2 VIBROMETER

A calibrated, certified vibrometer shall be provided for pump-vibration checking. Instrument shall be readable to 0.0025 millimeter deflection. Testing shall be performed by an experienced operator. Contractor shall provide a tabulation of readings and points read, together with instrument data. Vibrometer shall remain the property of the Contractor.

3.3 GROUTING

Shimming, alignment, and grouting of pump, driver, and bedplate shall be in accordance with the most stringent requirements of the manufacturer's instructions and as specified herein. After grouting has cured, bedplate shall be hammer-tested for voids. Poor grouting, as evidenced by voids, shall require resetting of pump assembly.

3.4 VIBRATION ISOLATION

Vibration isolation shall conform to the provisions of Section 15072, "Vibration Isolation for Air Conditioning Equipment."

3.5 ALIGNMENT

Pump and driver shall be aligned to manufacturer's maximum permissible tolerances, but in no case shall angularity exceed 0.5 degree nor shall parallel misalignment exceed 0.051 millimeter.

Pump shall be dowelled in place with AISI 18-8 corrosion-resistant steel spiral-wrapped pins before being subjected to pressure or piping reaction. After grouting and final alignment, and no sooner than after 40 hours of continuous operation, the driver shall be similarly dowelled in place. Taper pins are not acceptable.

3.6 PUMP ACCEPTANCE

Test reports for pumps shall be submitted on Hydraulic Tests, Efficiency Tests, Vibration, Output Efficiency, Surface Hardness Tests and Deflection Tests.

Prior to pump final acceptance, dial indicator gages shall be used to demonstrate that pump and motor are aligned as specified and that the pump casing is entirely free of any piping loads.

Prior to final acceptance, pump conformance to specifications shall be demonstrated by checking vibration with specified vibrometer while the pump is operating against shutoff head; i.e., with discharge valve closed.

Pump shall be operated and demonstrated to be nonoverloading at any operating point and that the flow capacity is as specified.

-- End of Section --

SECTION 15195

NATURAL GAS SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 105/A 105M	(1996) Standard Specification for Forgings, Carbon Steel, for Piping Components
ASTM A 181/A 181M	(1995; Rev B) Standard Specification for Forgings, Carbon Steel, for General-Purpose Piping
ASTM A 197M	(1987; R 1992) Standard Specification for Cupola Malleable Iron (Metric)
ASTM A 234/A 234M	(1997) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 278M	(1993) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 345 Degrees C (Metric)
ASTM A 53	(1996) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 666	(1994; Rev A) Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar
ASTM A 694/A 694M	(1995; Rev A) Standard Specification for Forgings, Carbon and Alloy Steel, for Pipe Flanges, Fittings, Valves and Parts for High Pressure Transmission Service
ASTM B 280	(1995; Rev A) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B 62	(1993) Standard Specification for

	Composition Bronze or Ounce Metal Castings
ASTM B 88M	(1995) Standard Specification for Seamless Copper Water Tube (Metric)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.11	(1996) Forged Steel Fittings, Socket-Welding and Threaded
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.1	(1995) Power Piping
ASME B31.8	(1992; Addenda B31.8a-1993) Gas Transmission and Distribution Piping Systems
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element

AMERICAN WELDING SOCIETY (AWS)

AWS-02	(1990) Welding Handbook; Eighth Ed; Vol Two - Welding Process

AMERICAN WATERWORKS ASSOCIATION (AWWA)

AWWA C104	(1990; 1st Ed) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

FEDERAL SPECIFICATIONS (FS)

FS L-C-530	(Rev C) Coating, Pipe, Thermoplastic Resin
FS QQ-B-654	(Rev A; Notice 1) Brazing Alloys, Silver

INTERNATIONAL STANDARDS ORGANIZATION (ISO)

ISO 7005-2	(1988) Metallic Flanges Part 2: Cast Iron Flanges

MILITARY SPECIFICATIONS (MS)

MS MIL-L-25567	(Rev D; Am 1) Leak Detection Compound, Oxygen Systems (Metric)

MS MIL-V-12003 (Rev F; Am 1) Valves, Plug: Cast-Iron or Steel, Manually Operated

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-69 (1996) Pipe Hangers and Supports - Selection and Application

MSS SP-83 (1995) Steel Pipe Unions Socket Welding and Threaded

MSS SP-86 (1987; R 1992) Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54 (1992) National Fuel Gas Code

NFPA 70 (1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 125 (1993) UL Standard for Safety Valves for Anhydrous Ammonia and LP-Gas (Other than Safety Relief)

UL 842 (1993; 7th Ed) UL Standard for Safety Valves for Flammable Fluids

UL 860 (1993) UL Standard for Safety Pipe Unions for Flammable and Combustible Fluids and Fire-Protection Service

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings shall be submitted for in accordance with paragraph entitled, "General Requirements," of this section.

Installation drawings shall be submitted for natural gas systems in accordance with the paragraphs entitled, "Underground Piping Systems Installation" and "Aboveground Piping Systems

Installation," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Piping Materials
Valves
Piping Specialties

SD-06 Test Reports

Test reports shall be submitted for the following tests in accordance with paragraph entitled, "Testing," of this section.

Pneumatic
Leakage
Pressure

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Piping Materials
Valves
Piping Specialties

1.4 GENERAL REQUIREMENTS

Section 15055, "Welding Mechanical," applies to work specified in this section.

Fabrication Drawings shall be submitted for natural gas systems consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents.

PART 2 PRODUCTS

2.1 UNDERGROUND PIPING MATERIALS

2.1.1 Piping Types

Ells and tees shall be of the same type and class of material as the pipe.

Type BCS-PS: Black carbon steel piping with polyethylene sheath shall conform to ASTM A 53, Type S seamless. In sizes through DN50 iron pipe size (ips), pipe shall have Schedule 40 wall.

Thermoplastic sheath shall conform to FS L-C-530. Sheath joints shall be made with thermally fitted shrinking sleeves applied with factory-approved

shrinking devices. Taped fitting protection and repairs shall be made in accordance with manufacturer's instructions. Electrical flaw detection testing at the factory shall require 10,000 volts to be impressed across the sheath. Sheath breakdown voltage shall be not less than 13,000 volts.

Fittings shall be long-radius butt weld carbon steel conforming to ISO 7005-2, MSS SP-86, ASTM A 234/A 234M and ASME B16.1 to match pipe wall thickness. Bending of pipe is not permitted. Aboveground terminal fittings shall be 1050 kilopascal working steam pressure (wsp) forged steel, weld neck flanges to match wall thickness, conforming to ASTM A 694/A 694M, ASME B16.5, and ASTM A 181/A 181M, Class 60.

Polyethylene pipe shall be equal to Dirscopipe 8000 (Phillips Petroleum) rated at 690 kPa (100 psig). #14 copper tracer wire and plastic banner indicating natural gas line shall run above pipe. Transition to steel before emerging from ground.

2.1.2 Natural Gas Shutoff Valve Assemblies

Lubricated plug valves

Valves shall be Type 1, Style A, taper plug type rated for not less than 1200 kilopascal water, oil, or gas (wog) service and shall conform to MSS SP-86 and MS MIL-V-12003.

Valves shall be cylindrical plug type, constructed to service pressure and materials requirements specified for taper plug valves. In addition, clearance between plug and body sealing surfaces shall be 0.0508 millimeter, maximum, for valves to DN50 ips and 0.075 to 0.127 millimeter for larger valves. Plug stem seal and bottom support shall be reinforced tetrafluoroethylene, and plug shall be bottom spring loaded.

Plug shall be restricted port type unless full ports or proportioning ports are specified.

Valves shall be provided with screwed end connections for all sizes DN25 ips and smaller and with flanged connections for all larger valves.

Valves shall have an effective sealing and lubrication system which, when actuated, forces movement of plug within seating surfaces.

Extended lubricant lines with check valves shall be provided for grease gun access at grade. Lubricant shall be identified and sufficient quantity provided to lubricate each valve at least once.

T-handle extension operators adapted to valve stem shall be provided for sizes DN150 ips and smaller.

T-handle extensions and worm and gear operator shall be provided for valves DN200 ips and larger. Operator shall not require input of more than 70 newton-meter of torque, shall be totally enclosed, grease packed, and sealed for 6000 millimeter head submerged service in brackish water. Worm and shaft shall be steel, gear shall be bronze. Worm shaft shall be mounted in bronze sleeve bearings. Operator shall have open and close

stops and plug position indication.

All external surfaces shall be coated with bituminous sealer conforming to AWWA C104.

2.1.3 Valve Boxes

Valve boxes shall be of not less than 5 millimeter thick cast-iron construction with locking cover with an appropriate identification legend. Cover shall require a special wrench for access. Boxes shall be adjustable extension type with screw- or slide-type adjustment. Valves DN75 and under shall be fitted with 108 millimeter diameter shaft. Valves DN100 and larger shall be fitted with 133 millimeter diameter shaft. Bases shall be fitted to the valve. Box full-extended length shall be greater than required by depth of cover by not less than 100 millimeter. One valve-operating wrench shall be supplied for each size of valve wrench nut. Guide rings shall be provided where operating rods are longer than 1800 millimeter. Internal and external surfaces shall be coated with bituminous sealer conforming to AWWA C104.

2.2 ABOVEGROUND PIPING MATERIALS

Type BCS-NG: Black carbon steel

Pipe (DN6 through DN80 and where indicated): Schedule 40 seamless welded black carbon steel, conforming to ASTM A 53, Grade B, Type S

Fittings (DN25 and under): Class 150 banded black malleable iron screwed, conforming to ASTM A 197M and ASTM A 234/A 234M

Unions (DN25 and under): Class 250 female, screwed, black malleable iron with brass to iron seat and ground joint, conforming to MSS SP-83 and UL 860

Couplings (DN25 and under): Heavyweight screwed black carbon steel

Fittings (DN32 and over): Steel butt weld, conforming to ASTM A 234/A 234M and ASME B16.9 to match pipe wall thickness, or steel socket weld, conforming to ASTM A 105/A 105M and ASME B16.11 rated at 14 Megapascal wog

Flanges (DN32 and over): Class 150 forged steel socket or welding neck to match pipe wall thickness, and conforming to ASME B16.5 and ASTM A 694/A 694M

Type CPR-NG: Copper; natural gas vent and control and instrumentation system tubing; 200 kilopascal and less

Tubing (all sizes with DN8 outside diameter minimum): Hard drawn or annealed seamless copper conforming to ASTM B 280, UNS C12200 conforming to ASTM B 88M.

Fittings (all sizes DN8 and up): Socket joint wrought copper, conforming to ASME B16.11. All fitting cup depths and tolerances shall conform to MSS SP-86.

SAE 45-degree flare type, rod or forged brass conforming to SAE 72, used only in exposed-to-view accessible places

Brazing rod Type 3, conforming to FS QQ-B-654

2.3 PIPING SPECIALTIES

2.3.1 Appliance Connectors

Connectors shall be corrugated bronze metal with brazed inverted flare-type brass fittings complete with transition for ips connection. Maximum length shall be 1800 millimeter. Connectors shall be AGA-approved type.

2.3.2 Natural Gas Pressure-Reducing Station

2.3.2.1 Pressure-Reducing Station

Pressure-reducing station shall be installed complete with a three-valve bypass-valved pressure indicator upstream of station, and valved pressure indicator downstream of station. Bypass valve shall have a proportioning port opening and shall be fitted with a locking device. All system components shall be of the size, capacity, and pressure-reduction capability indicated.

2.3.2.2 Pressure Regulator and Accessories

Pressure regulator shall be service-type, complete with automatic low-pressure cutoff and automatic pressure relief. Shop drawing shall be submitted and shall include performance curves.

Body shall be cast iron. Valve shall be capable of shutting off under supply pressures to 700 kilopascal. Valve spring range shall be 125 to 215 millimeter water gage (wg), and set point shall be 180 millimeter. Outlet pressure shall vary by not more than 13 millimeter wg from the set point over the capacity range of the regulator.

Pressure relief shall be diaphragm-operated, spring-loaded type with vent for relief of excess pressure. Release set point shall be 305 millimeter wg.

Low-pressure cutoff regulator shall be adjustable to shut off gas supply entirely if pressure drops below set point. Supply shall remain shut off until manual reset of regulator takes place.

Pressure regulator diaphragm vent and pressure relief vent shall be run as separate, jointless, full size vent lines connected to the vent tapping and terminating at an approved outside location with weatherproof, bugproof, screened vent cap.

2.3.3 Pressure Gages

Pressure gages shall conform to ASME B40.1, Type I, Class 1. Pressure-gage size shall be 90 millimeter nominal diameter. Case shall be corrosion-resistant steel conforming to any of the AISI 300 series of ASTM

A 666, with a No. 4 standard commercial polish or better. All gages shall be equipped with adjustable red marking pointer and damper screw adjustment in inlet connection.

2.3.4 Line Strainers

Strainers shall be Y-type with removable basket. Strainers in sizes DN50 ips and smaller shall have screwed ends; sizes DN65 ips and larger shall have flanged ends. Body working pressure rating shall exceed maximum service pressure of system in which installed by at least 50 percent. Body shall have cast-in arrows to indicate direction of flow. All strainer bodies fitted with screwed screen retainer shall have straight threads and shall be gasketed with nonferrous metal. Strainer bodies fitted with bolted-on screen retainers shall have offset blowdown holes. Body material shall be cast bronze conforming to ASTM B 62 or cast iron conforming to Class 30 ASTM A 278M. Where system material is nonferrous, strainer body material shall be nonferrous.

Minimum free hole area of strainer element shall be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens for natural gas service shall have mesh cloth not to exceed 0.152 millimeter. Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 304 corrosion-resistant steel.

2.4 VALVES

2.4.1 Ball Valves (BAV)

Ball valves shall be the fire-seal type, conforming to UL 842 and UL 125.

Valves shall be rated for service at not less than 1400 kilopascal at 93 degrees C.

Valve bodies in sizes DN25 ips and smaller shall be screwed-end type constructed of carbon steel.

Valve bodies in sizes DN32 ips and larger shall be flanged-end type constructed of carbon steel.

Valve bodies shall have socket weld ends or butt weld ends where indicated to be welded, and body shall be constructed of carbon steel.

Balls and stems shall be Type 316 corrosion-resistant steel.

Valves shall be suitable for flow from either direction and shall seal tightly in either direction.

Valves shall have full pipe size flow areas where noted.

Valve seats and seals shall be tetrafluoroethylene; seats shall have secondary corrosion-resistant steel seating surfaces to effect shutoff should resin be burned out.

Valve body construction shall be such that:

Torque from a pipe with valve in installed condition shall not tend to disassemble the valve by stripping setscrews or loosening body end inserts or coupling nuts.

Torque from a pipe shall be resisted by a one-piece body between end connections or by bolts in shear where body is of mating flange or surface bolted construction.

2.4.2 Diaphragm Control and Instrument Valves (DCIV)

Diaphragm valves in sizes DN8 and DN10 shall have a forged-brass body with reinforced tetrafluoroethylene diaphragm, AISI 300 series corrosion-resistant steel spring, and round phenolic handle. Handle shall be fitted with color-coded discs.

2.4.3 Gage Cocks (GC)

Gage cocks shall be T-head or lever-handle ground key type with washer and screw, constructed of polished ASTM B 62 bronze, 860 kilopascal. End connections shall suit the service, with or without union and nipple.

2.4.4 Nonpressure-Lubricated Gas Stops (LGS)

Gas stops through DN25 ips shall have an operating pressure rating of not less than 415 kilopascal, gas.

Locking feature shall be provided where noted.

2.4.5 Eccentric Plug Valves (EPV-UL)

Eccentric plug valve maximum size shall be limited to DN80 ips.

Eccentric plug valves shall be constructed with semisteel body, bronze plug with Buna-N resilient elastomer seals. Body sealing face shall be plastic coated. Body end connection shall be screwed for sizes DN25 ips and smaller and flanged in sizes through DN80 ips. Plug shall be top and bottom guided by oil-impregnated bronze bushings and shall be corrosion-resistant steel spring-loaded. Valves shall be rated at 1200 kilopascal wog and shall be UL listed for natural gas service. Valves shall be fitted with pinned lever operators.

Valves shall be provided with locking device where noted.

2.4.6 Lubricated Plug Valves (LPV)

Valves shall be Type 1, Style A, taper-plug type, rated for not less than 1200 kilopascal wog service and shall conform to MSS SP-86 and MS MIL-V-12003.

Valves may be cylindrical plug type, constructed to service-pressure and materials requirements specified for taper plug valves; in addition, clearance between plug and body-sealing surfaces shall not exceed 0.0508

millimeter for valves to DN50 ips and shall be 0.076 to 0.127 millimeter for larger valves; plug stem seal and bottom support shall be reinforced tetrafluoroethylene; plug shall be bottom spring loaded.

Plug shall be full port or restricted port type.

Regulator bypass valves shall be provided with proportioning ports and locking feature.

Valves shall be provided with screwed end connections for all sizes DN25 ips and smaller and flanged end connections for all larger valves.

Valves shall have an effective sealing and lubrication system which, when actuated, forces movement of plug within seating surfaces.

Check-valve-type lubrication fittings shall be provided for grease gun lubrication. Lubricant shall be identified and sufficient quantity shall be provided to lubricate each valve at least once.

Locking feature shall be provided, where noted.

2.4.7 Gasket Material

Gasket material and type shall be in accordance with NFPA 54.

PART 3 EXECUTION

3.1 UNDERGROUND PIPING SYSTEMS INSTALLATION

3.1.1 Installation

Installation of natural gas systems shall be performed in accordance with ASME B31.8 in the presence of the Contracting Officer who shall be notified by the Contractor 48 hours in advance of start of installation.

All excavations shall be dry and clear of extraneous materials when pipe is being laid.

Piping shall be laid beginning at the low point of a system; when in final position it shall be true to the grades and alignment indicated, with unbroken continuity of invert.

Connections between new work and existing gas line shall be made to the satisfaction of the Contracting Officer, using proper specials and fittings to suit the actual conditions. When connections are made by tapping into a gas main, the connecting fitting shall be the same size as the pipe to be connected.

Gas mains shall be graded for the complete drainage of condensate to drips placed at low points; service lines shall be graded to drain to the main line wherever practical.

On excavations occurring near and below building footing, the backfilling material shall consist of Class 2000A concrete poured or pressure grouted

up to the level of the footing.

Where pipe penetrates earth or concrete grade, not less than 300 millimeter of polyethylene-coated Type BCS-PS pipe shall be exposed to view.

Type BCS-PS materials shall be installed for underground and aboveground piping and in accordance with the manufacturer's instructions. Pipe shall be palletized in padded pallets at the factory and shall be handled from pallet to final position with padded gear. Surfaces shall be protected from the sun with black polyethylene sheeting. Prior to being lowered into a trench, sheeting shall be checked for continuity with 10,000 volts applied by a continuity detector with an audible alarm. In the trench, after joints and fittings have been made, previously untested surfaces shall be checked for continuity. When discontinuities in thermoplastic sheeting are found, not less than 300 millimeter of material upstream and downstream of the fault shall be removed and replaced.

After valves, and valve boxes have been inspected, and not less than 48 hours prior to being lowered into a trench, external surfaces shall be coated with a compatible bituminous coating for protection against brackish ground water.

Application shall be in accordance with the manufacturer's instructions and shall result in a dry-film thickness of not less than 0.30 millimeter.

After pressure testing and approval, valves and valve operators shall be thoroughly cleaned, coated with bitumen, wrapped with tape, and recoated with bitumen to form an impervious membrane. Tape shall be glass-fiber reinforced with parallel strands of continuous filament within the fiber structure, bonded with an insoluble, inert, resinous binder that is compatible with bituminous material used.

Prior to backfilling, coated and wrapped pipe and valves shall be tested with an electric holiday detector operating at from 10,000 to 15,000 volts. Defects shall be repaired by clipping back the coatings to the bare metal and recoating with the materials as specified for the original work and to the satisfaction of the Contracting Officer.

Defective materials found shall be distinctly marked and promptly removed from the site.

3.1.2 Valve Boxes

Valves and valve boxes shall be installed where indicated and shall be set plumb. Valve boxes shall be centered on the valves. Where feasible, valves shall be located outside traffic areas. Soil shall be carefully tamped around each valve box to a distance of 1200 millimeter on all sides of the box or to the undisturbed trench face if less than 1200 millimeter. Valve boxes located in roads or sidewalks shall be protected by a concrete slab as indicated.

3.2 ABOVEGROUND PIPING SYSTEMS INSTALLATION

3.2.1 Aboveground Piping

Aboveground piping with operating pressures of 3.5 kilopascal and less, designated "low pressure," shall be fabricated and installed in accordance with NFPA 54, AWS-02, MSS SP-69.

Aboveground piping with operating pressures in excess of 3.5 kilopascal, designated "high pressure," shall be fabricated and installed in accordance with ASME B31.8, AWS-02 and MSS SP-69.

Work shall be performed in the presence of the Contracting Officer who shall be notified 48 hours in advance of start of work.

Pipe shall be fabricated to measurements established on the job and shall be carefully worked into place without springing or forcing. Adequate provision shall be made for absorbing all expansion and contraction without stress in any part of the system.

Pipe, tubing, fittings, valves, equipment, and accessories shall be visibly clean and free of foreign material before being installed into the respective systems. Pipe shall be cleaned by hammering, shaking, or swabbing, or by a combination of methods. Lines shall be purged with dry, oil-free compressed air after erection, but purging out shall not be relied upon for removing all foreign matter. Purge velocity shall be equal to 1-1/2 times maximum normal flow velocity. During the progress of construction, open ends of pipe, fittings, and valves shall be properly protected at all times to prevent the admission of foreign matter. Plugs or caps shall be placed in the ends of installed work at all times when connecting work is not actually under way. Plugs shall be commercially manufactured products approved by the Contracting Officer. Outlets, including valve outlets, shall be securely closed gastight with a threaded plug or cap immediately after installation and shall be left closed until the gas equipment is connected thereto.

Piping shall be installed straight and true with approved offsets around obstructions and with expansion bends or fitting offsets essential to a satisfactory installation, and as may be necessary to increase headroom or to avoid interference with the building construction, electric conduit, or facilities equipment.

Natural gas piping smaller than DN15 ips shall not be concealed.

When installing piping that is to be concealed, the following and similar connections shall not be concealed: unions, tubing fittings, running threads, right and left couplings, and swing joints made by combinations of fittings.

Standard long sweep pipe fittings shall be used for changes in direction; no mitered joints or unapproved pipe bends will be permitted.

Tee connections shall be made with screwed tee fittings or butt, or, where pipe is being welded, branch connections may be made with either butt or socket welding tees or forged branch outlet fittings, either being acceptable without size limitation. Branch outlet fittings, where used, shall be forged, flared for improved flow where attached to the run,

reinforced against external strains, and designed to withstand full pipe-bursting strength requirements.

Horizontal piping shall have a grade of 25 millimeter per 31 meter.

Reducers shall be concentric or eccentric. Eccentric reducers shall be used where required to permit proper drainage of pipe lines. Bushings as reducers are not permitted. Drain valves shall be provided in all piping systems at low points.

Installation of piping shall be such as to prevent stresses and strains from being placed on connected equipment.

Dielectric connection shall be provided at inlet side to building pressure regulator.

Expansion bends in steel pipe shall be made from pipe sections and long radius welding elbows in sizes DN25 and larger. Expansion U-bends shall be cold sprung and welded into the line, which shall be anchored before removing the spreader from the expansion U-bend. Amount of cold spring shall be as indicated.

3.2.2 Joints

Joints larger than DN25 ips shall be welded.

Pipe ends shall be reamed before joint connections are made.

Screwed joints shall be made up with joint compound.

Joint compounds shall be applied to the male thread only, and care shall be exercised to prevent compound from reaching the interior of the pipe.

Screwed unions, welded unions, or bolted flanges shall be provided wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system.

Flanged joints shall be assembled with appropriate flanges, gaskets, and bolting. Clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system. Flange faces shall be parallel and the bores concentric. Gaskets shall be centered on the flange faces without projecting into the bore. Bolting shall be lubricated with oil and graphite before assembly to ensure uniform bolt stressing. Flange bolts shall be drawn up and tightened in staggered sequence in order to prevent unequal gasket compression and deformation of the flanges. Wherever a flange with a raised face is joined to a companion flange with a flat face, the raised face shall be machined down to a smooth matching surface and a full face gasket shall be used. After the piping system has been tested and is in service at its maximum temperature, bolting shall be retightened to achieve minimum gasket seating stress recommended by the gasket manufacturer. Only hex-head nuts and bolts shall be used.

Gasket material shall be fresh stock.

Uncoated metallic gaskets shall be assembled with specified compound.

Field-welded joints shall conform to the requirements of the AWS-02 and ASME B31.1.

Copper tubing for solder joints shall be cut square, and burrs shall be removed with approved cutting and reaming tools. Inside surfaces of fittings and outside surfaces of tubes in joint area shall be cleaned with steel wool before assembly of joint. Joint flux, solder, and heat source shall be applied in accordance with the manufacturer's instructions to provide proper capillary action to fill the socket space and to achieve 100 percent shear-line strength. Valves in copper piping shall have screwed ends with end adapters to suit mechanical connections, unless solder jointing is specified or indicated for a given application. Copper joints that fail pressure tests shall be remade with new materials, including pipe or tubing fittings and filler metal.

Copper tubing for mechanical joints shall be cut square, and burrs shall be removed with approved cutting and reaming tools. Care shall be exercised not to work-harden copper surfaces during flaring and, in case of doubt, tube ends shall be cut off and annealed by heating and air cooling in accordance with the manufacturer's instructions.

3.2.3 Control and Instrument Piping

Tubing shall be mechanically attached to supporting surfaces. Supports using adhesives shall not be acceptable.

Copper tubing horizontal supports for less than three tubes shall be rigid 25 by 10 millimeter metal channel and proprietary metal tube race for three or more tubes.

Copper tubing runs in soil shall be jointless and shall be protected from brackish ground water and leaching concrete alkali by 0.30 millimeter thick bituminous coating or equivalent PVC tape wrapping.

3.2.4 General Service Valve Locations

Valves shall be located to permit isolation of branch piping and each equipment item from the balance of the system and to allow safe and convenient access without moving equipment and with a minimum of piping and equipment disassembly.

Valves shall be provided in piping mains and branches and at equipment where indicated and where specified.

Three-valve bypasses shall be provided around pressure regulating valves and where indicated.

No valve shall be placed in an inaccessible space.

3.3 NATURAL GAS SYSTEMS TESTING

3.3.1 Tests

Prior to acceptance of the work, the Contractor shall test completed systems in the presence of the Contracting Officer.

Tests shall be Pneumatic and shall utilize dry, oil-free nitrogen. Testing shall be done in two stages, preliminary and acceptance.

Personnel not directly involved in pneumatic testing of ferrous piping in excess of 35 kilopascal shall be evacuated from the area.

Testing of any system for any purpose shall include preliminary testing by the process of swabbing of all joints under test with standard high-film-strength soap solution conforming to MS MIL-L-25567, and the subsequent observation for bubbles at internal pressures not in excess of 35 kilopascal.

When testing reveals that Leakage exceeds specified limits, the leaks shall be isolated and repaired, defective materials shall be replaced where necessary, and the system shall be retested until specified requirements are met. Leaking gasket joints shall be remade with new gaskets and new flange bolting. Removed bolting and gaskets shall not be used again. Leaking tubing joints shall be remade with new fittings and new tube ends.

Only standard piping flanges, plugs, caps, and valves shall be used for sealing off piping for test purposes.

Components that could sustain damage due to test pressure shall be removed from piping systems during testing. Piping system components such as valves shall be checked for proper operation under system test pressure.

No test media shall be added to a system during a test for a period specified or determined by the Contracting Officer.

Duration of a test will be determined by the Contracting Officer and shall be for a minimum of 15 minutes with a maximum of 24 hours. Tests may be terminated by the Contracting Officer at any point during this period after it has been determined that the permissible leakage rate has not been exceeded.

Test material shall be retained in piping system after successful testing until purged by natural gas. No ambient air shall be permitted to enter piping system.

Records of piping systems tests shall be prepared and maintained. Records shall show Governmental and Contractor test personnel responsibilities, dates, test gage identification numbers, ambient temperatures, pressure ranges, rates of pressure drop, and leakage rates. Each acceptance test shall require the signature of the Contracting Officer.

3.3.2 Test Gages

Contractor's test gages shall have dial size 125 millimeter or larger with accuracy of plus or minus one-half of 1 percent of full-scale range. Dial

graduations and pointer width shall be compatible with readability to one-half the accuracy extremes. Maximum permissible scale range for a given test shall be such that the pointer during a test shall have a starting point at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 days prior to the test, and shall show test gage number and the project number.

3.3.3 Acceptance Pressure Testing

Testing shall take place during steady ambient temperature conditions.

Ferrous piping systems shall be tested at 520 kilopascal.

Any reduction of test pressures shall be deemed to indicate the presence of leaks which shall be corrected unless the pressure loss can otherwise be accounted for. A correction of plus or minus 2 kilopascal will be allowed for each degree change between initial and final system temperature, plus for an increase in temperature and minus for a decrease.

Test duration shall be long enough to determine if there are any leaks but not less than 1 hour for each 14 cubic meter of pipe volume or fraction thereof, except that when testing a system having a volume of less than 0.3 cubic meter, the test duration may be reduced to 15 minutes. For piping systems having a volume of more than 680 cubic meter, the duration of the test shall be 24 hours.

Control and instrumentation tubing systems shall be tested at 200 kilopascal and the test pressure shall be maintained for a period of not less than 24 hours with no pressure drop.

3.3.4 Purging of Piping

During construction, where necessary, purge valves shall be provided and located to ensure complete system purging with discharge exterior to the building.

3.3.5 Lighting of Pilot Lights

Equipment using natural gas under this Contract shall be lighted in the presence of the Contracting Officer.

3.4 ELECTRICAL WORK

3.4.1 Electrical Service

Contractor shall refer to the electrical drawings and Division 16, "Electrical," of these specifications for specific information on the arrangement of electrical circuits and their effect on the equipment and work required.

3.4.2 Electrical Bonding and Grounding

Each aboveground portion of gas piping system upstream of the equipment

shutoff valve shall be electrically continuous and bonded to any grounding electrode, in accordance with NFPA 70.

3.4.3 Electrical Circuits

Electrical circuits shall not utilize gas piping or components, except that low voltage (50 volts or less) control circuits, ignition circuits, and electronic flame detection device circuits may use piping or components for a part of an electrical circuit.

An electrically operated normally open safety control shall be provided to shut off the flow of gas if the power fails.

-- End of Section --

SECTION 15211

LOW-PRESSURE COMPRESSED AIR SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S328	(1986) Specification for Structural Steel Buildings Load and Resistance Factor Design

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A112.18.1M	(1996) Plumbing Fixture Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 183	(1983; R 1990) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 197M	(1987; R 1992) Standard Specification for Cupola Malleable Iron (Metric)
ASTM A 234/A 234M	(1997) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 278M	(1993) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 345 Degrees C (Metric)
ASTM A 53	(1996) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 536	(1994) Standard Specification for Ductile Iron Castings
ASTM B 280	(1995; Rev A) Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B 62	(1993) Standard Specification for Composition Bronze or Ounce Metal Castings

ASTM C 592	(1980) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM D 2000	(1996) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 4080	(1996) Standard Specification for Trichloroethylene, Technical and Vapor-Degreasing Grade
ASTM E 1	(1995) Standard Specification for ASTM Thermometers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.22	(1995) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.3	(1992) Malleable-Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(1986) Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B19.3	(1991) Safety Standard for Compressors for Process Industries
ASME B31.1	(1995) Power Piping
ASME B31.3	(1996) Chemical Plant and Petroleum Refinery Piping
ASME B40.1	(1991) Gauges - Pressure Indicating Dial Type - Elastic Element
ASME-16	(1995) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage
ASME-19	(1995) Boiler and Pressure Vessel Code

AMERICAN WELDING SOCIETY (AWS)

AWS-02	(1990) Welding Handbook; Eighth Ed; Vol Two - Welding Process

FEDERAL SPECIFICATIONS (FS)

FS FF-S-325	(Int Amd 3) Shield, Expansion; Nail,

Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA S7.0.01 (1996) Quality Standard for Instrument Air

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (1996) Pipe Hangers and Supports - Selection and Application

MSS SP-72 (1992) Ball Valves with Flanged or Butt-Welding Ends for General Servic

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation Drawings shall be submitted for low-pressure compressed air systems in accordance with paragraphs entitled, "Drawings," "Aboveground Piping Materials," and "Underground Piping Materials," of this section.

SD-03 Product Data

Equipment and Performance Data submitted for piping systems.

Manufacturer's catalog data shall be submitted for the following items:

Aboveground Piping Materials
Piping Specialties
Supporting Elements
Air Compressors
Valves
Accessories
Miscellaneous Materials
Vibration Isolation

SD-05 Design Data

Design Analysis and Calculations for low-pressure compressed air systems shall be submitted for the following in accordance with paragraph entitled, "General Requirements," of this section.

Flow Rates
Air Distribution
Pressure Requirements
Insulation Requirements

Equipment and Performance Data submitted for piping systems shall show conformance with ASME Code.

SD-06 Test Reports

Test reports shall be submitted for the following items in accordance with paragraph entitled, "Compressed Air Systems Testing," of this section.

Hydrostatic Testing
compressed Air Systems Testing
Valve-Operating Tests
Drainage Tests
Pneumatic Testing

Each acceptance test shall require the signature of the Contracting Officer and two record copies shall be delivered to the Contracting Officer after acceptance.

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Aboveground Piping Materials
Supporting Elements
Valves
Miscellaneous Materials

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section.

1.4 GENERAL REQUIREMENTS

Section 15055, "Welding Mechanical," applies to work specified in this section.

Equipment and Performance Data submitted for piping systems shall show conformance with ASME Code.

Certificates for Riser Alarm Equipment and Sprinkler Heads shall be submitted meeting referenced standards contained within this section.

Design Analysis and Calculations for low-pressure compressed air systems shall consist of Flow Rates, Air Distribution, Pressure Requirements and Insulation Requirements meeting requirements for referenced standards contained in this section.

1.5 OPERATION AND MAINTENANCE

Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 days prior to testing the low-pressure compressed air System. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

1.6 DRAWINGS

Installation drawings shall be submitted for low-pressure compressed air systems in accordance with paragraphs entitled, "Aboveground Piping Materials" and "Underground Piping Materials," of this section.

Shop drawings shall be accompanied by curves indicating that an essentially flat reduced pressure curve for the capacity demand of the system will be met by the proposed valves.

Complete shop drawing data for pipe attachments shall be submitted for approval.

In lieu of separate hangers, the Contractor may submit for approval a shop drawing of trapeze hangers with a solid or split-ring clamp which he proposes to furnish.

PART 2 PRODUCTS

2.1 ABOVEGROUND PIPING MATERIALS

2.1.1 Compressed Air Systems 862 Kilopascal and Less

2.1.1.1 Type BCS Black Carbon Steel

Pipe DN6 through DN40 shall be Schedule 40, furnace butt welded, black carbon steel, conforming to ASTM A 53, Type F, Grade B.

Fittings DN50 and under shall be 1034 kilopascal gage wsp, banded, black malleable iron, screwed, conforming to ASTM A 197M and ASME B16.3.

Unions 50 millimeter and under shall be 1724 kilopascal gage wsp, female, screwed, black malleable iron, with brass-to-iron seat and ground joint conforming to ASME B16.39, ductile iron conforming to ASTM A 536 for grooved pipe couplings.

Couplings DN50 and under shall be standard weight, screwed, black carbon steel.

2.1.1.2 Type GCS Galvanized Carbon Steel

Pipe DN15 through DN50 shall be Schedule 40, seamless, galvanized steel, conforming to ASTM A 53, Grade B, Type S. Type F is acceptable for sizes less than DN50.

Fittings DN50 and under shall be 1034 kilopascal wsp, banded, galvanized, malleable iron, screwed, conforming to ASTM A 197M, ASME B16.3.

Unions 50 millimeter and under shall be 2068 kilopascal wsp, female, screwed, galvanized, malleable iron with brass-to-iron seat and ground joint.

2.1.2 Control and Instrumentation Tubing, to 207 kilopascal

2.1.2.1 Copper

Tubing all sizes with DN8 minimum outside diameter shall be hard-drawn seamless copper, conforming to ASTM B 280.

Fittings shall be solder joint wrought copper conforming to ASME B16.22.

Ball sleeve shall be of the compression type, forged brass, conforming to SAE 88, UL approved, with minimum pressure rating 1380 kilopascal at 38 degrees C.

Solder shall be 95-5 tin-antimony, alloy Sb 5, conforming to AWS-02.

Copper tubing systems may be installed using mechanical pipe couplings of a bolted type with a central cavity design pressure responsive gasket. Copper pipe and fittings shall be grooved in accordance with the coupling manufacturer's recommendations.

2.2 PIPING SPECIALTIES

2.2.1 Air Pressure Reducing Stations

Pressure reducing station shall be installed complete with relieving type pressure reducing valve, valved bypass, particle filter, pressure indicator upstream of station, pressure indicator downstream of station, and regulated air pressure relief valve.

Pressure regulator body shall be constructed of zinc or aluminum die castings, rated for the service. Diaphragm shall be reinforced air-, oil-, and water-resistant elastomer. All components, exposed to fluid stream being controlled, shall be of nonferrous. Valves shall be of a balanced construction relieving type to automatically prevent excess pressure buildup.

Filters shall be constructed of zinc die castings, rated for the service, and furnished with ips connections. Bowl materials shall be aluminum. Filter shall be serviceable by bowl quick-disconnect devices. Bowl shall be equipped with manual drain cock. Liquid particles shall be separated by centrifugal and quiet zone action. Solid particles to 15-micrometer size

shall be removed by filter elements of sintered bronze mesh.

Combination manual drain filter-regulator units conforming to the above requirements will be acceptable in lieu of separate units.

Pressure relief valves shall be rated for the pressure of the high-pressure side and sized for the full installed capacity of the pressure regulating station at the pressure of the low-pressure side. Valve shall be set at not more than 20 percent more than the correct low side pressure. Valve shall be rated and labeled. Seat material shall be suitable for the service.

2.2.2 Air Line Lubricators

Air line lubricators shall be of the pulse-type with pickup tube, polycarbonate resin bowl, large fill opening, metering rod flow adjuster, sight ball, and drain cock.

Lubricators shall be suitable for 1380 kilopascal at 74 degrees C.

2.2.3 Compressed Air Receivers

Compressed air receivers shall conform to the sizes and capacities specified. Such vessels shall be designed for the applicable working pressures and service in accordance with the ASME-16, and shall be labeled.

Vessels shall be complete with connections for drain, supports, and other required Accessories.

2.2.4 Grooved Pipe Couplings and Fittings

Couplings shall have a housing fabricated in at least two parts of malleable iron castings. Coupling gasket shall be molded synthetic rubber conforming to requirements of ASTM D 2000. Coupling bolts shall be oval-neck track-head type with hexagonal heavy nuts, conforming to ASTM A 183.

Pipe fittings used with couplings shall be fabricated of malleable iron castings. Where a manufacturer's standard size malleable iron fitting pattern is not available, fabricated fittings may be used.

Fittings shall be fabricated from Schedule 40, in accordance with ASTM A 53, Grade B, seamless steel pipe. Long radius seamless welding fittings with wall thickness to match pipe, conforming to ASTM A 234/A 234M and ASME B16.9.

2.2.5 Pressure Gages

Pressure gages shall conform to ASME B40.1. Pressure gages shall be Type I, Class 1, (pressure) for pressures indicated. Pressure gage size shall be 90 millimeter nominal diameter. Case shall be corrosion-resistant steel conforming to the AISI 300 series with an ASM No. 4 standard commercial polish or better. Gages shall be equipped with damper screw adjustment in inlet connection.

Gages shall be equipped with an adjustable, red marking indicator.

2.2.6 Thermometers

Thermometers shall conform to ASTM E 1. Thermometers shall be industrial pattern Type I, Class 3. All thermometers installed 1830 millimeter or higher above the floor shall have an adjustable angle body. Scale shall be not less than 178 millimeter long, and case face shall be manufacturer's standard polished aluminum. Thermometer range shall be as required for service, and shall be provided with nonferrous separable wells.

2.2.7 Line Strainers

Strainers shall be Y-type with removable basket. Strainers in sizes DN50 and smaller shall have screwed ends and in sizes DN65 and larger shall have flanged ends. Body working pressure rating shall exceed maximum service pressure of system in which installed by at least 50 percent. Body shall have cast-in arrows to indicate direction of flow. Strainer bodies fitted with screwed screen retainers shall have straight threads and shall be gasketed with nonferrous metal. Strainer bodies fitted with bolted-on screen retainers shall have offset blowdown holes. Strainers larger than DN65 shall be fitted with manufacturer's standard blowdown valve. Body material shall be cast iron conforming to ASTM A 278M Class 30. Where system material is nonferrous, strainer body material shall be nonferrous.

Minimum free-hole area of strainer element shall be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens for air service shall have mesh cloth not to exceed 0.15 millimeter. Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 304 corrosion-resistant steel.

2.3 AIR COMPRESSORS

An air compressor of the standard piston type shall be provided complete with air tank, air-cooled aftercooler and other appurtenances. Compressor and installation shall conform to ASME B19.3. Compressor capacity shall be as required for service and provide continuous control air when operating on a 1/3-on 2/3-off cycle. High efficiency filer on the discharge line. Control air delivered to the system shall conform to ISA S7.0.01.

2.4 VALVES

2.4.1 Ball Valves (BAV)

Ball valves shall conform to MSS SP-72. Valves shall be Style 1.

Grooved end ball valves may be used provided that the manufacturer certifies valve performance in accordance with MSS SP-72.

Valves shall be rated for service at not less than 1207 kilopascal at 93 degrees C.

Valve bodies in sizes DN50 and smaller shall be screwed end connection type

constructed of Class A copper alloy.

Balls and stems of valves DN50 and smaller shall be Class C corrosion-resistant steel alloy with hard chrome plate. Electroless nickel plating is acceptable.

Valves shall be designed for flow from either direction and shall seal equally tight in either direction.

Valves shall have full pipe size flow areas.

Valves with ball seals kept in place by spring washers are not acceptable. All valves shall have adjustable packing glands. Seats and seals shall be tetrafluoroethylene.

Valve body construction shall be such that torque from a pipe with valve in installed condition shall not tend to disassemble the valve by stripping setscrews or by loosening body end inserts or coupling nuts. Torque from a pipe shall be resisted by a one-piece body between end connections or by bolts in shear where body is of mating flange or surface-bolted construction.

2.4.2 Diaphragm Control and Instrument Valves (DCIV)

Diaphragm valves in sizes DN8 and DN10 shall have a forged brass body with reinforced tetrafluoroethylene diaphragm, AISI 300 series corrosion-resistant steel spring, and round phenolic handle.

2.4.3 Gage Cocks (GC)

Gage cocks shall be T-head or lever handle ground key type with washer and screw, constructed of polished ASTM B 62 bronze, and rated for 862 kilopascal saturated steam service. End connections shall suit the service, with or without union and nipple.

2.5 MISCELLANEOUS MATERIALS

2.5.1 Escutcheons

Escutcheons shall be manufactured from nonferrous metals and shall be chrome plated except when AISI 300 series corrosion-resistant steel is provided. Metals and finish shall be in accordance with ANSI A112.18.1M.

Escutcheons shall be one-piece type. Escutcheons shall maintain a fixed position against a surface by means of internal spring tension devices or setscrews.

2.5.2 Pipe Thread Compounds

Tetrafluoroethylene tape not less than 0.05 millimeter thick shall be used in compressed air systems for pipe sizes to and including DN25. Tetrafluoroethylene dispersions and other suitable compounds may be used for other applications upon approval by the Contracting Officer.

2.6 SUPPORTING ELEMENTS

Contractor shall provide all necessary piping system components and miscellaneous required supporting elements. Supporting elements shall be suitable for stresses imposed by system pressures and temperatures, and natural and other external forces.

Supporting elements shall be UL-listed and shall conform to requirements of ASME B31.3, MSS SP-58, and MSS SP-69, except as otherwise noted. Type devices specified herein are defined in MSS standards unless otherwise noted.

2.6.1 Building Structure Attachments

Concrete and masonry anchor devices shall conform to requirements of FS FF-S-325 Group II, Type 2, Class 2, Style 1.

Cast-in floor-mounted equipment anchor devices shall provide adjustable positions.

Masonry anchor devices shall be built-in, unless otherwise approved by the Contracting Officer.

Power-actuated anchoring devices shall not be used to support mechanical systems components.

Beam clamps shall be center loading Type 21 or 30, UL listed, cataloged, and load rated, and commercially manufactured.

2.6.2 Horizontal Pipe Attachments

Piping in sizes to and including DN50 shall be supported by Type 6 solid malleable-iron pipe rings except that split-band-type rings may be used in sizes up to DN25.

Trapeze hangers fabricated from approved structural steel shapes, with U-bolts, shall be used in congested areas and where multiple pipe runs occur. Structural steel shapes shall conform to supplementary steel requirements.

2.6.3 Vertical Pipe Attachments

Vertical pipe attachments shall be Type 8.

2.6.4 Hanger Rods and Fixtures

Only circular cross-section rod hangers shall be used to connect building structure attachments to pipe support devices. Pipe, straps, or bars of equivalent strength may be used for hangers only where approved by the Contracting Officer.

Turnbuckles, swing eyes, and clevises shall be provided as required by support system to accommodate pipe accessibility and adjustment for load and pitch.

2.6.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, such supplementary steel shall be designed and fabricated in accordance with AISC S328.

PART 3 EXECUTION

3.1 ABOVE GROUND PIPING SYSTEM INSTALLATION

3.1.1 Piping Systems

Piping systems shall be fabricated and installed in accordance with ASME B31.3, MSS SP-69, ASME-19, and applicable AWS requirements.

Pipe shall be fabricated to measurements established on the job and shall be carefully worked into place without springing or forcing.

Pipe, tubing, fittings, valves, equipment, and Accessories shall be clean and free of all foreign material before being installed in their respective systems. Pipe shall be cleaned by a method approved by the Contracting Officer. Lines shall be purged with dry, oil-free compressed air after erection, but purging shall not be relied upon for removing all foreign matter. Lines shall be purged at a velocity equal to 1-1/2 times maximum normal flow velocity. During the progress of construction, open ends of pipe, fittings, and valves shall be protected at all times to prevent the admission of foreign matter. Except when connections are actually underway, plugs or caps shall be installed on all pipe and component openings. Plugs or caps shall be commercially manufactured products.

Piping shall be installed straight and true, with approved offsets around obstructions and with necessary expansion bends or fitting offsets essential to a satisfactory installation and as may be necessary to increase headroom or to avoid interference with the building construction, electric conduit, or facilities equipment.

Standard long sweep pipe fittings shall be used for changes in direction. No mitered joints or unapproved pipe bends shall be permitted.

Tee connections shall be made with screwed tee fittings or grooved tee fittings, or, where pipe is being welded, branch connections shall be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitations. Branch outlet fittings shall be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full burst-pressure strength requirements. Tool space shall be provided between parallel piping runs whenever threaded unions or couplings are installed.

Horizontal piping shall have a grade of25.0 millimeter per 30480 millimeter.

Eccentric reducers shall be used where required to permit proper drainage of pipe lines. Bushings shall not be permitted for this purpose. Drain

valves shall be provided in piping systems at low points. Pipe drains shall consist of DN15 globe valves with renewable disks and 20 millimeter hose adapter.

Installation of piping shall be performed in a manner that will prevent stresses and strains from being imposed on connected equipment.

Expansion bends in steel pipe shall be made from pipe sections and long-radius welding elbows in sizes DN25 and larger. Expansion U-bends shall be cold sprung and welded into the line. Line shall be anchored before removing the spreader from the expansion U-bend.

3.1.2 Joints

Pipe ends shall be reamed before joint connections are made.

Screwed joints shall be made up with joint compound.

Joint compounds shall be applied to the male thread only, and care shall be exercised to prevent compound from reaching the interior of the pipe.

Screwed unions, welded unions, or bolted flanges shall be provided wherever required to permit convenient removal of equipment, valves, and piping Accessories from the piping system.

Copper tubing for solder joints shall be cut square, and burrs shall be removed with approved cutting and reaming tools. Inside surfaces of fittings and outside surfaces of tubes in joint area shall be cleaned before assembly of joint. Joint flux, solder, and heat source shall be applied in accordance with the manufacturer's instructions to provide proper capillary action to fill the socket space and to achieve 100 percent of shear-line strength capability. Valves in copper piping shall have screwed ends with end adapters to suit mechanical connections, unless solder joining is specified for a given application. Copper joints that fail pressure tests shall be remade with new materials, including pipe or tubing fittings and filler metal.

3.1.3 General Service Valve Locations

Valves shall be provided to permit isolation of branch piping and each equipment item from the balance of the system, to allow safe and convenient access without moving equipment, and to require a minimum of piping and equipment disassembly.

Valves shall be provided in piping mains and branches at equipment and equipment items.

Three-valve bypass shall be provided around each pressure-regulating valve.

Valves unavoidably located in furred or other normally inaccessible places shall be provided with access panels.

3.1.4 Bypass Throttling Valves

Valves shall be globe type with composition disc.

3.1.5 Supporting Elements Installation

Supporting elements shall be provided in accordance with the requirements of ASME B31.1, MSS SP-58, MSS SP-69. Piping shall be hung from building construction. No piping shall be hung from roof deck or from other pipe.

Piping shall run parallel with the lines of the building. Piping and components shall be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there will be not less than 13 millimeter of clear space between the finished surface and other work and between the finished surface and parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the building.

Identical service systems piping, where practical, shall be placed at same elevation and hung on trapeze hangers adjusted for proper pitch.

Spacing of trapeze hangers where piping is grouped in parallel runs shall be the closest interval required for any size pipe supported.

Where it is necessary to avoid any transfer of load from support to support or onto connecting equipment, pipe hangers shall be constant support type.

Approved pipe alignment guides, attached in an approved manner to the building structure, shall be provided to control pipe movement in true alignment in the piping adjacent to and on each side of all pipe expansion loops.

Anchors incorporated in piping systems for the purpose of maintaining permanent pipe positions shall be welded to the piping and attached to the building structure in a manner approved by the Contracting Officer.

Piping shall be suitably braced against sway and vibration. Bracing shall consist of brackets, anchor chairs, rods, and structural steel for Vibration Isolation.

Hangers and supports for piping shall be installed at intervals specified herein at locations not more than 900 millimeterfrom the ends of each runout and not over 25 percent of the specified interval from each change in direction of piping.

Load rating for all pipe hanger supports shall be based on weight and forces imposed on all lines. Deflection per span shall not exceed slope gradient of pipe. Schedule 40 and heavier pipe supports shall be in accordance with the following minimum rod size. Maximum allowable hanger spacing and concentrated loads will reduce allowable span proportionately:

PIPE SIZE (DN) MILLIMETE	ROD SIZE MILLIMETE	STEEL PIPE MILLIMETER
Up to 25	10	2438

PIPE SIZE (DN) MILLIMETE	ROD SIZE MILLIMETE	STEEL PIPE MILLIMETER
32 to 40	10	3048
50	10	3660

Where possible, vertical risers shall be supported at the base at intervals specified and shall be guided for lateral stability. Clamps shall be placed under fittings wherever possible. Carbon steel pipe shall be supported at each floor at not more than 4570 millimeter intervals for pipe DN50 and smaller and at not more than 6100 millimeter intervals for pipe DN65 and larger.

After the piping systems have been installed, tested, and placed in satisfactory operation, the Contractor shall firmly tighten hanger rod nuts and jam nuts to prevent any movement.

3.1.6 Sound Stopping

Effective sound stopping and adequate operating clearance shall be provided to prevent structure contact where piping penetrates walls, floors, or ceilings, into occupied spaces adjacent to equipment rooms, where similar penetrations occur between occupied spaces, and where penetrations occur from pipe chases into occupied spaces. Occupied spaces includes space above ceilings where no special acoustic treatment of ceiling is provided. Penetrations shall be finished to be compatible with surface being penetrated.

Sound stopping provisions shall be essentially the materials and procedures specified under "Sleeves" in this section.

All mineral materials shall conform to requirements specified under "Sleeves" in this section.

3.1.7 Sleeves

Sleeves are required where piping passes through masonry or concrete walls.

Sleeve work shall be laid out and set before construction of walls. Sleeves necessary to complete the work shall be furnished.

Where pipe sleeves are required after masonry are installed, holes to accommodate these sleeves shall be made with core drills. Sleeves shall be set in place with a two-component epoxy adhesive system approved by the Contracting Officer. No load shall be carried by such sleeves unless approved by the Contracting Officer.

Sleeves shall be flush with all ceilings.

Sleeves extending through load bearing walls, and sleeves through fire barriers shall be continuous and shall be fabricated from Schedule 40 steel pipe with welded anchor lugs. Other sleeves may be formed by molded linear

polyethylene liners or similar materials that are removable. Diameter of sleeves shall be large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and shall provide a minimum 10 millimeter clearance. Sleeve size shall accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and generation of noise.

Space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration shall be packed solid with a mineral fiber conforming to ASTM C 592, Form B, Class 8. Wherever the piping passes through firewalls, equipment room walls, floors and ceilings connected to occupied spaces, and other locations where sleeves or construction surface penetrations occur between occupied spaces, similar packing shall be provided. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration shall be filled with an elastomer calk to a depth of 13 millimeter. Surfaces to be calked shall be oil- and grease-free.

3.1.8 Escutcheons

Escutcheons shall be provided at penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, escutcheons shall be provided on both sides of the partition. Plates shall be provided at the underside only of such ceilings, where suspended ceilings are installed. Plates shall be large enough to fit around the insulation, for insulated pipes. Escutcheons shall be chrome-plated in occupied spaces and shall be of sufficient size to conceal openings in building construction. Escutcheons shall be firmly attached with setscrews.

3.1.9 Flashings

Required flashings shall be provided at mechanical systems penetrations of building boundaries.

3.2 COMPRESSED AIR SYSTEMS TESTING

Prior to acceptance of the work, completed systems shall be pressure-tested in the presence of the Contracting Officer.

Testing shall be done in two stages: preliminary stage and acceptance stage, including gage tests.

No testing shall be performed until personnel not directly involved in the test have been evacuated from the area.

Contractor may conduct tests for his own purposes, but preliminary testing and the acceptance test shall be conducted as specified.

3.2.1 Preliminary Stage Tests

Components that could be damaged by test pressure shall be removed from

piping systems to be tested.

Valve-Operating Tests and Drainage Tests shall be performed according to referenced standards.

Piping system components, such as valves, shall be checked for proper operation under system test pressure.

No test media shall be added to a system during a test for a period specified or determined by the Contracting Officer.

Duration of a test will be determined by the Contracting Officer and will be for a minimum of 15 minutes with a maximum of 24 hours. Test may be terminated by direction of the Contracting Officer at any point after it has been determined that the leakage rate is within limits.

Test records of all piping systems tests shall be prepared and maintained. Records shall show Governmental and Contractor test personnel responsibilities, dates, test gage identification numbers, ambient temperatures, pressure ranges, rates of pressure drop, and leakage rates.

Tests shall be hydrostatic. Only potable water shall be used for testing. Government will supply testing water at a location determined by the Contracting Officer. Contractor shall be responsible for approved disposal of contaminated water. Temperature of water used for testing shall not be low enough to cause condensation of atmospheric moisture on system surfaces. Supplementary heat shall be provided, when necessary.

To preclude injury and damage, necessary precautions shall be taken by venting the expansive force of compressed air trapped during high-pressure Hydrostatic Testing. When purging or vent valves are not provided, the Contracting Officer may require the removal of any system component such as plugs or caps to verify that the water has reached all parts of the system.

Upon completion of testing, the system shall be drained and purged with dry air. System dryness shall be verified by hygrometer comparison with purging air.

Irrespective of the amount of measured leakage, visible leaks or defects in the pipeline shall be immediately repaired.

3.2.2 Test Gages

Contractor's test gages shall conform to ASME B40.1 and shall have a dial size of 200 millimeter or larger. Maximum permissible scale range for a given test shall be such that the pointer during a test shall have a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 days prior to test use, test gage number, and the project number, unless otherwise approved by the Contracting Officer.

3.2.3 Acceptance Pressure Testing

Testing shall take place during steady-state ambient temperature conditions.

Ferrous piping systems shall be tested at 1-1/2 times maximum operating pressure. Test pressure shall be maintained for a period of not less than 2 hours with an allowable pressure drop of 14 kilopascal during that time unless otherwise approved by the Contracting Officer.

3.3 COMPRESSED AIR SYSTEM CLEANING

Rust and dirt shall be removed from the bore and exterior surface of all piping and equipment. Pipeline strainers, temporary and permanent, shall be cleaned during purging operations, after startup, and immediately prior to final acceptance by the Government.

New steel piping shall be flushed with trichloroethylene conforming to ASTM D 4080, Type 1, until visible grease, dirt, and other contaminants have been removed.

3.4 COMPRESSED AIR SYSTEMS IDENTIFICATION

Identification plates shall be protected and kept clean. Damaged and illegible identification plates shall be replaced at no additional expense.

Piping shall be labeled and arrowed at each point of entry and exit of piping passing through walls; at each change in direction, such as at elbows and tees; and in congested or hidden areas, at each point required to clarify service or indicate a hazard. Each riser shall also be labeled.

In long straight runs, labels shall be located at distances visible to each other, but in no case shall the distance between labels exceed 22860 millimeter. Labels shall be legible from the primary service and operating area.

-- End of Section --

SECTION 15225

CHEMICAL-WASTE DRAINAGE SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 518M	(1992) Corrosion-Resistant High-Silicon Iron Castings (Metric)
ASTM C 1036	(1991) Standard Specification for Flat Glass
ASTM D 1559	(1989) Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2447	(1993) Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80 Based on Outside Diameter
ASTM D 2665	(1994; Rev A) Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 4101	(1995) Propylene Plastic Injection and Extrusion Materials

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.12	(1991) Cast-Iron Threaded Drainage Fittings

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Installation Drawings shall be submitted in accordance with pargraph entitled, "General Requirements," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following

items:

Borosilicate Glass Materials
High-Silicon Cast Iron Material
Polyethylene Material
Polypropylene Material
Polyvinylchloride Material

SD-06 Test Reports

Test Reports shall be submitted in accordance with pargraph entitled, "Installation and Testing," of this section.

SD-07 Certificates

Listing of Product Installations shall be submitted in accordance with pargraph entitled, "Installation and Testing," of this section.

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Borosilicate Glass Materials
High-Silicon Cast Iron Material
Polyethylene Material
Polypropylene Material
Polyvinylchloride Material

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Installation Drawings shall be submitted for chemical-waste drainage systems in accordance with the manufacturer's recommended instructions.

PART 2 PRODUCTS

2.1 BOROSILICATE GLASS, TYPE BSG

Borosilicate Glass Materials for drain, waste, and vent piping systems shall be tempered and annealed in conformance with ASTM C 1036. Coupling shall be AISI Type 304 corrosion-resistant steel lined with Buna-N resilient member supporting a tetrafluoroethylene liner. Liner shall be the only material wetted by waste stream. Piping class shall be BSG-1.

Vent-system materials 1800 millimeter and higher above the floor shall be Type PP or PVC with extra-heavy Type HSCI extension through roof.

2.2 HIGH-SILICON CAST IRON, TYPE HSCI

High-Silicon Cast Iron Material (ASTM A 518M) for drain, waste, and vent piping systems shall be bell-and-spigot or beaded-end straight barrel,

extra heavy, acid-resistant soil pipe containing not less than 14-1/2 percent silicon. Joint seals shall be lead and acid-resistant packing. Mechanical joint shall be a coupling constructed of AISI Type 304 corrosion-resistant steel with chloroprene resilient member supporting a tetrafluoroethylene liner. Liner shall be the only material wetted by waste stream. Nut shall be tightened to a minimum of 12 newton-meter.

Vent-system materials 1800 millimeter and higher above the floor shall be Type PP or Type PVC with extra-heavy Type HSCI extensions through roof.

2.3 POLYETHYLENE DRAIN, WASTE, AND VENT, TYPE PE-DWV

Polyethylene Material for drain, waste, and vent piping systems shall be manufactured from polyethylene (PE) olefin resins in conformance with ASTM D 2447 and ASME B16.12 for applicable dimensions and configurations. Pipe wall thickness shall be Schedule 40. PE materials shall be Type PE-2306, black, specifically suitable for joining by fusion of interfaces into a homogeneous mass at high temperatures. Threaded assemblies shall be molded. No thread cutting will be permitted.

Vent extensions through the roof shall be extra-heavy Type HSCI.

Selected drainage-system components may be manufactured from polypropylene (PP) materials, provided proposed means and methods of connection are recommended by the manufacturing source.

2.4 POLYPROPYLENE DRAIN, WASTE, AND VENT, TYPE PP-DWV

Polypropylene Material for drain, waste, and vent piping systems shall be manufactured from Type I - 19509, black olefin resins conforming to ASTM D 4101. Materials shall be manufactured and tested in accordance with applicable provisions of ASTM D 2447. Materials dimensions and configurations shall comply with applicable provisions of ASME B16.12.

Pipe-wall thickness shall be Schedule 40, and minimum burst pressure when tested in accordance with ASTM D 1559 for 60 to 90 seconds, shall be as follows:

Size (millimeter) DN	40	50	80	100
Burst Pressure (kilopascal)	4585	380	3650	3100

PP materials shall be specifically suitable for joining interfaces into a homogeneous mass by fusion at high temperatures. Threaded assemblies shall be molded. No thread cutting will be permitted.

Vent extensions through the roof shall be extra-heavy Type HSCI.

Selected drainage system components shall be manufactured from PE materials when so specified, and provided proposed means and methods of connection are recommended by the manufacturing source.

2.5 POLYVINYLCHLORIDE DRAIN, WASTE, AND VENT, TYPE PVC-DWV

Polyvinylchloride Material drain, waste, and vent piping-system materials shall be manufactured from Type I normal impact resins in conformance with ASTM D 2665 and ASME B16.12 for applicable dimensions. Material shall be gray and specifically suited for joining socket interfaces into a homogeneous mass by solvent-cement welding.

Fittings shall be molded to produce, upon insertion of pipe, an interference fit at approximately 2/3 of the depth of the socket. No thread cutting will be permitted.

Vent extensions through the roof shall be extra-heavy type HSCI.

PART 3 EXECUTION

3.1 INSTALLATION AND TESTING

Test Reports consisting of system operation tests shall be submitted for chemical-waste drainage systems.

Listing of Product Installations for chemical-waste drainage systems shall include identification of at least five units, similar to those proposed for use, that have been in successful service for a minimum of five years. List shall include purchaser, address of installation, service organization, and date of installation.

Equipment shall be installed and tested in accordance with manufacturer's recommendations.

-- End of Section --

SECTION 15410

PLUMBING FIXTURES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME A112.19.2M	(1995) Vitreous China Plumbing Fixtures
ASME A112.21.1M	(1991) Floor Drains

FEDERAL SPECIFICATIONS (FS)

FS WW-P-401	(Rev E; Am 1) Pipe and Pipe Fittings, Cast-Iron, Soil

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

IAPMO-01	(1994) Uniform Plumbing Cod

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Records of Existing Conditions shall be submitted in accordance with pargarph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

The following drawings shall be submitted in accordance with pargarph entitled, "General Requirements," of this section.

Detail Drawings
Connection Diagrams

Installation drawings shall be submitted for plumbing fixtures in accordance with the paragraph entitled, "Installation," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items including all spare parts.

Plumbing Fixtures and Trim
Sanitary Drain, Waste, and Vent Fixtures

SD-04 Samples

Manufacturer's Standard Color Charts shall be submitted in accordance with pargarph entitled, "General," of this section.

SD-06 Test Reports

Test reports shall be submitted for plumbing fixtures in accordance with the paragraph entitled, "Tests," of this section.

SD-07 Certificates

Listing of Product Installation shall be submitted in accordance with pargarph entitled, "Installation," of this section.

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Plumbing Fixtures and Trim
Sanitary Drain, Waste, and Vent Fixtures

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with pargarph entitled, "Operation and Maintenance," of this section.

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to this section.

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

Detail Drawings shall be submitted for plumbing fixtures consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents.

Connection Diagrams shall be submitted for plumbing fixtures indicating the relations and connections of components and apparatus by showing the general physical layout, dimensions, and arrangements of each.

PART 2 PRODUCTS

2.1 GENERAL

Fixtures shall be of the types defined herein and of the size and capacities indicated.

Manufacturer's Standard Color Charts shall be submitted for plumbing fixtures showing the manufacturer's recommended color and finish selections.

2.2 PLUMBING FIXTURES AND TRIM

Fixtures shall be furnished with the accessories for a complete installation, such as supply fittings, angle valves, escutcheons, couplings, nuts, drain fittings, and pop-up waste fittings, even if the accessories are not specifically called out herein. Rubber compression type connections are not acceptable and brass ferrule type fittings are required.

Vitreous-china and enameled cast-iron plumbing fixtures shall be the product of the same manufacturer, and unless otherwise specified, shall be white. Manufacturer shall be a company of established reputation in the manufacture of plumbing fixtures and one that assembles the plumbing outfits and assumes responsibility for all products supplied.

Exposed traps and double-cone supply tubes for fixtures and equipment shall be connected to rough-piping at the wall, unless otherwise specified. Floor and wall plates shall be as specified herein or as covered by the outfit numbers. Exposed-to-view fixture trimmings, fittings, and fasteners shall be chromium-plated or nickel-plated brass with polished, bright surfaces.

Exposed-to-view fixture supports shall be enameled iron to match the fixture.

Supplies and wastes for lavatories shall be to wall. Sleeves are not required at penetrations.

Each lavatory shall be fitted with a plunger-operated liquid-soap dispenser.

Ledge-back openings shall be located to place the faucet spout over the bowl drain.

2.2.1 Fixture Supports

Wall-hung fixtures shall be supported by ferrous-metal carriers. Where specified, carriers shall be combination type with adjustable fittings. Water closets and urinals shall have supporting feet not less than 250 millimeter long, unless construction requires shorter feet or bases.

Lavatories shall be supported from the wall by wall carriers with concealed arms.

Lavatories shall be supported by carriers with concealed adjustable arms and supporting feet not less than 250 millimeter long.

Supporting arms of slab-type lavatories shall be concealed by secure deep-drawn, chrome-plated covers.

Supporting feet shall have not more than 40 millimeter of concrete topping over structural slab for effective concealment.

2.2.2 Lavatories

Lavatories and fittings shall conform to ASME A112.19.2M.

Type Barrier Free: Lavatories shall be slab type, wall hung, 508 by 689 millimeter. Inside opening shall be substantially rectangular.

Supply fittings shall conform to applicable requirements for faucets in ASME A112.19.2M.

Supply fitting spout angle and length over the bowl shall provide a water-free back ledge. Horizontal distance from the centerline of the spoutless aerator to the centerline of the supply piping shall be not less than 125 millimeter, and the vertical distance between the centerline of the spout (less aerator) and the fitting base shall be not less than 70 millimeter. Supply fittings with handles capable of being turned 360 degrees are not acceptable.

Supply piping shall be chrome-plated brass, threaded in accordance with the requirements of ASME A112.19.2M.

Drain fittings shall conform to ASME A112.19.2M, strainer drain, unless otherwise specified, but with perforated removable strainer and 32 millimeter tailpiece. Adjustable P-trap, with cleanout, shall be Type I.

2.2.3 Service Sinks

Service sinks and fittings shall conform to ASME A112.19.2M.

Type SS-T: Service sinks shall be single bowl, three-side access, floor mounted, terrazzo, with four-side cap-tiling flange, and fabricated from Class 302, annealed corrosion-resistant steel. Approximate size of the fixture shall be 900 by 600 millimeter overall and 300 millimeter high. Supply fitting shall be a 250 millimeter spout, chrome-plated, single, compression with vacuum breaker and 1200 millimeter hose with holding bracket. Drain fitting shall be 80 millimeter.

2.2.4 Water Closets

Water closets shall conform to ASME A112.19.2M.

Type WC-Q: Water closets shall be office and industrial, elongated bowl with flush valve, syphon-jet, floor outlet, and constructed for quiet operation. Seat shall be elongated open front, solid molded high-impact polystyrene, with check hinge, and without a cover. Flush valve shall be exposed, with vacuum breaker and screwdriver stop, constructed for quiet operation.

2.3 SANITARY DRAIN, WASTE, AND VENT FIXTURES

2.3.1 Floor Drains

Floor drains shall be complete with traps.

Floor drains located in slabs on earth shall have hub outlets; those in slabs not on earth shall have threaded outlets or hub outlets, as required to match piping used.

Floor drains shall have bottom outlets.

Floor drains shall have integral seepage pans and weep holes.

Ferrous floor drain surfaces, except the top of grates, shall be given a heavy coating of coal-tar enamel. Coating shall be applied either at the factory or in the field before installation and before rusting has occurred.

Trap primers shall be all bronze with nonferrous trim floor. Drains shall be fitted with cast-iron primer adapters.

FD-1: Floor drains shall conform to ASME A112.21.1M, area-drain type, and the requirements specified herein. Strainer shall be deep flanged, tractor type. Strainer and body shall be capable of sustaining a platen load of not less than 36 kilonewton, applied within 3 seconds, before failure. Cracking of the strainer or body shall be considered as failure. Strainer free area shall be not less than 11000 square millimeter.

2.3.2 Roof Drains

Type RD-A: Roof drains shall be heavy pattern, all cast-iron construction with integral clamping surfaces not less than 50 millimeter wide, which includes a clamping ring and gravel guard where necessary. Beehive- or dome-shaped strainer diameter shall be approximately 300 millimeter and height shall be not less than 125 millimeter. Open area of the strainer shall be not less than twice the area of the nominal drain outlet. Drain body and bolting shall be corrosion-protected with manufacturer's standard enamel and electrodeposited coating.

Roof drains shall prevent water accumulation on the roof from exceeding 75 millimeter or 750 pascal load.

2.3.3 Cleanouts

Cleanouts shall be gastight and watertight and sized to provide quick and easy access for plug removal and rodding tools. Cleanouts shall be aesthetically located with respect to tile patterns, masonry bond, and alignment.

Cleanouts in ceramic tile, resilient tile flooring, and finished walls shall be rectangular.

No cleanout plug shall terminate in or above a finished floor or wall surface, except in stack bases and where indicated.

Cleanouts shall have cast-brass raised-head plugs. Not less than two tools for each size and type plug shall be delivered to the Contracting Officer.

Cleanouts set outside of the building and cleanouts in building floors shall have adjustable housings.

Cast-iron bodies shall be coated with manufacturer's standard material.

Type CO-1: Cleanouts shall have a cast-iron body and a setscrew adjustable housing with deep-set tractor-type, cast-iron, scoriated cover. Construction shall be heavy duty and suitable for AASHTO H-10 loading.

Type CO-2: Cleanouts shall have a cast-iron body and adjustable housing with polished nickel-brass or nickel-bronze heavy-duty frame, and scoriated, secured cover. Cover thickness shall be not less than 10 millimeter.

Type CO-3: Cleanouts shall have a cast-iron body and adjustable housing with cover recessed to a depth to accommodate specified resilient flooring material. Surfaces and fasteners exposed to view shall be constructed of polished nickel-bronze or approved nickel-brass.

2.3.4 P-Traps

P-traps shall be extra-heavy cast iron conforming to FS WW-P-401.

PART 3 EXECUTION

3.1 INSTALLATION

Listing of Product Installation shall be submitted for plumbing fixtures identifying at least five units, similar to those proposed for use, that have been in successful service for a minimum of five years. The list shall include purchaser, address of installation, service organization, and date of installation.

Materials, equipment, and fixtures shall be installed as indicated and specified and in accordance with the manufacturer's recommendations.

Installation of plumbing fixtures shall conform to the published or written instructions of the manufacturer for the specific project application, except as otherwise specified herein.

Fixtures shall be clean and free of deleterious material before being installed. Before connecting to water, waste, vent or trap service, the fixture lines shall be blown out with compressed air. During the progress of construction, open ends of fixtures shall be protected at all times to prevent the admission of foreign matter.

3.2 TESTS

The floor drain body and its standard specification strainer shall be tested in compression, while loaded with a 530 kilonewton capacity

hydraulic machine, by means of a 65 millimeter square, 25 millimeter thick platen placed at the geometric center of the strainer. Deflection measurements from the bottom of the platen shall be taken using a deflection gage graduated in .03 millimeter increments. Cast-iron strainers shall be loaded as rapidly as possible; load-to-failure should be applied within 2 to 2.5 seconds, and maximum deflection at failure by cracking shall be noted. Ductile-iron and nonferrous strainer permanent deformation shall constitute failure. These strainers shall be loaded to a deflection of 1.6 millimeter without permanent deformation and to a deflection of 3.2 millimeter at which or before which, permanent deformation will occur.

Leak tests shall be conducted in accordance with IAPMO-01, except as otherwise provided herein. Tests shall be hydrostatic, unless otherwise specified. Only potable water shall be used for testing. Government will supply the test water, but the Contractor shall be responsible for approved disposal of contaminated water.

Duration of the test will be determined by the Contracting Officer, who may also terminate the test at any point after it has been determined that fixtures are watertight.

Record of testing shall be maintained by the Contractor and shall be submitted to the Contracting Officer upon acceptance of the equipment by the Government.

3.3 OPERATION AND MAINTENANCE

Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 days prior to testing of plumbing fixtures. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

-- End of Section --

SECTION 15700

HEATING / VENTILATION / AIR CONDITIONING SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(1989; 5th Ed) National Standards for Testing and Balancing, Heating, Ventilating, and Air Conditioning Systems

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC M017	(1992) Manual of Steel Construction, Volume II, Connections

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG-911	(1991) LRFD Cold-Formed Steel Design Manual

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 300	(1994) Test Code for Sound Rating Air Moving Devices
AMCA 301	(1990) Methods for Calculating Fan Sound Ratings from Laboratory Test Data

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 106	(1997; Rev A) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A 123	(1992; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 234/A 234M	(1997) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel

ASTM A 436	(1984; R 1992) Standard Specification for Austenitic Gray Iron Castings
ASTM A 527/A 527M	(1990) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM A 53	(1996) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 694/A 694M	(1995; Rev A) Standard Specification for Forgings, Carbon and Alloy Steel, for Pipe Flanges, Fittings, Valves and Parts for High Pressure Transmission Service
ASTM B 61	(1993) Standard Specification for Steam or Valve Bronze Castings
ASTM B 62	(1993) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM C 1139	(1990) Standard Specification for Fibrous Glass Thermal Insulation and Sound Absorbing Blanket and Board for Military Application
ASTM C 552	(1991) Standard Specification for Cellular Glass Thermal Insulation
ASTM C 553	(1992) Standard Specification for Mineral Fiber Blanket and Felt Insulation (Industrial Type)
ASTM C 612	(1993) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM D 1784	(1992) Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM F 568	(1995) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-04	(1997) Handbook, Fundamentals (SI Edition)
ASHRAE-05	(1995) Handbook, HVAC Applications (SI Edition)

ASHRAE-07	(1997) Handbook, HVAC Systems and Equipment (SI Edition)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1	(1983; R 1992) Pipe Threads, General Purpose (Inch)
ASME B1.21M	(1978; R 1991) Metric Screw Threads - MJ Profile
ASME B16.21	(1992) Nonmetallic Flanged Gaskets for Pipe Flanges
ASME B16.3	(1992) Malleable-Iron Threaded Fittings, Classes 150 and 300
ASME B16.34	(1996) Valves - Flanged, Threaded and Welding End
ASME B16.5	(1996) Pipe Flanges and Flanged Fittings
ASME B16.9	(1993) Factory-Made Wrought Steel Buttwelding Fittings
ASME B36.10M	(1985) Welded and Seamless Wrought Steel Pipe

AMERICAN WATERWORKS ASSOCIATION (AWWA)

AWWA C504	(1994) Standard for Rubber-Seated Butterfly Valves

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825	(1990; Supple I, II & III) Approval Guide

INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA RP60.9	(1981) Piping Guide for Control Centers

MILITARY SPECIFICATIONS (MS)

MS MIL-P-26915	(Rev B) Primer Coating, Zinc Dust Pigmented, for Steel Surfaces

MANUFACTURER'S STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-67	(1995) Butterfly Valves
MSS SP-72	(1992) Ball Valves with Flanged or Butt-Welding Ends for General Service

MSS SP-80 (1997) Bronze Gate, Globe, Angle and Check Valves

MSS SP-86 (1987; R 1992) Guidelines for Metric Data in Standards for Valves, Flanges, Fittings and Actuators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 220 (1992) Standard Types of Building Construction

NFPA 90A (1996) Standard for the Installation of Air Conditioning and Ventilating Systems

NATIONAL SANITATION FOUNDATION (NSF)

NSF Std 14 (1990) Plastics Piping Components and Related Materials

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-03 (1992) Fibrous Glass Duct Construction Standard

SMACNA-06 (1985; 1st Ed) HVAC Duct Construction Standards - Metal and Flexible

SMACNA-07 (1993) HVAC Systems - Testing, Adjusting and Balancing

UNDERWRITERS LABORATORIES (UL)

UL 181 (1994; 8th Ed) UL Standards for Safety Factory-Made Air Ducts and Air Connector

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Connection Diagrams and Control Diagrams shall be submitted for the following systems in accordance with paragraph entitled, "Diagrams," of this section.

Air Systems
Hydronic Systems
Air-Hydronic Systems
Unitary Systems

Schematics shall be submitted for each HVAC duct system in accordance with paragraph entitled, "Diagrams," of this section.

Installation Drawings shall be submitted for the following systems in accordance with the paragraph entitled, "Installation," of this section.

Air Systems
Hydronic Systems
Air-Hydronic Systems
Unitary Systems

SD-03 Product Data

Equipment and performance data shall be submitted for the following items including sound data for supply air-diffusion devices in terms of Noise Criteria (NC) index for the capacity range of the device. Data shall also include air and hydronic pressure differences, the direction of air and water flow, temperature differentials, power rating, operating temperatures and pressures, and limit or safety temperatures and pressures.

Air Diffusers
Fans
Boilers
Coils
Valves
Ductwork
Compressor
Heat Exchangers
Piping
Vibration Isolators
Insulation
Unit Heaters
Air Handling Units
Variable Volume Boxes
Filters

Manufacturer's catalog data shall be submitted for the following items in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Air Diffusers
Fans
Boilers
Coils
Ductwork
Compressor

Heat Exchangers
Piping
Vibration Isolators
Insulation
Unit Heaters
Air Handling Units
Variable Volume Boxes
Filters
Spare Parts
Accessories

Equipment foundation data for the following items shall include equipment weight and operating loads; horizontal and vertical loads; starting torques and their direction; rpm of equipment; size, location and projection of anchor bolts; horizontal and vertical clearances for installation, operation, and maintenance; plan dimensions of foundations and relative elevations; and installation requirements such as noise abatement, vibration isolation, and utility services.

Vibration Isolators
Boilers
Piping
Compressor
Coils
Valves
Unit Heaters
Fans
Air Handling Units
Ductwork
Air Diffusers
Variable Volume Boxes

SD-04 Samples

Manufacturer's Standard Color Chart shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-05 Design Data

Design analysis and calculations shall be submitted for HVAC Systems and shall include the following items when applicable.

Flow Rates
Air Distribution
Design Pressures and Losses
Fan and Pump Design Speeds
Sound and Comfort Design
Vibration Calculations
Insulation Requirements
Filter Requirements
Boiler and Chiller Design

SD-06 Test Reports

Test reports shall be submitted for the following items on each type of HVAC system.

Pressure Tests
Vacuum Testing
Operating Test

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions shall be submitted in accordance with paragraph entitled, "Installation," of this section.

Operating Instructions shall be submitted for all proposed equipment.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following systems in accordance with paragraph entitled, "Operation and Maintenance," of this section.

Air Systems
Hydronic Systems
Air-Hydronic Systems
Unitary Systems

1.3 MECHANICAL SYSTEMS IDENTIFICATION

Contractor shall provide a coordinated system of piping identification which includes:

A framed and plastic-protected diagrammatic layout of piping systems, showing and identifying piping, ducting, automatic or manual control locations, equipment, and valve locations. Where existing systems are being modified, existing layouts shall be brought up to date to include such modifications.

Metal tag-identified major valves, piping systems components, and equipment

1.3.1 Diagrams

Connection, control and installation diagrams for Air Systems, Hydronic Systems, Air-Hydronic Systems and Unitary Systems shall be submitted meeting referenced standards within this section.

Design analysis and calculations shall be submitted for HVAC Systems and shall include the following items when applicable. Chart listing of equipment shall be by designation numbers and showing capacities to include Flow Rates, Air Distribution, Design Pressures and Losses, Fan and Pump Design Speeds, Sound and Comfort Design, Vibration Calculations, Insulation

Requirements, Filter Requirements and Boiler Design. They shall also include heating and cooling capacities, horsepower, pipe sizes, and voltage and current characteristics.

Diagrams shall be neat mechanical drawings provided with extruded aluminum frames and 4 millimeter acrylic plastic protection. Location shall be as directed by the Contracting Officer.

Connection diagrams shall be submitted for the following systems indicating the relations and connections of devices and apparatus by showing the physical layout of all controls, the interconnection of one system (or portion of system) to another, and internal tubing, wiring, and other devices.

Control diagrams shall be submitted for the following systems indicating the physical and functional relationship of equipment, electrical diagrams showing size, type and capacity of the systems, and pneumatic diagrams for air and gas systems.

Schematics shall be submitted for each HVAC duct system indicating dampers, regulating devices, terminal units, supply outlets, return and exhaust inlets, and the size, velocity and flow (cubic meter per minute or liter per second) for main branch circuits or ducts. Drawings shall include air intakes and exhaust air and relief air louvers where applicable.

1.3.2 Metal Tags

Identification tags made of brass or aluminum indicating function of a control or similar component shall be installed on system devices. Tags shall be 50 millimeter in diameter; marking shall be stamped.

1.3.3 Service Labeling

Piping, including that concealed in accessible spaces, exposed, bare, painted, or insulated, shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction.

1.4 STORAGE AND PROTECTION OF EQUIPMENT AND MATERIALS

Equipment and materials stored at the site shall be fully protected from damage, dirt, debris, and weather.

1.5 AUTOMATIC CONTROL OF SYSTEMS

Automatic control systems shall be complete in all details and shall include accessories to maintain specified conditions.

Automatic temperature control system shall be DDC.

Sequence of operations to be controlled shall be as shown on drawings.

1.6 GENERAL REQUIREMENTS

Material, Equipment, and Fixture Lists shall be submitted showing

manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Manufacturer's Standard Color Chart shall be submitted for all HVAC equipment and accessories that will be exposed-to-view and shall consist of color chips.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Mechanical materials and equipment, spare parts and accessories, to be provided under this contract shall be current standard catalog products of manufacturers regularly engaged in the manufacture of the products.

2.2 MATERIAL AND EQUIPMENT

Mechanical material and equipment shall meet the specified requirements and shall be suitable for the installation shown. Components bearing the same part number shall be identical in form, fit, and function. Materials and equipment shall be new and free from defects.

2.3 IDENTIFICATION PLATES

Standard manufacturer's identification plates shall be provided for each individual piece of equipment.

2.4 STEEL PIPING FOR HEATING AND HOT WATER

Water piping for 1050-, 2500-kilopascal service shall be black carbon steel (BCS).

2.4.1 Type BCS (1000-kPa Service)

Pipe or tube (DN6 through DN250): Schedule 40 for water, seamless black carbon steel, conforming to ASTM A 53, or ASTM A 106, and ASME B36.10M

Fittings (DN6 through DN50): 2100-kilopascal working steam pressure (wsp) banded malleable iron, screwed end, conforming to ASME B16.3 and ASTM A 234/A 234M

Fittings DN65 through DN250): Wall thickness to match pipe, long radius, butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB.

Unions (DN6 through DN50): 1800-kilopascal wsp, malleable iron, screwed end, ground joint, with brass or bronze seat insert.

Flanges (DN65 through DN250): 1000-kilopascal, forged carbon steel, welding neck, with raised face or flat face and concentric finish, conforming to ASME B16.5 and ASTM A 694/A 694M

Flange gaskets: Gaskets shall conform to MSS SP-86 and ASME B16.21.

Bolting: Hexhead bolts and nuts shall conform to ASTM F 568.

2.4.2 Type BCS (2500-kPa Service)

Pipe or tube (DN6 through DN250): Schedule 40 for water, seamless black carbon steel, conforming to ASTM A 106 and ASME B36.10M

Fittings (DN65 through DN250): Schedule 40 for water, butt weld, black carbon steel, conforming to ASME B16.9 and ASTM A 234/A 234M

Flanges (DN65 through DN250): 2100-kilopascal, forged carbon steel, weld neck, with raised face and concentric serrated finish, conforming to ASME B16.5 and ASTM A 694/A 694M

Gaskets: Spiral-wound, non-asbestos fiber material filled, carbon steel, with centering provisions, conforming to ASME B16.5, Group 1 , and ASTM A 694/A 694M

Bolting: Heavy hexhead, carbon-steel bolts or bolt studs and semifinished heavy hex-nuts, conforming to ASTM F 568, Grade B

2.5 VALVES

2.5.1 Gate Valves

Body end connections shall be flanged for valves larger than DN50, unless butt weld ends are required. Screwed or socket weld shall be used for sizes DN50 and under.

For water usage, seat and seal material shall be of the manufacturer's standard Teflon, Viton, or nylon.

2.5.1.1 Type 2500

Valves shall be rated 2100 kilopascal wsp and shall conform to ASME B16.34.

Body to bonnet connection shall be union or gasketed-bolted type for valves DN50 and under and gasketed-bolted type for valves larger than DN50. Bonnet shall be OS&Y type, rising stem.

2.5.1.2 Type 1000

Valves shall be rated 1000-kilopascal wsp and shall conform to ASME B16.34.

Body to bonnet connection shall be union or gasketed-bolted type for valves DN50 and under and gasketed-bolted type for valves larger than DN50. Bonnet shall be OS&Y type, rising stem.

2.5.1.3 Type 850

Valves shall be rated 850-kilopascal wsp and shall conform to ASME B16.34.

Valves, in sizes DN50 and under, shall be union-bonnet type.

Stem shall be rising and backseating type.

2.5.2 Globe and Angle Valves

Body end connections shall be flanged for valves larger than DN50, unless butt weld ends are required. Screwed or socket weld shall be used for sizes DN50 and under.

For water usage, seat and seal material shall be of the manufacturer's standard Teflon, Viton, or nylon.

2.5.2.1 Type 2500

Valves shall be rated 2100-kilopascal wsp and shall conform to ASME B16.34.

2.5.2.2 Type 1000

Valves shall be rated 1000-kilopascal wsp and shall conform to ASME B16.34.

Pressure-regulating station bypass valves shall be Type 150.

2.5.2.3 Type 850

Valves shall be rated 850-kilopascal wsp and shall conform to MSS SP-86 and MSS SP-80, globe or angle.

Valves DN50 and under in size shall be union bonnet type.

Stem shall be rising and backseating type.

2.5.3 Check Valves

2.5.3.1 Type 2500

Valves shall be rated 2100-kilopascal wsp and shall conform to applicable portions of ASME B16.34.

Valves shall be horizontal swing-check type.

Body end connections shall be flanged for valves larger than DN50 unless butt weld ends are required. Screwed or socket weld shall be used for sizes DN50 and under.

Body-to-cover connection shall be union or gasketed-bolted type.

Trim materials, including hinge pin, shall be manufacturer's standard corrosion-resistant alloys for the specified service.

2.5.3.2 Type 850

Valves shall be rated 850-kilopascal wsp and standard horizontal swing type.

Body end connections shall be flanged for valves larger than DN50 and screwed in sizes DN50 and under.

Body-to-cover connection in sizes larger than DN50 shall be gasketed-bolted type.

Swing-check pin shall be corrosion-resistant steel, bronze, or brass. Swing check angle of closure shall be manufacturer's standard, unless a specific angle is required.

Valve disk shall be regrindable metal or renewable composition type.

2.5.4 Manual Radiator Valves

Valves to control heating medium to heating element shall be packless type. Valve end connection shall be the same size as the supply line.

2.5.5 Cone-Plug Balancing Valve (CPBV)

Cone-plug balancing valves in sizes through DN32 shall be thread end, conforming to ASME B1.20.1 and ASME B1.21M, and shall be rated for service at not less than 1200 kilopascal at 121 degrees C. Valve body and components shall be ASTM B 61 bronze or manufacturer's equal-strength brass materials. Valve plug shall be swivel-type contoured cone and shall not rattle or make any noise in service at any balancing position. Valve shall have high temperature, service-rated packing, with bushing in bottom of gland and gland adjustment. Valves shall be fitted with a memory device which shall permit a valve set at a balance point to be opened or closed but not opened beyond the balance point. Valve shall be nonrising stem type.

2.5.6 Eccentric Plug Valves (EPV)

Eccentric plug valves in sizes DN50 and smaller shall be constructed of manufacturer's standard brass or bronze materials conforming to ASTM B 61 or ASTM B 62. Valves shall be rated for service at 1200-kilopascal maximum nonshock pressure at 121 degrees C. Valve body shall have screwed ends. Eccentric plug surfaces in contact with flow shall be coated with a 60 to 70 Shore A durometer hardness elastomer, resistant to treated water.

Reopening, limited to eccentric plug valves in sizes DN65 and larger, shall be constructed of Type 2 nickel-alloy iron conforming to ASTM A 436. Valves shall be rated for service at 1200-kilopascal maximum nonshock pressure at 121 degrees C. Valve body shall have screwed ends. Eccentric plug surfaces shall be coated with a 60 to 70 Shore A durometer hardness elastomer, resistant to treated water.

2.5.7 Ball Valves (BAV)

2.5.7.1 Metal

Valves shall conform to MSS SP-72.

Valves shall be rated for service at not less than 1200 kilopascal at 93 degrees C.

Valve bodies in sizes DN50 iron pipe size (ips) and smaller shall be

screwed-end-connection type, constructed of Class A copper alloy.

Valve bodies in sizes DN65 ips and larger shall be flanged-end connection type, constructed of Class D, E, or F material.

Balls and stems of valves DN50 ips and smaller shall be manufacturer's standard Class A copper alloy with 900 Brinell hard-chrome plate finish or Class C corrosion-resistant steel alloy with hard-chrome plate.

Ball and stems of valves DN65 ips and larger shall be manufacturer's standard Class C, corrosion-resistant steel alloy with hard-chrome plate. In valves DN150 ips and larger, balls shall be Class D with 900 Brinell hard-chrome plate.

Valves shall be suitable for flow from either direction and shall seal equally tight in either direction.

Valves shall have full-pipe-size flow areas.

Valves with ball seals kept in place by spring washers are not acceptable. Valves shall have adjustable packing glands. Seats and seals shall be tetrafluoroethylene.

2.5.7.2 Polyvinylchloride (PVC)

Ball valves shall be manufactured from a PVC compound that meets the requirements of Class 12454-B PVC as outlined in ASTM D 1784. Valves shall also conform to NSF Std 14.

Valves shall have Teflon ball seals and Viton stem and body seals. Ball valves shall carry a pressure rating of 1000-kilopascalcirculating water pressure (cwp) at 24 degrees C.

2.5.7.3 Chlorinated Polyvinylchloride (CPVC)

Ball valves shall be manufactured from a compound that meets or exceeds the requirements for Class 23447-B CPVC in ASTM D 1784. Valves shall also conform to NSF Std 14.

Valves shall have Teflon ball seals and Viton stem and body seals. Ball valves shall carry a pressure rating of 1000-kilopascal cwp at 24 degrees C.

2.5.8 Butterfly Valves (BUV)

Butterfly valves shall conform to MSS SP-67, except as modified and supplemented herein.

Butterfly valves shall be wafer type for mounting between specified flanges and shall be rated for 1000 kilopascal (150 psig) shutoff and nonshock working pressure.

Valves installed in insulated piping systems shall be provided with extended bonnets placing the operator beyond the specified insulation.

Disk shall be free of external ribs and shall be streamlined.

Use of taper pins to secure the valve disk to the shaft is prohibited.

Shafts shall be a standard manufacturer's component for the valve provided.

Seats and seals shall be resilient-elastomer type designed for field removal and replacement. Elastomers shall be Buna-N, ethylene propylene terpolymer, chloroprene, or approved equivalent, formulated for continuous immersion service at 121 degrees C, minimum, and shall be applied at least 10 percent below maximum continuous service temperature. Bonding adhesives, if used, shall comply with elastomer temperature requirements and shall have an effective life equal to or greater than the elastomer.

Seals on DN500 and smaller valves shall be designed to use standard split-V packing, dual O-rings, and quad rings or they shall be of the adjustable pull-down type.

Seats may be installed in the valve body or on the disk except that circular cross-section O-ring construction is not acceptable.

Seat or disk matting surfaces shall be corrosion-resistant material such as austenitic gray cast iron and bronzes specified for the disk or the materials specified for stems. These materials shall be welded to substrate and ground or shall be mechanically retained. Plated or similarly applied surfacing materials are not acceptable.

Bearings shall be permanently lubricated sleeve type of manufacturer's standard corrosion-resistant steel, bronze, nickel-copper alloy, nylon, or filled tetrafluoroethylene. Bearings shall be designed for a pressure not exceeding the published design load for the bearing material or one-fifth of the compressive strength of the bearing or shaft material. The operating end of the shaft shall be provided with dual inboard bearings or a single inboard and an outboard bearing in or beyond the operator.

Padlocking feature shall be provided to make valve tamperproof.

For balancing service, valve operators shall have provision for infinite position locking.

Manual nonchain-operated valves through DN150 shall be provided with not less than nine-position, lever-lock handles not exceeding 450 millimeter in length.

Manual valves DN200 and larger, or smaller if the application torque exceeds a pull of 110 newton meter shall be provided with gear operators.

Where valves are indicated to be chain operated, all sizes shall be equipped with gear operators, and chain length shall be suitable for proper storage and operation.

Gear operators shall be worm-gear type. Operator shall be totally enclosed in a cast-iron housing, suitable for grease or oil lubrication. Gears shall be hobcut. Cast-iron-housed traveling-nut operators conforming to

AWWA C504 and MSS SP-86 are acceptable. Maximum manual pull on the handwheel or chain wheel shall be 110 newton-meter.

Modulating or remotely actuated two-position service valves shall be provided with pneumatic operators, pilot positioners, valve position indicators, boosters, and relays where necessary. Operating air supply pressure shall be as indicated in the contract documents.

Pneumatic operator and adjustable stroke crosslink system shall be provided for bypass operation.

Maximum load on a pneumatic operator shall not exceed 85 percent of rated operator capacity.

2.5.9 Dial Cocks

Dial cocks in sizes DN65 ips and smaller with pointer and etched position dial shall be rated 1000-kilopascal wsp and shall be of manufacturer's standard all-brass construction.

2.5.10 Diaphragm Control and Instrument Valves (DCIV)

Diaphragm control and instrument valves in sizes DN8 and DN10 shall have a forged-brass body with reinforced tetrafluoroethylene diaphragm, and an AISI 300 series corrosion-resistant steel spring with round phenolic handle. Handle shall be fitted with disks color-coded in accordance with MSS SP-86 and ISA RP60.9.

2.6 VIBRATION ISOLATORS

Rubber shall be natural rubber. Elastomer shall be chloroprene. Shore A durometer measurement of both materials shall range between 40 and 60.

Weather-exposed metal vibration-isolator parts shall be corrosion protected. Springs shall be chloroprene coated.

Exact mounting sizes and number of vibration isolators shall be determined by the isolator manufacturer based on equipment that will be installed. Equipment rpm and spring deflections shall be checked to verify that resonance cannot occur.

2.6.1 Mountings

Type A: Composite pad, with 7 millimeter thick elastomer top and bottom layers, molded to contain a pattern with nonslip characteristics in all horizontal directions. Elastomer loading shall not exceed 275 kilopascal. Minimum overall thickness shall be 25 millimeter. Deflections shall be limited to 6.4 millimeter or less.

Type B: Double rubber-in-shear or elastomer-in-shear with molded-in steel reinforcement in top and bottom. Deflections shall be limited to 13 millimeter or less.

Type C: Free-standing laterally stable open-spring type for deflections

over 13 millimeter, with built-in bearing and leveling provisions, 7 millimeter thick Type A base elastomer pads, and necessary accessories. Outside diameter of each spring shall be equal to or greater than 0.9 times the operating height of the spring under rated load.

Type D: Partially housed type, containing one or more vertically restrained springs with at least 13 millimeter clearance maintained around springs, with adjustable limit stops, 7 millimeter thick Type A base elastomer pads, and necessary accessories.

Type E: Pendulum-suspension configuration with free-standing stable spring with resilient horizontal and vertical restraints to allow movements of not more than 7 millimeter in each direction, 7 millimeter thick Type A base elastomer pads.

Type F: Combination spring and rubber-in-shear or elastomer-in-shear steel framed for hanger-rod mounting. Minimum total static deflection shall be 25 millimeter.

2.6.2 Bases

Type U: Unit isolators without rails, structural-steel bases, or inertia blocks

Type S: Structural-steel bases common to a supported assembly, made from welded-joint mill-rolled structural steel with closed-perimeter configuration, isolators attached to outrigger supports

Height of steel members shall be sufficient to provide stiffness required to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components.

2.6.3 Pipe and Duct Vibration Isolation

Type G: Isolators shall be devices with in-series contained steel springs and preformed fibrous-glass or chloroprene-elastomer elements for connecting to building-structure attachments. Devices shall be loaded by supported system during operating conditions to produce a minimum spring and elastomer static deflection of 25 millimeter and 10 millimeter, respectively.

Type H: Isolators shall be devices with contained chloroprene-elastomer elements for connecting to building-structure attachments. Devices shall be loaded by supported system during operating conditions to produce a minimum elastomer static deflection of 10 millimeter.

Type J: Isolators shall be devices with elastomers mounted on floor-supported columns or directly on the floor. Devices shall be loaded by supported system during operating conditions to produce a minimum elastomer static deflection of 10 millimeter.

2.6.4 Floor-Mounted Piping

Type K: Isolators shall be devices with springs mounted on floor-supported

columns or directly on the floor. Devices shall be loaded by supported system during operating conditions to produce a minimum spring static deflection of 25 millimeter.

2.6.5 Vertical Piping

Type L: Isolators shall be pipe base-support devices with one or more contained steel springs. Devices shall be loaded by supported system during operating conditions to produce a minimum static deflection of 25 millimeter Devices shall be equipped with precompression and vertical-limit features, as well as a minimum 7 millimeter thick elastomer sound pad and isolation washers, for mounting to floor.

Type M: Isolators shall be elastomer mounted baseplate and riser pipe-guide devices. Elastomer elements shall be contained double acting, and elastomers under rated load shall have a minimum static deflection of 10 millimeter. Isolator shall be sized to accommodate thermal insulation within the stationary guide ring.

2.7 INSULATION

Thermal-insulation system materials shall be noncombustible, as defined by NFPA 220.

Surfaces to be insulated, extent of insulation, and thickness of insulation shall be as indicated on the contract drawings.

Insulation thickness and duct sizes are in millimeter. Nominal duct thickness sizes are internal dimensions. Internal insulation is permitted. Pipe callouts are nominal pipe sizes in millimeter.

Mineral fiber blanket and felt insulation shall have a thermal conductivity less than 0.037 watt per square meter per degrees K at operating temperatures, a density greater than. 64 kilogram per cubic meter. Insulation shall conform to ASTM C 553.

Mineral fiber rigid board and block insulation shall have a thermal conductivity less than 0.063 watt per square meter per degrees K at operating temperature, a density greater than 48 kilogram per cubic meter. Insulation shall conform to ASTM C 612.

Fibrous glass blanket and board insulation shall have a thermal conductivity less than 0.039 watt per square meter per degrees K at operating temperature, a density greater than 16 kilogram per cubic meter. Insulation shall conform to ASTM C 1139.

Cellular glass shall have a minimum thermal conductivity less than 0.048 watt per square meter per degrees K a density of 120 to 136 kilogram per cubic meter.

Cellular elastomer shall have a minimum thermal conductivity less than 0.039 watt per square meter per degrees K.

Cellular glass shall conform to ASTM C 552, Type II (pipe covering).

2.7.1 Adhesives

Adhesives shall be as recommended by the insulation manufacturer.

2.7.2 Jacketing

Jacketing shall be as recommended by the insulation manufacturer.

2.7.3 Coatings

Coatings shall be as recommended by the insulation manufacturer.

Coating color shall be as selected by the Contracting Officer.

Finish coating for cellular elastomer insulation shall be a polyvinylchloride lacquer approved by the manufacturer of the cellular elastomer.

2.8 BOILERS

Minimum efficiency shall be 80 percent at steady state combustion as tested in accordance with DOE test procedures.

2.8.1 Factory Testing

Boilers, completely factory-assembled, shall be tested at the manufacturer's plant, and a certificate by an independent testing agency shall be submitted by the Contractor for approval.

2.8.2 Modulated Gas Fired Pulse Pak Pulse Combustion Packaged Hydronic Heating Boilers

Contractor shall furnish and install a Natural Gas Fired Pulse Combustion Hot Water Boiler as manufactured by Fulton or equal.

Each unit shall be pulse combustion type complete with boiler fittings and automatic controls. The boiler (with all wiring) shall be completely factory assembled as a self contained unit. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with maximum water working pressure of 850 PA. Boiler shall also comply with CSD-1 Code requirements.

The boiler shall have no minimum flow requirements or minimum return water temperature requirements. The boiler shall be a firetube design, utilizing the principles of pulse combustion. The boiler, due to the nature of pulse combustion, shall be self-venting and self-aspirating, required no forced or induced draft fan to supply air for combustion after ignition. Adequate openings shall be provided for access to the water side of the boiler.

The combustor shall be constructed of SA-53B ERW pipe. The vessel shell shall be SA-53B ERW pipe of SA-285 Grade C plate. The heads shall be SA-516 Grade 70 plate. The pressure vessel shall be fully insulated with

50mm of high temperature insulation.

2.8.3 Boiler Flue Venting

The Pulse Combustion Boiler shall be A.G.A./C.G.A. approved as a Direct Vent Boiler, with conventional chimney or stack not required. The boiler shall have the combustion air intake supply ducted in from the outside. Exhaust venting shall be constructed of AL-29-4C.

2.8.4 Boiler Fittings

Temperature and pressure gauge shall be provided with the boiler.

2.8.5 Pulse Boiler Combustion Equipment

The flame safeguard shall be Fulton RM7865. The control shall provide a 35 second prepurge and postpurge. The control shall maintain a running history of operating hours, number of cycles, and most recent six failures. This control shall have the capacity to be connected to a Keyboard Display Module which will retrieve that information.

Each pulse boiler shall be equipped for modulated gas input. Fuel flow shall be controlled by a valve in the fuel train. Air flow shall be controlled by a 316-L butterfly valve located in the exhaust vent. Both valves will be connected to a modulation motor which is controlled by a 4-20 ma signal from a microprocessor based temperature controller. Turn down shall be 5:1.

The pulse combustor location shall be such that all combustor assembly components are located within water backed areas. Pulse combustion controls shall be of on/off operative type and are to include:

A. Operating Temperature Controller for automatic start and stop of the pulse combustor.

B. High Limit Temperature Controller (manual reset).

C. One Low Water Cutoff Probe in boiler shell.

D. Air Safety Switch to prevent operation until sufficient prepurge air is assured.

E. Proof of Flame Switch to prove combustion. All controls are to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. All controls shall be mounted and wired according to A.G.A./C.G.A. and UL requirements. Electric power supply 120 volts, 60 cycle single phase.

2.8.6 Operating Manual

A. Instructions for installation, operation, and maintenance of the boiler shall be contained in a manual provided with each boiler unit.

B. A wiring diagram corresponding to the boiler shall be affixed to the

boiler near the electrical panel.

2.8.7 Warranty

The pressure vessel shall be guaranteed against thermal shock for 10 years when utilized in a closed loop hydronic heating system with a temperature differential of 77 degrees C or less. The pressure vessel and exhaust assembly shall be covered by a three (3) year non-prorated warranty against flue gas corrosion. All other components are covered by a one year (12 month) warranty from the job acceptance date.

2.9 UNIT HEATERS (HOT WATER)

Unit heaters shall be suspended type and arranged for discharge of air as indicated on the construction drawings. Unit shall comply with applicable American Gas Association standards.

2.9.1 Casing

Casing shall be manufactured of not less than 1 millimeter steel. Casing inside and outside shall be given a phosphate pretreatment, primer, and baked enamel finish. Horizontal louvers shall be provided and shall be completely recessed inside of the casing frame.

2.9.2 Fans

Fans shall be propeller type, designed and manufactured for unit heater application. Fans shall have a minimum of three aluminum blades.

2.9.3 Motors

Motors shall be totally enclosed, with sleeve bearings and built-in overload protection. Motors shall be mounted to back panel by a fan guard motor mount constructed of spring steel wire.

2.9.4 Controls

Controls shall include high limit switch, fan controls. An integral junction box for power and control connections shall be provided.

2.9.5 Propeller Unit Heaters (PUH)

2.9.5.1 Vertical Discharge Units

Vertical discharge units shall operate at speeds not in excess of 1,200 revolutions per minute (rpm), except that units with 15 kilowatt per hour output and less shall operate at speeds up to 1,800 rpm. Discharge opening shall be covered with a fanguard.

Louver cone diffusers shall be provided.

2.9.5.2 Horizontal Discharge Units

Maximum volume and face velocity for horizontal discharge units shall be:

CUBIC METER PER SECON	METER PER SECOND
Up to 0.47	4.1
0.48 to 1.42	4.6
1.43 and over	5.1

Adjustable double deflection louvers shall be provided.

2.9.5.3 Heating Elements

Heating elements shall be manufacturer's standard construction, rated for service at not less than 150 degrees C at 520 kilopascal.

2.9.5.4 Casings

Casings with smoothly contoured propeller orifice rings shall be constructed of 1 millimeter or thicker cold-rolled carbon steel. Casing surface finish shall include phosphate pretreatment, prime coating, and baked enamel finish.

2.9.5.5 Propellers and Motors

Propellers shall have not less than four aluminum blades and shall be dynamically balanced.

Horizontal-discharge units shall be provided with fan inlet safety guard.

Motors shall be mounted on elastomer vibration isolators.

2.9.5.6 Sound Rating

Unit heater shall be tested and sound rated in accordance with AMCA 300and AMCA 301.

2.9.5.7 Control

Unit heaters shall be controlled by line-voltage thermostats.

2.9.6 Cabinet Unit Heaters (CUH)

Cabinet unit heaters shall be quiet-operating type, complete with heating elements, fans and drives, filters, baffles and division walls, control provisions, and enclosures with access panels as necessary.

Cabinet shall be sized not larger than indicated in the detail drawings.

Unit pressure components shall be rated for service at not less than 1050 kilopascal at system working temperature.

2.9.6.1 Heating Element (CUH)

Heating element shall be manufacturer's standard aluminum fin or serpentine copper-type tube and shall be drainable and ventable.

Cataloged capacity of the heating element shall be constant and permanent.

Tube material shall be seamless deoxidized copper.

Fins shall be mechanically connected to the tubes. Loose fins at operating temperatures will be regarded as causing a reduction in capacity, and the Contractor shall replace such material at no additional cost to the Government. Elements with bent fins are not acceptable.

Expansion provisions and supports shall be such that element movement is strainfree and noiseless.

Face area of the coil shall be not less than that indicated in the detail drawings.

2.9.6.2 Fan and Drive Assembly (CUH)

Fan shall be centrifugal, forward-curved, double-width, double-inlet type, and shall be statically and dynamically balanced.

Fan drives shall be direct.

Fan drives shall be direct, except where belt drives are indicated in detail drawings. Belt-drive motors shall be fitted with adjustable rails and an adjustable sheave to permit 20 percent adjustment to fan speed. Independent fan shafts shall be elastomer mounted in self-aligning antifriction or sleeve-type bearings, with essentially lifetime lubrication.

Drives shall be two-, three-, or four-speed and switch positions shall include an off position.

Rotating elements shall be statically and dynamically balanced, and fan and drive assembly shall be vibration isolated.

Direct-drive motors shall not exceed 1,200 rpm.

2.9.6.3 Filters (CUH)

Filters shall be installed in a bypass-proof frame to ensure filtering of all moving air before entry into heating element and shall be removable without tools.

2.9.6.4 Enclosures (CUH)

Enclosure configuration shall be as indicated in the detail drawings.

Enclosure surface finish shall include manufacturer's standard phosphate pretreatment, prime coat, and baked enamel finish in color as selected by the Contracting Officer.

2.9.6.5 Insulation (CUH)

Backs of recessed units shall be insulated with not less than 13 millimeter of 48 kilogram per cubic meter density fibrous-glass insulation conforming to NFPA 90A.

2.9.6.6 Control Cycle (CUH)

Sequence of operation shall be as indicated in the Control Diagrams.

Control components shall conform to requirements specified under paragraph entitled, "Controls."

2.10 DUCTWORK

2.10.1 Galvanized Steel Ductwork Materials

Galvanized steel ductwork sheet metal shall be carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A 527/A 527M, G90. Duct surfaces to be painted shall be treated by phosphatizing.

Sheet metal thickness and reinforcement thickness shall conform to ASHRAE-05, ASHRAE-07 and SMACNA-06.

2.10.1.1 Duct Hangers

Duct hangers in contact with galvanized duct surfaces shall be galvanized steel.

2.10.1.2 Mill-Rolled Reinforcing and Supporting Materials

Mill-rolled structural steel shall conform to ASTM A 36/A 36M and, whenever in contact with sheet metal ducting, shall be galvanized to commercial weight of zinc.

2.10.2 Rigid Fibrous-Glass Ductwork Materials

Rigid fibrous-glass duct system, including tapes, adhesives, vapor barriers, and joint sealers, shall conform to requirements of NFPA 90Aand shall have FM P7825 approval and UL 181, Class 1 airduct listing, and be so labeled. Duct system shall have a thermal-conductivity K-value of 0.45 watt per meter degrees K for flat and 0.40 watt per meter degrees K for round duct at 24 degrees C mean temperature. Duct system shall have a noise-reduction coefficient of 0.070 and a vapor-transmission rate of less than 0.011 nanogram per pascal second square meter for flat board and 0.06 nanogram per pascal second square meter for round duct. Minimum density shall be 80 kilogram per cubic meter for flat board and 52 kilogram per cubic meter for round duct. Vapor barrier shall be factory applied. Materials shall be odorless and nonallergenic when in service.

2.10.3 Flexible Duct Materials

Flexible duct connectors shall be in accordance with UL 181, Class 1

material and shall comply with NFPA 90A.

Metal duct shall be bendable through 180 degrees without damage, with an inside bend radius not greater than one-half the diameter of duct. Metal shall be aluminum or carbon steel protectively zinc-coated with materials conforming of ASTM A 123 or MS MIL-P-26915.

Wire-reinforced cloth duct shall consist of a chloroprene or vinyl-impregnated and coated fibrous-glass cloth bonded to and supported by a corrosion-protected spring steel helix. Fabric may be a laminate of metallic film and fibrous glass. Working pressure rating of ducting shall not be less than three times maximum system pressure, and temperature range shall be within minus 27 to 75 degrees C.

Wire-reinforced fibrous-glass duct shall consist of a minimum 16 kilogram per cubic meter density fibrous glass bonded to and supported by corrosion-protected spring helix. Vapor barrier shall be a 0.102 millimeter minimum, pigmented polyvinylchloride film. Duct shall be bendable without damage through 180 degrees with an inside bend radius not greater than two duct diameters. Minimum wall thickness shall be 25 millimeter. Thermal conductivity shall be not greater than 0.40 watt per meter degrees K at 24 degrees C mean. Permeance shall be not greater than 0.06 nanogram per pascal second square meter. Working pressure range shall be from minus 125 pascal to plus 375 pascal; working temperature shall range from minus 29 to 121 degrees C. Minimum sustained velocity without delamination shall be 12.2 meter per second. Materials shall conform to NFPA 90A. Acoustic properties shall be submitted for approval.

2.10.4 Manual Volume Dampers

Volume damper construction shall conform to ASHRAE-05, ASHRAE-07and SMACNA-06.

Dampers shall be equipped with an indicating quadrant regulator having a locking feature externally located and easily accessible for adjustment. Where damper rod lengths exceed 760 millimeter, a regulator shall be provided at each end of damper shaft.

Damper shafts shall have two-end bearings.

Splitter damper shall be 0.85 millimeter sheet metal, or 0.8 millimeter (2 gages) heavier than duct in which installed; i.e., 1.0 millimeter splitter in 0.85 millimeter duct, up to 1.6 millimeter maximum. Hinges shall be full length piano-type or 3 millimeter thick door type.

Damper shaft shall be full length and shall extend beyond damper blade. A 10 millimeter square shaft shall be used for damper lengths up to 500 millimeter and a 13 millimeter square shaft shall be used for damper lengths 500 millimeter and larger. Where necessary to prevent damper vibration or slippage, adjustable support rods with locking provisions external to duct shall be provided at damper blade end.

Dampers in ducts having a width perpendicular to the axis of the damper that is greater than 300 millimeter shall be multiblade type having a

substantial frame with blades fabricated of 1.6 millimeter metal. Blades shall not exceed 250 millimeter in width and 1200 millimeter in length and shall be pinned or welded to 13 millimeter diameter shafts. Dampers greater than 1200 millimeter in width shall be made in two or more sections with intermediate mullions, each section being mechanically interlocked with the adjoining section or sections. Blades shall have graphite-impregnated nylon or oil-impregnated sintered bronze bearings and shall be connected so that adjoining blades rotate in opposite directions.

2.10.4.1 Gravity Backdraft and Relief Dampers

Frame shall be constructed of not less than 40 by 100 millimeter, adequately reinforced, 1.6 millimetergalvanized carbon steel. Frames and mullions shall be solidly secured in place and sealed with elastomer calking against air bypass.

Maximum blade width shall be 225 millimeter; maximum blade length shall be 900 millimeter. Blade material shall be 1.6 millimeter galvanized steel, 2.0 millimeter 6063 or 5052 alloy aluminum, or 1.3 millimeter AISI 18-8 corrosion-resistant steel. Blades shall be provided with mechanically retained seals and 90-degree limit stops.

Dampers used for relief service shall have blades linked together to open not less than 30 degrees on 12.5 pascal differential pressure.

Shaft bearings shall be graphite-impregnated nylon or oil-impregnated bronze.

2.10.4.2 Power-Operated Dampers

Dampers shall conform to applicable requirements specified under paragraph entitled, "Controls and Instrumentation."

2.10.4.3 Flexible Connectors for Sheet Metal

Connectors shall be UL-listed, 6 kilogram per square meter, fire-retardant, airtight, woven fibrous-glass cloth impregnated with chloroprene. Clear width, not including clamping section, shall be within 75 to 125 millimeter.

2.10.4.4 Fire Dampers

Fire dampers in ductwork shall be provided at firewall barriers.

Fire dampers shall be constructed and labeled in accordance with UL.

2.11 AIR DIFFUSERS

Supply diffusers shall be provided with combination damper and equalizing grid; damper shall be extracting-splitter type, except where otherwise specified.

Gaskets shall be provided for supply-terminal air devices mounted in finished surfaces.

Color selection shall be from manufacturer's standard color chips and approved by the Contracting Officer.

Low-velocity systems shall encompass ductwork and plenums where maximum air velocity is 13 meter per second and maximum static pressure is 500 pascal, positive or negative.

2.11.1 Type Air-Diffusion Devices

Construction of air-diffusion devices shall be aluminum.

2.11.1.1 Type DRA

Type DRA supply diffuser shall be round with five or more expanding cones with beaded edges to provide hemispherically diffused discharge air. Cones shall be arranged to provide a minimum of four air paths that simultaneously diffuse air at 0.10 to 0.25 meter per second and aspirate room air at 25 to 35 percent of discharge volume.

Antismudge ring shall be provided.

Extended cones shall be provided.

2.11.1.2 Type DRB

Type DRB supply diffuser shall be round with four or more expanding cones to provide hemispherically diffused discharge air. Cones shall be arranged to provide a minimum of three air paths that simultaneously diffuse air at 0.10 to 0.25 meter per second. Pattern adjustment shall range from horizontal to downward projection, and any intermediate point, when mounted on exposed ductwork.

Integral or separate antismudge ring shall be provided.

Extended ceiling cone shall be provided.

2.11.1.3 Type DRC

Type DRC combination supply and return diffuser shall be round with four expanding cones; cones shall be arranged to provide one return air path and two supply air paths. A butterfly supply-air damper and an annular return-air damper shall be provided.

Antismudge ring shall be provided.

2.11.1.4 Type DRE

Type DRE supply diffuser shall be round with three or more expanding cones to provide discharge air paths that shall be, minimally, two-position adjustable for horizontal or vertical discharge.

Antismudge ring shall be provided.

2.11.1.5 Type DRH

Type DRH supply diffuser shall be half-round with four or more semiconical expanding members to discharge diffused air in a 180-degree pattern. Cones shall be arranged to provide a minimum of three air paths that shall simultaneously diffuse air at 0.10 to 0.25 meter per second. Opposed-blade volume control damper shall be provided.

2.11.1.6 Type DP Series

Type DP series supply diffuser shall have a square or rectangular, perforated face plate with opposed blade or splitter-damper volume control, white baked enamel exterior finish, and black matte finish on exposed-to-view interior surface. (Type DP series diffusers fit a hung ceiling grid system.)

Type DPA shall provide one-way deflection or two-way opposed deflection.

2.11.1.7 Type DLB

Type DLB supply diffuser shall be linear bar type, frame mounted, with extruded-aluminum bar and frame.

Bars shall be 6 millimeter thick by 20 millimeter high, 13 millimeter on center. Bar spacing shall be pencil-proof. Bar deflection angle shall be zero degrees.

Floor- and sill-mounted diffusers shall be heavy-duty reinforced construction to carry loads of not less than 4800 pascal.

Diffusers shall be continuous length with hairline butt joints.

Mitered end caps shall be provided where diffuser run terminates.

Dampers shall be opposed-blade type.

An integral, pivoted, bar-type access door shall be provided.

Straightening grids shall be provided.

2.11.1.8 Type DLS

Type DLS supply diffuser shall be linear slot type, extruded aluminum construction, with fully adjustable integral air pattern and volume control vanes that deflect air pattern from horizontal along ceiling to straight down, or any intermediate setting. Pattern control element shall permit complete blanking-off of slot.

Slot width shall be 20 millimeter.

Number of slots per unit run shall be as indicated in the manufacturer's catalog data.

Butts in continuous runs shall be aligned for hairline joints.

Ends of diffuser shall butt against walls without mitered end caps. End caps shall be provided where slot terminates.

Exposed-to-view part of frame shall be anodized aluminum; interior exposed-to-view components shall have a black matte finish.

2.11.1.9 Type DSA

Type DSA supply diffuser shall be square with four or more expanding flared members to provide radially diffused discharge air. Flared members shall be arranged to provide a minimum of four air paths that simultaneously diffuse air at 0.10 to 0.25 meter per second. Pattern adjustments shall include horizontal, vertical projection, and an intermediate position or range.

Integral extended surface to fit into module of lay-in ceiling shall be provided.

2.11.1.10 Type GS

Type GS supply grille shall be double deflection type with adjustable face bars parallel to short dimension and adjustable rear bars parallel to long dimension.

Integral extended surface to fit into module of lay-in ceiling shall be provided.

2.11.1.11 Type GR

Type GR return grilles shall be single deflection type with fixed face bars.

Grilles installed in vertical surfaces shall have horizontal face bars set downward at approximately 35 degrees from vertical.

Grilles installed in horizontal surfaces shall have face bars straight and parallel to short dimension.

Integral extended surface to fit into module of lay-in ceiling shall be provided.

2.11.1.12 Type GCA

Type GCA shall have an individually adjustable, horizontal, curved-blade grille and a one-way pattern.

2.11.1.13 Type GCB

Type GCB shall have an individually adjustable, vertical, curved-blade grille and a one-way pattern.

2.11.1.14 Type GCD

Type GCD shall have an individually adjustable, vertical, curved-blade grille and a two-way pattern.

2.11.1.15 Type GCE

Type GCE shall have an individually adjustable, vertical and horizontal, curved-blade grille and a three-way pattern.

2.11.1.16 Type GCF

Type GCF shall have an individually adjustable, vertical and horizontal, curved-blade grille and a four-way pattern.

2.11.1.17 Type RS

Type RS shall be supply register, double-deflection type, with adjustable face bars parallel to short dimension and adjustable rear bars parallel to long dimension. Dampers shall be opposed-blade type.

Integral extended surface to fit into module of lay-in ceiling shall be provided.

2.11.1.18 Type RR

Type RR shall be return register, single-deflection type, and shall have fixed face bars with opposed-blade dampers.

Registers installed in vertical surfaces shall have horizontal face bars set downward at approximately 35 degrees from vertical.

Registers installed in horizontal surfaces shall have face bars set straight and parallel to short dimension.

2.11.1.19 Type RCA

Type RCA shall have an individually adjustable, horizontal, curved-blade register and a one-way pattern with opposed-blade damper.

2.11.1.20 Type RCB

Type RCB shall have individually adjustable, vertical, curved-blade register and a one-way pattern with opposed blade damper.

2.11.1.21 Type RCC

Type RCC shall have an individually adjustable, horizontal, curved-blade register and a two-way pattern with opposed blade damper.

2.11.1.22 Type RCD

Type RCD shall have an individually adjustable, vertical, curved-blade register and a two-way pattern with opposed blade damper.

2.11.1.23 Type RCE

Type RCE shall have an individually adjustable, vertical and horizontal,

curved-blade register and a three-way pattern with opposed-blade damper.

2.11.1.24 Type RCF

Type RCF shall have an individually adjustable, vertical and horizontal, curved-blade register and a four-way pattern with opposed-blade damper.

2.11.1.25 Type TS

Type TS supply troffer complete assembly shall be provided as indicated in the manufacturer's catalog data. Air handling section of unit shall be installed under this section.

2.11.1.26 Type TR

Type TR return troffer shall conform to requirements for Type TS supply troffer.

2.11.1.27 Type TSR

Type TSR combination supply and return troffer assembly shall be provided as indicated in the manufacturer's catalog data.

2.11.2 Rigid Fibrous-Glass Ductwork

Rigid fibrous-glass ductwork may be used within limitations established by NFPA 90A.

2.12 MIXING BOXES

2.12.1 Variable Constant-Volume Boxes

Casing shall be fabricated from galvanized steel and shall have internal thermal and acoustic insulation. Insulation shall be coated to prevent erosion and shall conform to NFPA 90A.

Casing internal leakage shall be limited to 2 percent of nominal box capacity when the internal pressure is 250 pascal.

Casing shall be fitted with rigid, airtight access panels, easily removable, and of ample size to give free access to interior parts.

2.13 FILTERS

2.13.1 Filter Gages and Manometers

Air filter gages or manometers shall be provided for each type filter assembly. Gages shall be the dial-indicator type, graduated to read 0 to 500 pascal, except that gages for HEPA filters shall read 0 to 750 pascal. Manometers shall measure from minus 125 to 750 pascal and be equipped with a built-in indicator bubble. Gage or manometer shall be connected to static-pressure ports of approved design and located so that resistance to airflow will be correctly indicated.

PART 3 EXECUTION

3.1 INSTALLATION

Materials and equipment shall be installed in accordance with the requirements of the contract drawings and approved recommendations of the manufacturers. Installation shall be accomplished by workers skilled in this type of work. Installation shall be so made that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Emergency switches and alarms shall be installed in conspicuous locations.

Manufacturer's Installation Instructions shall be submitted indicating the manufacturer's recommended method and sequence of installation for HVAC systems.

Installation drawings shall be installed in accordance with referenced standards in this section. Drawings shall show details of equipment room layout and design.

Pipe valves and specialties shall be installed in accordance with manufacturer's recommendations and in accordance with paragraphs entitled, "Steel Pipe," "Valves," and "Refrigeration Specialties."

3.2 CLEANING

Exposed surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish painting or are enclosed within the building structure.

Before final acceptance, mechanical equipment, including piping, ducting, and fixtures, shall be clean and free from dirt, grease, and fingermarks.

3.3 INSULATION SYSTEMS

Insulation and system components shall be installed per the manufacture's instructions.

Workmanship shall reflect the best current practices in the trade. Contours on exposed work shall be smooth and continuous.

3.3.1 Hot-Water Piping

Insulation shall be cellular glass with PVC jacket. Thickness shall be not less than that given in the following list. Aboveground pipes, valve bodies, fittings, unions, flanges, and miscellaneous surfaces shall be insulated.

PIPE SIZES (DN) DIAMETER NOMINA	INSULATION THICKNESS MILLIMETER
Up to 100	40

PIPE SIZES (DN) DIAMETER NOMINA	INSULATION THICKNESS MILLIMETER
100 to 200	50
200 and over	65

3.4 BOILERS

Boilers shall be installed and tested in accordance with manufacturer's recommendations.

3.5 AIR HANDLING UNITS

3.5.1 Installation

Coils shall be installed in accordance with the manufacturer's recommendations. Dampers shall be set in a fixed position to provide the outside air quantity scheduled.

Floor drains shall be provided where indicated in the equipment room layout drawings. Drain line shall be not less than DN50.

3.5.2 Enclosure Test

Services of a competent, factory-trained manufacturer's representative shall be provided to supervise assembly, inspection, and testing of the enclosure.

Enclosure rigidity shall be tested by starting and stopping fans. No audible enclosure popping noise, deflection, or deformation in excess of specified limits shall result.

3.6 DUCTWORK

3.6.1 Installation

Sheetmetal construction shall be provided in accordance with the recommendations for best practices in ASHRAE-05, ASHRAE-07, SMACNA-06 and NFPA 90A.

Fibrous-glass ductwork shall be provided in accordance with the recommendations for best practice outlined in SMACNA-03, provisions of NFPA 90A requirements, and manufacturer's instructions where construction methods are not covered by SMACNA-03. Rectangular duct requirements, where applicable, shall apply for round duct.

Where construction methods for certain items are not indicated or described in the referenced standards or herein, the work shall be performed in accordance with ASHRAE-04.

Supplementary steel shall be designed and fabricated in accordance with AISI SG-911 and AISC M017.

3.6.2 Openings in Roofs and Walls

Building openings are fixed as indicated in the equipment room layout drawings and equipment shall be provided to suit. Contractor may propose to alter these openings upon prior approval by the Contracting Officer and at his expense.

Openings indicated in outside walls and roof are approximate. Within 45 days after the award of contract, detail drawings showing exact opening dimensions and location of the equipment shall be submitted to the Contracting Officer for approval.

3.6.3 Ductwork Cleaning Provisions

Open ducting shall be protected from construction dust and debris in a manner approved by the Contracting Officer. Dirty assembled ducting shall be cleaned by subjecting main and branch interior surfaces to air streams moving at velocities two times the specified working velocities, at static pressures within maximum ratings. This may done with filter-equipped, wheel mounted, portable blowers; compressed-air operated perimeter lances that direct the compressed air and which are pulled in the direction of normal air flow; or other means approved by the Contracting Officer. Compressed air used for cleaning ducting shall be water- and oil-free. Prior to acceptance, dust and debris shall be removed from exterior surfaces.

3.6.4 Fire Damper Tests

Operation tests shall be performed on each fire damper in the presence of the Contracting Officer by activating fusible link with localized heat. New links shall be provided and installed after successful testing.

3.7 FILTERS

Filter supports and retention elements shall be coordinated to provide a substantial, structurally sound, leakproof installation. Filter arrangements shall be as indicated in the manufacturer's catalog data.

Holding frames shall be gasketed on perimeter, or calked to each other, to supplementary steel, or to closures with elastomeric compounds recommended by the filter manufacturer. Substrate shall be prepared in accordance with the elastomer manufacturer's instructions, including the priming of surfaces in areas where the elastomer is not confined.

3.8 CONTROLS

3.8.1 Installation

Installation of control components shall be done by Contractor-certified control and instrumentation specialists or factory representatives.

Installation shall conform to the published or written instructions of the manufacturer.

Tubing shall be concealed, except in mechanical rooms or areas where other piping is exposed.

Multiple tube runs shall be neatly nested.

3.8.2 Testing, Calibration, and Acceptance

After completion of control and instrument piping, control equipment shall be tested and adjusted in terms of design, function, systems balance, and performance, and shall otherwise be made ready for air handling systems acceptance tests. Data showing set points and final adjustments of controls shall be provided.

3.8.3 Operating Instructions and Operator Training

Six copies of written operating maintenance instructions and not less than 8 hours of operator training shall be provided.

3.9 AIR-HANDLING SYSTEMS TESTING

Tests shall be performed prior to insulation of surfaces, painting, and concealment of work.

3.9.1 Low-Velocity Duct Systems

Portions of systems shall be inspected and tested to positive or negative pressures, or both, whichever is normal to the portion of system under test, to verify the following:

There are no visible mechanical defects.

There is no audible leakage at any point when area ambient noise is at normal-occupancy level.

No leakage is perceptible to the hand, when placed within 150 millimeter of a joint.

3.9.2 High-Velocity Duct Systems

High-velocity, high, and medium pressure systems shall be structurally tested at static pressures 50 percent in excess of total fan pressure. Leakage testing shall be at a pressure 25 percent higher than normal operating pressure, and in dual duct systems at maximum pressure at mixing box, when inlet valve is shut off. System will be acceptable provided:

There are no visible mechanical defects.

Measured total system leakage does not exceed 0.5 percent of total system cubic meter per second capacity.

There is no audible leakage at any point when area ambient noise is at normal-occupancy level.

3.9.3 Test Apparatus and Procedures

Test apparatus and procedures shall be similar in all respects to that defined in ASHRAE-05, ASHRAE-07 and SMACNA-07. Filtered blower inlet and automatic safety relief device shall be provided to protect system. Accuracy of measurement of leakage flow rate shall be certified to be within 2 percent of total leakage flow.

3.10 AIR AND HYDRONIC SYSTEMS TESTING, AND ADJUSTMENT

Operational balancing and adjustment of air-handling and hydronic systems shall be performed under the direction of an independent balancing agency whose field representative is a registered professional engineer. Work shall be done in accordance with ASHRAE-07, ASHRAE-05, Chapter 12 and Chapter 50, AABC MN-1or SMACNA-07, where applicable, the requirements of the contract documents, and in the presence of the Contracting Officer.

3.10.1 Air-Handling Systems

Final volume conditions for all systems shall be within plus or minus 5 percent of the conditions indicated on contract drawings.

Balancing and adjustment apparatus, procedures and test report shall be in accordance with Section II of ASHRAE-07, ASHRAE-05, Chapter 12 and Chapter 50, AABC MN-1or SMACNA-07.

3.10.2 Hydronic Systems

3.10.2.1 Balancing, Adjustment, and Acceptance

Systems final flow conditions shall be within plus or minus 5 percent of conditions indicated on contract drawings.

Complete air balance shall have been accomplished before water balance begins.

3.10.2.2 Hydronic Systems Preparation

Hydronic systems shall be tested at 125 percent of rated pressure.

All valves shall be opened to full-open position, including coil-stop valves, bypass valves, and return-line balancing cocks.

Rotation of pumps shall be checked only after obtaining approval.

Expansion tanks shall be checked to determine that they are not air-bound and that system is full of water.

3.10.3 Adjustment and Acceptance Criteria

After balance and adjustment operations have been completed, the system shall be tested as a whole to verify that all items perform as an integral part of the system and that temperature and conditions are evenly controlled. Corrections and adjustment shall be made as necessary to produce the required specifications.

3.10.4 Test Report

Operational test reports shall be provided on systems tested. Test report format shall be approved by the Contracting Officer.

3.11 OPERATION AND MAINTENANCE

Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 days prior to testing the system involved. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Test data shall be legible and of good quality.

-- End of Section --

SECTION 15720

AIR HANDLING UNITS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AIR CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 430	(1989) Central-Station Air-Handling Units

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 211	(1994) Certified Ratings Program - Air Performance

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 51	(1985) Laboratory Methods of Testing Fans for Ratin

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Equipment and Performance Data shall be submitted for air handling units in accordance with the specification. Data shall consist of use life, total static pressure and coil face area classifications, and performance ratings.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Equipment and Performance Data shall be submitted for air handling units in accordance with paragraph entitled, "General Requirements," of this section.

Manufacturer's catalog data shall be submitted for the following items:

Unit Cabinet
Fan

Drain Pans
Insulation
Plenums
Spare Parts

SD-02 Shop Drawings

Installation Drawings shall be submitted for air handling units in accordance with paragraph entitled, "AHU Equipment Installation," of this section.

SD-07 Certificates

Listing of Product Installations shall be submitted for air handling units in accordance with paragraph entitled, "AHU Equipment Installation," of this section.

Certificates shall be submitted for following items showing conformance with the referenced standards contained in this section.

Unit Cabinet
Fan
Drain Pans
Insulation
Plenums
Spare Parts

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for air handling units in accordance with paragraph entitled, "Operation and Maintenance," of this section.

PART 2 PRODUCTS

2.1 AIR HANDLING UNIT (AHU)

Air Handling Unit shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule.

Substation of any product other than that specified, must assure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.

Unless stated otherwise, air handling unit is to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close approximation to the intent of this specification will not be considered equal. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as CETL, ETL, UL, CSA prior to shipment.

Prewired air handling unit shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the National Electric Code.

All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

Provide a system of motor control, including all necessary terminal block, motor contractors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays.

Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.

Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet the standard of the specification installation.

The air handling unit and major components shall be products of manufacturer's regularly engaged in the production of such equipment and with a minimum of 15 continuous years of proven production experience.

Manufacturer shall have a fully implemented and auditable quality assurance program, equal to the ISO-9002 Quality Standard.

Air Handling Unit shall be as manufactured by Engineered Air and be base bid. Alternate products must show savings and clearly indicate all areas where they do not meet specified product.

2.2 UNIT CONSTRUCTION

Unit casing shall be a minimum of 18 gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

All walls, roofs, and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and, and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

The unit shall be provided with a 22 gauge solid, metal liner over insulated areas.

Unit shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, electrical control panels, burner compartments, compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

a. Provide hinged access doors, fully lined, with Leverlok handles, operable from both sides for burner, electrical and compressor compartments.

b. Provide hinged access doors in welded steel frames. Doors shall be fully lined with closed cell bulb gasket and Leverlok handles, operable from both sides for airside components.

c. Hinged access doors shall be provided with tie back clips.

Provide marine lights with Lexan bulb covers in each fan section. Lights shall be wired in EMT conduit to a switch with pilot light. 120 volt power supply by others.

Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.

All units shall be internally insulated with:

50 mm thick nominal, 48 kg./cu. m density acoustic insulation.

Nominal 48 kg./cu.m. insulation is secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

Cooling coil drain pans shall be fabricated of stainless steel and are an integral part of the floor paneling, a minimum of 50mm deep, with welded corners. Drain pans shall extend a minimum of 150mm downstream of coil face and be provided with a 38mm S.S. M.P.T. drain connection. Drain pans must have a fast pan and be sloped and pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.

Air handling unit shall be weatherproofed and equipped and installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, louvers or hoods on air intakes and exhaust openings with 25mm galvanized inlet screens; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 50mm with three break interlocking design; outer wall panels extend a minimum of 6mm below the floor panel; drain trap(s) connections for field supply and installation of drain traps.

a. Units mounted on roof curbs incorporate welded floor to base construction. Floors are off three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.

Provide full perimeter roof mounting curb of heavy gauge sheet metal, 300mm high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 25mm upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof mounting curb shall be provided by the roofing subcontractor. Continuous structural support of curb by others.

2.3 FANS

Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be provided with a rust inhibiting coating.

Airfoil fans shall be equipped with greasable, self aligning ball or roller type pillow block bearings.

Drives shall be adjustable on fans with motors 3.7kw or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.

Provide full section return air fan as schedule. The use of power exhaust propeller or centrifugal fan arrangements will not be considered.

Provide variable air volume fan control for units via variable frequency drives (by EC) minimize CFM or 35% on DX systems.

Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

Provide OSHA approved belt guards on all fans.

Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor which is welded to the structural frame of the unit. All fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 25mm static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

Provide external grease lines from all fan bearings to terminate at the outer surface of cabinet on blower access side.

Fan motors shall be ODP super high efficiency.

2.4 COILS

Coils shall be 12.7mm O.D. as manufactured by Engineered Air

Refrigerant evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Where a hot gas bypass is required, the inlet shall be at the refrigerant distributor.

Refrigerant coils with multiple compressors shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions. Provision for use of thermal

expansion valves must be included for variable air volume and/or make-up air applications.

2.5 GAS HEAT SECTION (DJ) - INDIRECT FIRED

General

Heating section shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority, and carry the approval label of that authority as a complete operating package.

Heat exchangers must exceed the ASHRAE 90.1 requirement of steady state efficiency at low fire.

Operating natural gas pressure at unit manifold shall be 1.74 kPa (178mm) gas manifold shall be provided to IRI standards.

Heat Exchanger

Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane tabulators, and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 25mm of insulation between the outer cabinet and inner liner. Blower assemblies close coupled to duct furnace type heat exchangers are not acceptable.

Burner

The burner assembly shall be a blow through positive pressure type with an intermittent pilot ignition system to provide a high seasonal efficiency. Flame surveillance shall be with a solid state programmed flame relay c/w flame rod. The burner and gas train shall be in a cabinet enclosure. Insulation in the burner section shall be covered by a heat reflective galvanized steel liner. Atmospheric burners, or burners requiring power assisted venting are not acceptable.

Unit incorporating shall include 15:1 turndown (HT burner) for. The high turndown burner minimum input shall be capable of controlling at 6.7% of its rated input without on/off cycling and include built in electronic linearization of fuel and combustion air. Efficiency shall increase from hi to lo fire.

Venting

Installation and venting provisions must be in accordance with C.G.A. Standards B149.1, ANSI Z223.1-NFPA54, and local authorities have jurisdiction. Type A, L, and/or PS venting required on indoor units.

Controls

Electronic DJM (Modulating Fuel w/Modulating Combustion Air)

Solid state analyzer complete with proportional and integral control and with a discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature. Combustion air motor speed variers in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions.

Combustion efficiency of high efficiency heat exchangers shall increase 4-5% from high fire to low fire on units incorporating 15:1 turndown (HT Burner). Heat exchangers shall provide a minimum of 78% efficiency throughout the entire operating range.

Alternate manufacturers units which do not incorporate a variable speed combustion air blowers shall have a modulating gas valve and a combustion air damper with a linear linkage connected to an actuator which has a minimum of 100 steps of control.

2.6 FILTERS

Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.

Bag or cartridge type filters shall slide into an extruded aluminum track against a gasketed sealer strip. Associated 50mm prefilters shall slide into an integral track in the aluminum extrusion.

Pleated Panel Disposal Pre-Filters:

50mm Non-woven cotton and synthetic fabric media with a metal support grid and rigid heavy-duty board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. The filter media shall have an efficiency of 25-30% on ASHRAE Standard 52.1-92, and minimum MERV 6 per ASHRAE 52.2-1999.

Rigid Supported Media Box Final Filters:

Air filters shall be high performance, 300mm deep pleated, totally rigid and disposable type. Each filter shall consist of synthetic media; corrosion resistant metal media support grid; contour stabilizers on both air entering and leaving sides; and non-corrosive metal enclosing frame. The media pack shall be bonded to the inside periphery of the enclosing frame to ensure a leak-free configuration.

Filter shall have an average efficiency of 80-85% an average arrestance of not less than 99% in accordance with ASHRAE Standard 52.1-1992. The minimum efficiency reporting value (MERV) when tested under ASHRAE 52.2-1999 shall be no less than 14.

Filter media shall meet U.L. Class 2 standards.

Provide filter bank with "Dwyer 2000 magnehelic" air filter gauge, complete

with static pressure tips and aluminum tubing, all factory installed. Filter gauge to have a range of 0 to 249 Pa. Where two or more filter banks are connected to a single gauge, multiple gauge kit with manual shut-off cocks in the air tubing shall be provided.

The filter gauge shall be mounted inside of a weatherproof enclosure with viewing window.

2.7 DAMPERS

Damper frames shall be u-shaped galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of 12.7mm aluminum, shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.

Blades shall be 18 gauge galvanized metal with two breaks on each edge and three breaks on centerline for rigidity. The pivot rod shall "nest" in the centerline break. Damper edges shall interlock. Maximum length of damper between supports shall be 1050mm. Damper linkage brackets shall be constructed of galvanized metal.

Dampers shall be:

Certified low leak dampers shall be tested and certified under AMCA Standard 500-89 by an accredited test laboratory. These dampers include: rigidly formed galvanized steel frame with corner reinforcing brackets; heavy duty galvanized damper blades secured with bolts to continuous 133mm aluminum drive rods; all weather PVC double seal blade gasket; tempered aluminum alloy blade end seal, epoxy enameled coated; oil impregnated bronze bushings; and non-corrosive smooth acting linkage.

Mixing dampers shall be parallel blade type.

Gravity relief dampers shall be single blade gasketed design.

Mixing Box Controls

Provide a modulating normally closed damper operator controlled from an adjustable modulating mixed air temperature control with an adjustable minimum outside air positioning potentiometer. Damper actuators by temperature control contractor (Siemens).

2.8 MECHANICAL COOLING

Compressors

Compressors shall be hermetic type, 3600 RPM, set on resilient neoprene mounts and complete with line voltage break internal overload protection, internal pressure relief valve and crankcase heater.

Air Cooled Condenser

Condenser coils shall be copper tube type, mechanically expanded into

aluminum fins. Coils shall be factory tested with air at 2000 kPa while immersed in an illuminated water tank.

Condenser fans shall be direct driven propeller type arranged for vertical draw through air flow. Motors shall be weather resistant type, with integral overload protection and designed for vertical shaft condenser fan applications. Fan and motor assemblies shall be mounted on a formed orifice plate for optimum efficiency with minimum noise level.

Condenser to form an integral part of the unit.

Packaged Air Conditioning Units

Packaged units shall operate down to 10 C as standard. Where applicable, multiple refrigeration circuits shall be separate from each other. Refrigeration circuits shall be complete with liquid line filter-driers, and service ports fitted with Schraeder fittings. Units with over 21 kW (Refrig.) hermetic compressors and all units with semi-hermetic compressors shall also incorporate load compensated thermal expansion valves with external equalizers and combination sight glass moisture indicators. The complete piping system shall be purged and pressure tested with dry nitrogen, then tested again under vacuum. Each system shall be factory run and adjusted prior to shipment.

1. Controls for hermetic compressor shall include compressor and condenser fan motor contactors, supply fan contactors and overload protection control circuit transformer, cooling relays, ambient compressor lockout, automatic reset low pressure controls, and high pressure controls on compressors over 18 kW (Refrig.). Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

2. Provide five minute anti-cycle timers.

3. Provide interstage time delay timers.

4. Provide hot gas bypass on the lead compressor to maintain adequate suction pressure in the event of low loads.

5. Make-up air and VAV units shall have a minimum 5 compressors.

6. Provide optional compressor service valves for packaged units incorporating hermetic compressors.

Cooling Control

Electronic

Engineered Air C-TRAC electronic temperature control system with the capability of providing up to 5 stages of cooling control to maintain discharge temperature. The minimum run and off time for compressors shall be 4 minutes at full load startup, and may range up to 8 minutes under part load conditions. The C-TRAC shall

incorporate a PI (proportional/integral) control scheme that reduces temperature droop by resetting to the set point after each stage is cycled on. C-TRAC shall include:

1. Modulating discharge air control with BMS reset control (0-10 V, or 4-20 ma) with built-in modulating high and low limit.

In heating range, the C-TRAC will provide a signal to the following second level devices:

1. Model DJM controller for Series DJ industrial heater as specified. (Refer to DJ Section).

All controls shall be coordinated with temperature control contractor (Siemens).

PART 3 EXECUTION

3.1 AHU EQUIPMENT INSTALLATION

Equipment shall be installed in accordance with manufacturer's recommendations.

Installation drawings shall be in accordance with referenced standards in this section.

Listing of Product Installations shall be submitted for air handling units showing a minimum of 5 installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. List shall include purchaser, address of installation, service organization, and date of installation.

3.2 AHU TESTING

AHU and components shall be performance tested and rated in accordance with AMCA 211 and ASHRAE 51. AHU ratings shall be in accordance with ARI 430.

3.3 OPERATION AND MAINTENANCE

Contractor shall submit Operation and Maintenance Manuals prior to testing the air handling units. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

-- End of Section --

SECTION 15815

LOW PRESSURE DUCTWORK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S328	(1986) Specification for Structural Steel Buildings Load and Resistance Factor Design

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1992; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 653/A 653M	(1996) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-05	(1995) Handbook, HVAC Applications (SI Edition)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1996) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-06	(1985; 1st Ed) HVAC Duct Construction Standards - Metal and Flexible

UNDERWRITERS LABORATORIES (UL)

UL 181	(1994; 8th Ed) UL Standards for Safety Factory-Made Air Ducts and Air Connectors

UL 555 (1995; 5th Ed) UL Standard for Safety Fire Dampers

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Records of Existing Conditions shall be submitted n accordance with paragraph entitled, "General Requirements," of this section.

Material, Equipment, and Fixture Lists shall be submitted for low pressure ductwork systems in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

The following shall be submitted for low pressure ductwork systems in accordance with paragraph entitled, "Design Requirements," of this section.

Connection Diagrams
Fabrication Drawings
Installation Drawings
As-Built Drawings

SD-03 Product Data

Design Analysis and Calculations shall be submitted for low pressure ductwork systems in accordance with paragraph entitled, "Design Requirements," of this section.

Manufacturer's catalog data shall be submitted for the following items:

Galvanized Steel Ductwork Materials
Flexible Duct Materials
Power Operated Dampers
Flexible Connectors
Fire Dampers and Wall Collars
Gravity Backdraft and Relief Dampers
Manual Volume Dampers

SD-04 Samples

Manufacturer's Standard Color Chart shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-06 Test Reports

Test reports shall be submitted for low pressure ductwork systems on the following tests in accordance with the paragraph entitled, "Ductwork Leakage Tests" and "Fire Damper Tests," of this section.

Operation Tests
Ductwork Leakage Tests

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be provided for:

Power Operated Dampers
Fire Dampers and Wall Collars

1.3 PERFORMANCE REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Section 15072, "Vibration Isolation for Air Conditioning Equipment," applies to work in this section.

1.4 DESIGN REQUIREMENTS

Low-pressure systems shall encompass ductwork and plenums where maximum air velocity is 10.1 meter per second and maximum static pressure is 500 pascal water gage (wg), positive or negative.

Fabrication Drawings shall be submitted for low pressure ductwork systems consisting of fabrication and assembly details to be performed in the factory. Drawings shall show details of equipment room layout and design.

Connection Diagrams shall be submitted for low pressure ductwork systems indicating the relation and connection of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Design Analysis and Calculations shall be submitted for low pressure ductwork systems indicating the manufacturer's recommended air velocities, maximum static pressures, temperature calculations and acoustic levels.

Installation Drawings shall be submitted for low pressure ductwork systems in accordance with the manufacturer's recommended instructions.

As-Built Drawings shall provide current factual information including deviations from, and amendments to the drawings and concealed or visible changes in the work, for low pressure ductwork systems.

Manufacturer's Standard Color Chart shall indicate the manufacturer's standard color selections and finishes for low pressure ductwork.

1.5 GENERAL REQUIREMENTS

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

Material, Equipment, and Fixture Lists shall include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

PART 2 PRODUCTS

2.1 GALVANIZED STEEL DUCTWORK MATERIALS

Galvanized steel ductwork sheet metal shall be carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A 653/A 653M, Z275. Duct surfaces to be painted shall be treated by phosphatizing.

Sheet metal gages and reinforcement thickness shall conform to SMACNA-06.

2.1.1 Duct Hangers

Duct hangers in contact with galvanized duct surfaces shall be galvanized steel painted with inorganic zinc.

2.1.2 Mill-Rolled Reinforcing and Supporting Materials

Mill-rolled structural steel shall conform to ASTM A 36/A 36M and, whenever in contact with sheet metal ducting, shall be galvanized in accordance with ASTM A 123.

Equivalent strength, proprietary-design, rolled-steel structural support systems may be submitted for approval in lieu of mill-rolled structural steel.

2.2 FLEXIBLE DUCT MATERIALS

Flexible duct connectors shall be in accordance with UL 181, Class 1 material and shall comply with NFPA 90A.

Metal duct shall be bendable through 180 degrees without damage, with an inside bend radius not greater than one-half the diameter of duct. Metal shall be carbon steel zinc-coated ASTM A 123.

Wire-reinforced cloth duct shall consist of a vinyl-impregnated and coated fibrous-glass cloth bonded to and supported by a corrosion-protected spring steel helix. Fabric may be a laminate of metallic film and fibrous glass. Working pressure rating of ducting shall be not less than three times maximum system pressure, and temperature range shall be 29 to plus 79 degrees C.

2.3 MANUAL VOLUME DAMPERS

Volume damper construction shall conform to SMACNA-06.

Dampers shall be equipped with an indicating quadrant regulator with a locking feature externally located and easily accessible for adjustment. Where damper rod lengths exceed 760 millimeter, a regulator shall be provided at each end of damper shaft.

All damper shafts shall have two-end bearings.

Splitter damper shall be 0.85 millimeter sheet metal. Hinges shall be full length piano-type.

Damper shaft shall be full length and shall extend beyond damper blade. A 10 millimeter square shaft shall be used for damper lengths up to 500 millimeter and a 15 millimeter square shaft shall be used for damper lengths 500 millimeter and larger. Where necessary to prevent damper vibration or slippage, adjustable support rods with locking provisions external to duct shall be provided at damper blade end.

Dampers in ducts having a width perpendicular to the axis of the damper that is greater than 300 millimeter shall be multiblade type having a substantial frame with blades fabricated of 1.6 millimeter metal. Blades shall not exceed 250 millimeter in width and 1220 millimeter in length and shall be welded to 15 millimeter diameter shafts. Dampers greater than 1220 millimeter in width shall be made in two or more sections with intermediate mullions, each section being mechanically interlocked with the adjoining section or sections. Blades shall have graphite-impregnated nylon bearings and shall be connected so that adjoining blades rotate in opposite directions.

2.4 GRAVITY BACKDRAFT AND RELIEF DAMPERS

Frame shall be constructed of not less than 40 by 100 millimeter reinforced 1.6 millimeter galvanized carbon steel. Frames and mullions shall be solidly secured in place and sealed with elastomer calking against air bypass.

Maximum blade width shall be 230 millimeter, and maximum blade length shall be 900 millimeter. Blade material shall be 1.6 millimeter galvanized steel or 1.3 millimeter AISI 18-8 corrosion-resistant steel. Blades shall be provided with mechanically retained seals and 90-degree limit stops.

Dampers used for relief service shall have blades linked together to open not less than 30 degrees on 12 pascal wg differential pressure.

Shaft bearings shall be graphite-impregnated nylon.

Counterbalanced dampers shall be equipped with fixed or adjustable counterbalancing weights.

Gravity backdraft dampers in sizes 460 by 460 millimeter or smaller, when furnished integral with air moving equipment, may be equipment manufacturer's standard construction.

2.5 POWER-OPERATED DAMPERS

Dampers shall conform to applicable requirements specified under Section 15902, "Control Systems."

2.6 FLEXIBLE CONNECTORS FOR SHEET METAL

Connectors shall be UL-listed, .68 kilogram per square meter, fire-retardant, airtight, woven fibrous-glass cloth impregnated with chloroprene. Clear width, not including clamping section, shall be 76 to 125 millimeter.

2.7 FIRE DAMPERS AND WALL COLLARS

Fire damper locations shall be in accordance with NFPA 90A.

Fire dampers in ductwork shall be provided at firewall barriers.

Fire dampers shall be constructed and labeled in accordance with UL 555to provide damper and mounting fire-resistance that equals or exceeds fire-resistance of the construction in which installed. For link loads in excess of 90 newton, UL-approved quartzoid links shall be provided.

Wall collars shall be constructed in accordance with UL 555.

PART 3 EXECUTION

3.1 INSTALLATION

Sheet metal construction shall be provided in accordance with the SMACNA-06 and NFPA 90A.

Construction methods for any other items that are not covered herein shall be in accordance with ASHRAE-05.

Supplementary steel shall be designed and fabricated in accordance with AISC S328.

Fabrication shall be airtight and shall include necessary reinforcements, bracing, supports, framing, gasketing, sealing, and fastening to provide rigid construction and freedom from vibration, airflow-induced motion, noise, and excessive deflection at specified maximum system air pressure.

Dampers located behind architectural intake or exhaust louvers shall be enclosed by a rigid sheet metal collar and sealed to building construction with elastomers for complete air tightness.

Outside air-intake ducts and plenums shall be sheet metal and shall have soldered watertight joints.

Offsets and transformations shall be provided as required to avoid interference with the building construction, piping, or equipment.

Wherever ducts pass through firewalls or through walls or floors dividing

conditioned spaces from unconditioned spaces, a flanged segment shall be provided in that surface during surface construction.

Sheet metal surfaces to be painted or surfaces to which adhesives will be applied shall be clean and free of oil, grease, and deleterious substances.

Where interiors of ducting may be viewed through air diffusion devices, the viewed interior shall be sheet metal and shall be painted flat black.

Duct strength shall be adequate to prevent failure under pressure or vacuum created by fast closure of ductwork devices. Leaktight automatic relief devices shall be provided.

Plenum anchorage provisions, sheet metal joints, and other areas shall be made airtight and watertight by calking mating galvanized steel and concrete surfaces with a two-component elastomer.

3.2 RECTANGULAR SHEET METAL DUCTS

Angle iron frames shall be welded at corners and ends, whenever possible. Angle iron reinforcements shall be riveted or welded to ducts not more than 150 millimeter on center, with not less than two points of attachment. Spot welding, where used, shall be 75 millimeter on center.

Standard seam joints shall be sealed with an elastomer compound.

Crossbreaking shall be limited to 1220 millimeter and shall be provided on all ducts 200 millimeter wide and wider. Bead reinforcement shall be provided in lieu of crossbreaking where panel popping may occur. Where rigid insulation will be applied, crossbreaking is not required.

3.2.1 Longitudinal Duct Seams

For duct sizes through 300 millimeter, corner seams shall be button-punch snap lock. For duct sizes 330 millimeter and larger corner locks shall be used.

3.2.2 Joints and Gaskets

Companion angle flanges shall be bolted together with 8 millimeter diameter bolts and nuts spaced 150 millimeter on center. Flanged joints shall be gasketed with chloroprene full-face gaskets 3 millimeter thick, with Shore A 40 durometer hardness. Gaskets shall be one piece and vulcanized at joints.

3.2.3 Flexible Duct Joints

Joints between flexible duct without sheet metal collars and round metal ductwork connections shall be made by trimming the ends, coating the inside of the flexible duct for a distance equal to depth of insertion with elastomer calk, and by securing with sheet metal screws or binding with a strap clamp.

3.2.4 Square Elbows

Double-vane duct turns shall be provided in accordance with SMACNA-06.

3.2.5 Radius Elbows

Radius elbows shall conform to SMACNA-06. Radius elbows shall have an inside radius equal to the width of the duct. Where installation conditions preclude use of standard elbows, the inside radius may be reduced to a minimum of 0.5 times duct width and turning vanes shall be installed in accordance with the following schedule.

WIDTH OF ELBOWS	RADIUS OF TURNING VANES IN PERCENT OF DUCT WIDTH		
MILLIMETE	VANE NO.	VANE NO.	VANE NO. 3
Up to 406	56	--	--
430 to 120	43	73	--
1245 and over	37	55	83

Where two elbows are placed together in the same plane in ducts 760 millimeter wide and larger, the guide vanes shall be continuous through both elbows rather than spaced in accordance with above schedule.

3.2.6 Outlets, Inlets, and Duct Branches

Branches, inlets, and outlets shall be installed so that air turbulence will be reduced to a minimum and air volume properly apportioned. Adjustable splitter dampers shall be installed at all supply junctions to permit adjustment of the amount of air entering the branch. Wherever an air-diffusion device is shown as being installed on the side, top, or bottom of a duct, and whenever a branch takeoff is not of the splitter type, a commercially manufactured air extractor shall be provided to allow adjustment of the air quantity and to provide an even flow of air across the device or duct it services.

Where a duct branch is to handle more than 25 percent of the air handled by the duct main, a complete 90-degree increasing elbow shall be used with an inside radius of 0.75 times branch duct width. Size of the leading end of the increasing elbow within the main duct shall have the same ratio to the main duct size as the ratio of the related air quantities handled.

Where a duct branch is to handle 25 percent or less of the air handled by the duct main, the branch connection shall have an inside radius of 0.75 times duct branch width, a minimum arc length of 45 degrees, and an outside radius of 1.75 times duct branch width. Arc shall be tangent to duct main.

3.2.7 Duct Transitions

Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, the angle of the side of the transition piece from the straight run of duct connected thereto shall not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.2.8 Branch Connections

Radius tap-ins shall be constructed in accordance with SMACNA-06.

3.2.9 Access Openings

Access doors and panels shall be installed in ductwork adjacent to fire dampers at controls or at any item requiring periodic inspection, adjustment, maintenance, or cleaning.

Minimum size of access opening shall be 305 by 460 millimeter, unless precluded by duct dimensions or otherwise indicated.

Access door construction shall be in accordance with SMACNA-06, except that sliding doors may be used only for special conditions upon prior approval. Insulated doors shall be double-panel type.

Access doors that leak shall be made airtight by adding or replacing hinges and latches or by construction of new doors adequately reinforced, hinged, and latched.

Duct access shall be particularly suitable for commercial duct cleaning methods utilizing vacuum devices. Access openings shall be spaced with a frequency and at points which will permit ready access to duct internals with essentially no duct or insulation cutting. Where access through an air-diffusion device or through access doors specified herein is not available at a specific point, 200 millimeter diameter, 1.6 millimeter access plates shall be provided not more than 3000 millimeter on center. Where duct is insulated and vapor-sealed, mastic seals shall be provided around circumference of access. When access plate is in place and insulated, the location shall be externally identified.

3.2.10 Duct Supports

Selection of hanging system shall be at the Contractor's option. The following support sizes, configurations, and spacings are given to show the minimal type of supporting component required. Where installed loads are excessive for the specified hanger spacings, hangers, and accessories, the hanger spacing may be reduced. After system startup, any duct support device which, due to length, configuration, or size, vibrates or causes possible failure of a member or damage to ducting shall be replaced or the condition shall be alleviated.

Hanger rods, angles, and straps shall be attached to beam clamps. Concrete inserts and masonry anchors and fasteners shall be approved for the application.

Where support from metal deck systems is required, support requirements shall be coordinated with installation of metal deck.

Ductwork and equipment shall not be hung from roof deck, piping, or other ducts or equipment. Maximum span between any two points shall be 3000 millimeter with lesser spans for duct assemblies, interferences, and loads imposed or permitted.

There shall be not less than one set of hangers for each point of support. Hangers shall be installed on both sides of all duct turns, branch fittings, and transitions.

Hangers shall be sufficiently cross-braced to eliminate vertical and lateral sway.

Rectangular ducts up to 915 millimeter shall be supported by strap hangers attached at not less than three places to not less than two duct surfaces in different planes.

Perforated strap hangers shall not be acceptable.

Rectangular ducting, 915 millimeter and larger, shall be supported by trapeze hangers. Ducts situated in unconditioned areas and required to have insulation with a vapor-sealed facing shall be supported on trapeze hangers. Hangers shall be spaced far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside of the trapeze. Under no circumstances shall duct hangers penetrate the vapor-sealed facing.

Where trapeze hangers are used, the bottom of the duct shall be supported on angles sized as follows:

WIDTH OF DUCT, MILLIMETE	MINIMUM BOTTOM ANGLE SIZE, MILLIMETER
760 and smaller	32 by 32 by 3
790 to 1220	40 by 40 by 3
1245 to 1830	40 by 40 by 4.7
1855 to 2440	50 by 50 by 6
2465 and larger	80 by 80 by 6

Where ductwork system contains heavy equipment, excluding air-diffusion devices and single-leaf dampers, such equipment shall be hung independently of the ductwork by means of rods or angles of sizes adequate to support the load.

Ducting supported from roof purlins shall be supported at points not greater than one-sixth of the purlin span from the roof truss. Load per hanger shall not exceed 1780 newton when support is from a single purlin or 3560 newton when hanger load is applied halfway between purlins by means of auxiliary support steel provided under this section. When support is not halfway between purlins, the allowable hanger load shall be the product of 400 times the inverse ratio of the longest distance to purlin-to-purlin

spacing.

When the hanger load exceeds the above limits, reinforcing of purlin(s) or additional support beam(s) shall be provided. When an additional beam is used, the beam shall bear on the top chord of the roof trusses and bearing shall be over gusset plates of top chord. Beam shall be stabilized by connection to roof purlin along bottom flange.

Purlins used for supporting fire-protection sprinkler mains, electrical lighting fixtures, and electrical power duct or cable tray shall be considered fully loaded, and supplemental reinforcing or auxiliary support steel to support ductwork shall be provided for these purlins.

3.3 PLENUM CONSTRUCTION

Intake and discharge plenum shall have companion angle joints with the following minimum thickness of materials:

LONGEST ANGLES SIDE MILLIMETE	SHEET METAL USS GAGE ALL SIDE	COMPANION ANGLES MILLIMETE	REINFORCEMENT INCHES, 610 MM ON CENTER MAXIMUM
To 1220	1.0	40 by 40 by 3	40 by 40 by 3
1245 to 2135	1.3	50 by 50 by 3	50 by 50 by 4.7
2160 to 3048	1.6	50 by 50 by 3	50 by 50 by 3
3075 and larger	2.0	50 by 50 by 4.7	50 by 50 by 4.7

At the floor line and other points where plenums join masonry construction, panels shall be bolted 300 millimeter on center to 50 by 50 by 4.7 millimeter thick hot-dip galvanized steel angle that has been secured to the masonry with masonry anchors and bolts 600 millimeter on center and calked tight to the masonry.

Panels shall be anchored to curbing by not less than 50 by 50 by 4.7 millimeter thick hot-dip galvanized steel angle iron. Concrete curbing shall include angle iron nosing with welded studs for the anchoring of panels. Nosing shall be level at curb height within plus or minus 1 millimeter.

Plenum access doors shall be constructed in accordance with SMACNA-06except that access doors smaller than man-access doors shall have door openings framed with angle iron that is one commercial size smaller than specified panel reinforcement.

Man-access door size shall be per SMACNA-06 and paragraph entitled, "Access Openings," of this section. Insulated and uninsulated construction shall be per SMACNA-06. Door openings shall be framed with channel iron. Doors shall be framed with angle iron. Channel iron and angle iron shall be approximately the same size as specified panel reinforcement. Exterior door skin shall be 1.6 millimeter. Latches shall be fabricated steel,

hinges shall be at least 100 millimeter long, and bolting shall be at least 10 millimeter diameter.

Angle iron and channel iron shall have welded and ground miter corners.

3.4 MANUAL VOLUME DAMPERS

Balancing dampers of the splitter, butterfly, or multilouver type, shall be provided to balance each respective main and branch duct.

Dampers regulated through ceilings shall have regulator concealed in box mounted in the ceiling, with a cover finish aesthetically compatible with ceiling surface. Where ceiling is of removable construction, regulators shall be above ceiling, and location shall be marked on ceiling in a manner acceptable to the Contracting Officer.

3.5 FLEXIBLE CONNECTORS FOR SHEET METAL

Air handling equipment, ducts crossing building expansion joints, and fan inlets and outlets shall be connected to upstream and downstream components by treated woven-cloth connectors.

Connectors shall be installed only after system fans are operative, and vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkle caused by misalignment or fan reaction. Width of surface shall be curvilinear.

3.6 INSULATION PROTECTION ANGLES

Galvanized 1.0 millimeter sheet steel, formed into an angle with a millimeter exposed long leg with a 10 millimeter stiffening break at outer edge, and with a variable concealed leg, depending upon insulation thickness shall be provided.

Angles shall be installed over insulation edges terminating by butting against a wall, floor foundation, frame, and similar construction. Angles shall be fastened in place with blind rivets through the protection angle, insulation, and sheet metal duct or plenum. Angles shall be installed after final insulation covering has been applied.

3.7 DUCT PROBE ACCESS

Holes shall be provided with neat patches, threaded plugs, or threaded or twist-on caps where indicated, and where necessary, for air-balancing pitot tube access. Extended-neck fittings shall be provided where probe access area is insulated.

3.8 OPENINGS IN ROOFS AND WALLS

Openings indicated in outside walls and roof are approximate.

3.9 DUCTWORK CLEANING PROVISIONS

Open ducting shall be protected from construction dust and debris in a

manner approved by the Contracting Officer. Dirty assembled ducting shall be cleaned by subjecting main and branch interior surfaces to air streams moving at velocities two times the specified working velocities, at static pressures within maximum ratings. Ducting shall be cleaned by a method approved by the Contracting Officer. Compressed air used for cleaning ducting shall be water- and oil-free. Prior to acceptance of the work, dust and debris shall be removed from exterior surfaces.

3.10 FIRE DAMPER TESTS

Operation tests shall be performed on each fire damper in the presence of the Contracting Officer by enervating fusible link with localized heat. New links shall be provided and installed after successful testing.

3.11 DUCTWORK LEAKAGE TESTS

Contractor shall conduct leakage test on new duct in accordance with Section 15950, "Testing, Adjusting and Balancing." Test shall be performed prior to installing ductwork insulation.

3.12 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

-- End of Section --

SECTION 15818

MEDIUM/HIGH PRESSURE DUCTWORK

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S328	(1986) Specification for Structural Steel Buildings Load and Resistance Factor Design

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1992; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 36/A 36M	(1996) Standard Specification for Structural Steel
ASTM A 653/A 653M	(1996) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process
ASTM A 924/A 924M	(1994) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM C 1071	(1991) Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
ASTM D 257	(1993) Standard Test Methods for D-C Resistance or Conductance of Insulating Materials

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-04	(1997) Handbook, Fundamentals (SI Edition)
ASHRAE-07	(1997) Handbook, HVAC Systems and Equipment (SI Edition)

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8	(1992) Specification for Filler Metals for Brazing

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1996) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-06	(1985; 1st Ed) HVAC Duct Construction Standards - Metal and Flexible
SMACNA-09	(1989; 1st Ed) HVAC Duct Systems Inspection Guide

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE AMS 2480E	(1992) Phosphate Treatment Paint Base

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC-01	(1993; 3rd Ed) Good Painting Practice Steel Structures Painting Manual, Volume 1

1.2 DESIGN REQUIREMENTS

Section 15003, "General Mechanical Provisions," apply to work specified in this section.

Section 15072, "Vibration Isolation for Air Conditioning Equipment" applies to work in this section.

Section 15055, "Welding Mechanical," applies to work specified in this section.

Equipment and Performance Data shall be submitted for medium/high pressure ductwork systems consisting of use life, system functional flows, safety features, and mechanical automated details. Curves indicating tested and certified equipment response and performance characteristics shall also be submitted.

Design Analysis and Calculations shall be submitted for medium/high pressure ductwork systems indicating the manufacturer's recommended air velocities, maximum static pressure, and temperature calculations.

1.3 SCOPE OF WORK

High velocity systems shall encompass ductwork where:

Minimum air velocity exceeds 10 meter per second or static pressure exceeds 500 pascal.

Medium static pressure ranges from over 500 pascal through 750 pascal, positive or negative, or over 750 pascal through 1500 pascal positive.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists and Records of Existing Conditionsshall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

The following shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

Connection Diagrams
Fabrication Drawings
Installation Drawings
As-Built Drawings

SD-03 Product Data

Equipment and Performance Data shall be submitted for medium/high pressure ductwork systems in accordance with paragraph entitled, "Design Requirements," of this section.

Manufacturer's catalog data shall be submitted for the following items:

Galvanized Steel Ductwork Materials
Brazing Materials
Mill-Rolled Reinforcing and Supporting Materials
Round Sheet Metal Duct Fittings
Round, High-Pressure, Double-Wall Sheet Metal Ducts
Turning Vanes
Dampers
Sound Traps
Flexible Connectors

SD-05 Design Data

Design Analysis and Calculations shall be submitted for medium/high pressure ductwork systems in accordance with paragraph entitled, "Design Requirements," of this section.

SD-06 Test Reports

Test reports shall be submitted for medium/high pressure ductwork systems in accordance with the paragraphs entitled, "Ductwork

Leakage Tests" and "Fire Damper Tests," of this section.

Ductwork Leakage Tests
Operational Tests

SD-07 Certificates

Listing of Product Installations for medium/high pressure ductwork systems in accordance with paragraph entitled, "Installation," of this section.

Certificates shall be submitted, showing conformance with the referenced standards contained in this section for:

Galvanized Steel Ductwork Materials
Brazing Materials
Mill-Rolled Reinforcing and Supporting Materials
Round Sheet Metal Duct Fittings
Round, High-Pressure, Double-Wall Sheet Metal Ducts
Turning Vanes
Dampers
Sound Traps
Flexible Connectors

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section.

1.5 GENERAL REQUIREMENTS

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

Material, Equipment, and Fixture Lists shall include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

1.6 DRAWINGS

Connection Diagrams shall be submitted for medium/high pressure ductwork systems indicating the relation and connection of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Fabrication Drawings shall be submitted for medium/high pressure ductwork systems consisting of fabrication and assembly details to be performed in the factory.

Installation Drawings shall be submitted for medium/high pressure ductwork

systems. Drawings shall show details of equipment room layout and design.

As-Built Drawings shall provide current factual information including deviations from, and amendments to, the drawings and concealed or visible changes in the work, for medium/high pressure ductwork systems.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Ductwork Materials

Galvanized steel ductwork sheet metal shall be carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A 924/A 924M and ASTM A 653/A 653M, Designation G90. Duct surfaces to be painted shall be treated by phosphatizing.

Sheet metal thickness and reinforcement thickness shall conform to ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06.

2.1.2 Brazing Materials

Brazing materials shall be silicon bronze conforming to AWS A5.8.

2.1.3 Mill-Rolled Reinforcing and Supporting Materials

Mill-rolled structural steel shall conform to ASTM A 36/A 36M and, wherever in contact with sheet metal ducting, shall be galvanized to commercial weight of zinc or coated with materials conforming to ASTM A 123 ,SSPC-01.

Equivalent strength, proprietary design, rolled-steel structural support systems may be submitted for approval in lieu of mill-rolled structural steel.

2.2 COMPONENTS

2.2.1 Round Sheet Metal Duct Fittings

Fittings shall be shop fabricated.

Fittings shall be manufactured as separate fittings, not as tap collars welded or brazed into duct sections.

Offset configurations shall be submitted for approval.

Miter elbows shall be two-piece type for angles less than 31 degrees, three-piece type for angles 31 through 60 degrees, and five-piece type for angles 61 through 90 degrees. Centerline radius of elbows shall be 1-1/2 times fitting cross section diameter.

Crosses, increasers, reducers, reducing tees, and 90-degree tees shall be conical type.

Cutouts in fitting body shall be equal to branch tap dimension or, where

smaller, excess material shall be flared and rolled into smooth radius nozzle configuration.

2.2.2 Round, High-Pressure, Double-Wall Sheet Metal Ducts

Ducts and fittings shall be shop fabricated.

Construction shall comprise an airtight, vapor barrier, outer pressure shell, a 25 millimeter insulation layer, and a perforated-metal inner liner that completely covers the insulation throughout the system.

Insulation shall conform to NFPA 90A and ASTM C 1071. Thermal conductivity shall be in accordance with ASTM D 257.

2.2.3 Duct and Fitting Gages

Outer pressure shell shall be as specified in ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06; the inner liner shall be as recommended by the manufacturer but not lighter than 0.55 millimeter.

Perforations shall be 2.5 millimeter diameter, and the open area shall be 13 percent.

2.2.4 Reinforcement

Inner liners of both duct and fittings shall be supported by metal spacers welded in position to maintain spacing and concentricity.

2.2.5 Fittings

Divided flow fittings shall be made as separate fittings, not tap collars into duct sections, with the following construction requirements:

Sound, airtight, continuous welds at intersection of fitting body and tap

Tap liner securely welded to inner liner, with weld spacing not to exceed 75 millimeter

Insulation shall be packed around the branch tap area for complete cavity filling.

Branch connection shall be carefully fit to cutout openings in inner liner without spaces for air erosion of insulation and without sharp projections that cause noise and airflow disturbance.

Seams in the pressure shell of fittings shall be continuously brazed. Galvanized areas that have been damaged by welding shall be protected with manufacturer's standard corrosion-resistant coating.

Offset configurations shall be submitted for approval.

Elbows shall be two-piece type for angles through 35 degrees, three-piece type for angles 36 through 71 degrees, and five-piece type for angles 72

through 90 degrees.

Crosses, increasers, reducers, reducing tees, and 90-degree tees shall be conical type.

2.2.6 Turning Vanes

Turning vanes shall be double-wall type, commercially manufactured for high-velocity system service.

2.2.7 Dampers

Low pressure drop, high-velocity manual volume dampers, and high-velocity fire dampers shall be constructed in accordance with ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06.

2.2.8 Flexible Connectors for Sheet Metal

Connectors shall be UL listed, 915 gram per square meter, waterproof, fire-retardant, airtight, woven fibrous-glass cloth, double coated with chloroprene. Clear width, not including clamping section, shall be 150 to 200 millimeter.

PART 3 EXECUTION

3.1 PREPARATION

Sheet metal construction shall be provided in accordance with the recommendations for best practices in ASHRAE-07, Chapter 16, SMACNA-06, NFPA 90A, and ASHRAE-04, Chapter 32.

Where construction methods for certain items are not described in the referenced standards or herein, the work shall be performed in accordance with recommendations for best practice defined in ASHRAE-07.

Sheet metal surfaces to be painted and surfaces to which adhesives are to be applied shall be clean and free of oil, grease, and deleterious substances.

Duct strength shall be adequate to prevent failure under service pressure or vacuum created by fast closure of duct devices. Leaktight, automatic relief devices shall be provided.

Supplementary steel shall be designed and fabricated in accordance with AISC S328.

3.2 INSTALLATION

Listing of Product Installations for medium/high pressure ductwork systems shall include identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. List shall include purchaser, address of installation, service organization, and date of installation.

Fabrication shall be airtight and shall include reinforcements, bracing, supports, framing, gasketing, sealing, and fastening to provide rigid construction and freedom from vibration, airflow-induced motion and noise, and excessive deflection at specified maximum system air pressure and velocity.

Where ducts pass through firewalls, a flanged duct segment with fire damper and access door shall be provided in that surface during surface construction.

3.3 APPLICATION

3.3.1 Rectangular Sheet Metal Ducts

3.3.1.1 Medium-Pressure Gages, Joints, and Reinforcement

Minimum sheet metal gages, joints, and reinforcements between joints shall be in accordance with ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06.

Sheet metal minimum thickness, transverse reinforcement between joints, and joints of ducts shall be in accordance with the following:

LONGEST SIDE (mm)	SHEET METAL THICKNESS ALL SIDES	COMPANION ANGLE (mm)	REINFORCEMENT ANGLES INCHES, 600 (mm) ON CENTER MAXIMUM (BACK TO BACK)
2450 to 2750	1.6	50 by 50 by 3, two tie rods along angle	Two 50 by 50 by 3, two tie rods along angle
2451 to 3350	1.6	50 by 50 by 5, two tie rods along angle	Two 50 by 50 by 5, two tie rods along angle
3351 and longer	2.0	50 by 50 by 5, with tie rods every 1200 mm	Two 50 by 50 by 5, with tie rods every 1200 mm

3.3.1.2 Medium- and High-Pressure Branches, Inlets, Outlets

Branches, inlets, and outlets shall be installed to minimize air turbulence and to ensure proper airflow.

Dampers shall be installed so that the amount of air entering duct mains can be adjusted.

Commercially manufactured air extractors shall be provided to allow adjustment of the air quantity and to provide an even flow of air across the device or duct served.

Where a duct branch is to handle over 25 percent of the air handled by the duct main, a complete 90-degree increasing elbow shall be used, with an inside radius of 0.75 times duct branch width. Size of the trailing end of the increasing elbow within the main duct shall be in the same ratio to the main duct size as the ratio of the relative air quantities handled.

Where a duct branch is to handle 25 percent or less of the air handled by the duct main, the branch connection shall have an inside radius of 0.75 times branch duct width, a minimum arc length of 45 degrees, and an outside radius of 1.75 times duct branch width. Arc shall be tangent to duct main.

3.3.1.3 High-Pressure Gages, Joints, and Reinforcement

Sheet metal minimum thickness, joints, and reinforcement between joints shall be in accordance with ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06.

The following types of ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06transverse joints shall be used:

Welded flange joint with angle

Companion angle flanged joint

The following types of longitudinal seams shall be used:

Approved lock seams, back brazed, or continuously brazed seams for ducts with largest dimension up to 1800 millimeter

Continuously welded or brazed seams for ducts with largest dimension greater than 1800 millimeter

Sheet metal minimum thickness, transverse reinforcement between joints, and companion angle joints of ducts with longest side greater than 2550 millimeter shall be in accordance with the following:

LONGEST SIDE (mm)	SHEET METAL THICKNESS ALL SIDES	COMPANION ANGLE (mm)	REINFORCEMENT ANGLES INCHES, 600 (mm) ON CENTER MAXIMUM (BACK TO BACK)
2450 to 2750	1.6	50 by 50 by 3, two tie rods along angle	Two 50 by 50 by 3, two tie rods along angle
2451 to 3350	1.6	50 by 50 by 5, two tie rods along angle	Two 50 by 50 by 5, two tie rods along angle
3351 and	2.0	65 by 65 by 5,	Two 65 by 65 by 5,

LONGEST SIDE (mm)	SHEET METAL THICKNESS ALL SIDES	COMPANION ANGLE (mm)	REINFORCEMENT ANGLES INCHES, 600 (mm) ON CENTER MAXIMUM (BACK TO BACK)
longer		with tie rods every 600 mm	with tie rods every 600 mm

3.3.2 Round Sheet Metal Ducts

3.3.2.1 Duct Gages, Joints, and Reinforcement

Sheet metal minimum thickness, joints, and reinforcement between joints shall be in accordance with ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06.

Longitudinal duct joint shall be manufactured by machine, with spiral lockseams to and including 1500 millimeter diameters, and to dimensional tolerances compatible with fittings provided.

Ducts shall have supplemental girth angle supports, riveted with solid rivets 150 millimeter on center, or tack welded to duct. Girth angles shall be located as follows:

DIAMETER, MILLIMETE	REINFORCEMENT-MAXIMUM SPACING, MILLIMETER
625 to 915	32 by 32, 3.2 thick, 1825 millimeter on center
916 to 1270	32 by 32, 3.2 thick, 1525 millimeter on center
1271 to 1525	38 by 38, 3.2 thick, 1220 millimeter on center

Draw band girth joints are not acceptable.

Slip joints shall be made up by coating the male fitting with elastomer sealing materials, exercising care to prevent mastic from entering fitting bore, leaving only a thin annular mastic line exposed internally. Sheet metal screws shall be used to make assembly rigid, not less than four screws per joint, maximum spacing 150 millimeter. Pop rivets shall not be used. All joints shall be taped and heat sealed.

Bolt heads and nuts shall be hex-shaped, M8 for ducts up to 1270 millimeter diameter, and M10 for 1271 millimeter diameter ducts and larger.

Flanges shall be continuously welded to duct on outside of duct and intermittently welded with 25 millimeter welds every 100 millimeter on inside joint face. Excess filler metal shall be removed from inside face. Galvanized areas that have been damaged by welding shall be protected with

manufacturer's standard corrosion-resistant coating.

3.3.2.2 Duct Transitions

Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, the angle of the side of the transition piece from the straight run of duct connected thereto shall not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.3.3 Round, High Pressure, Sheet Metal Duct Installation

3.3.3.1 Joints

An inner coupling shall be provided to align the inner lining to maintain good airflow conditions equivalent to standard round high-pressure duct joints. Butt joints are not suitable for the inner liner. This alignment shall be accomplished by extending the liner of the fitting for slip joint into the pipe by the use of a double concentric coupling with the two couplings held by spacers for rigidity and wall spacing. For ducts over 860 millimeter inside diameter, a separate coupling for inner alignment, with the pressure shells joined by angle-ring flanged connections, shall be provided.

3.3.3.2 Insulation Ends

At the end of an uninsulated section or run where internally insulated duct connects to uninsulated spiral duct, fitting, fire damper or flexible duct, an insulation end-fitting shall be installed to bring the outer pressure shell down to nominal size.

3.3.4 Transverse Reinforcement Joints

Transverse reinforcements shall be riveted with solid rivets to duct sides 150 millimeter on center. Transverse reinforcement shall be welded at all corners to form continuous frames.

3.3.5 Joint Gaskets

Flanged joints shall be gasketed with chloroprene full-face gaskets 3.2 millimeter thick, Shore A 40 durometer hardness. Gaskets shall be one piece, vulcanized at joints.

3.3.6 Radius Elbows

Elbow proportions and radius elbows shall be fabricated in accordance with ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06.

3.3.7 Plenum Connections

Round duct connections shall be welded joint bellmouth type.

Rectangular duct connections shall be bellmouth type, constructed in accordance with ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06.

3.3.8 Access Openings

Access panels shall be installed in ductwork adjacent to fire dampers.

Minimum size of access opening shall be 300 by 450 millimeter, unless precluded by duct dimension.

Access openings shall be framed by welded and ground miter joint, 4 millimeter thick strap steel, with 7 millimeter studs welded to frame. Cover plate shall be not less than 1.6 millimeter, reinforced as necessary for larger sizes.

In lieu of access doors, readily accessible flanged duct sections may be provided upon approval. Stable hanger supports shall be provided for disconnected duct termini.

3.3.9 Duct Supports

Duct support shall be installed in accordance with ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06. Duct hangers shall meet the minimum size specified in ASHRAE-07, Chapter 16, ASHRAE-04, Chapter 32 and SMACNA-06. Two hangers shall be provided where necessary to eliminate sway. Support attachment to duct surfaces, shall be by solid rivet.

Round, double-wall duct supports shall be as recommended by the manufacturer except that minimum hanger ring and strap size shall be 40 by 4 millimeter.

Selection of hanging system shall be at the Contractor's option, and shall take into account the location and precedence of work under other sections, interferences of various piping and electrical conduit, equipment, building configuration, structural and safety factor requirements, vibration, and imposed loads under normal and abnormal service conditions. Support sizes, configurations, and spacings are given to show the minimal type of supporting components required. If installed loads are excessive for the specified hanger spacing, hangers, and accessories hanger spacing shall be reduced. After system startup, any duct support device which, due to length, configuration, or size, vibrates or causes possible failure of a member, shall be replaced or the condition shall otherwise be alleviated. Special care shall be exercised to preclude cascade-type failures.

Hanger rods, angles, and straps shall be attached to beam clamps. Concrete inserts, masonry anchors, and fasteners shall be approved for the application.

Hardened high-carbon spring-steel fasteners fitted onto beams and miscellaneous structural steel are acceptable upon prior approval of each proposed application and upon field demonstration of conformance to specification requirements. Fasteners shall be made from steel conforming to AISI Type 1055, treated and finished in conformance with SAE AMS 2480E,

Type Z (zinc phosphate base), Class 2 (supplementary treatment). A 72-hour load-carrying capacity shall be verified by a certified independent laboratory.

Hanger spacing shall provide a 20-to-1 safety factor for supported load.

Maximum load supported by any two fasteners shall be 45 kilogram.

Friction rod assemblies are not acceptable.

Ductwork and equipment shall not be hung from roof deck, piping, or other ducts or equipment. Maximum span between any two points shall be 3000 millimeter, with lesser spans as required by duct assemblies, interferences, and permitted loads imposed.

There shall be not less than one set of hangers for each point of support. Hangers shall be installed on both sides of all duct turns, branch fittings, and transitions.

Hangers shall be sufficiently cross braced to eliminate sway vertically and laterally.

Rectangular ducts up to 900 millimeter shall be supported by strap-type hangers attached at not less than three places to not less than two duct surfaces in different planes.

Perforated strap hangers are not acceptable.

Rectangular ducting, 900 millimeter and larger, shall be supported by trapeze hangers. Ducts situated in unconditioned areas and required to have insulation with a vapor-sealed facing shall be supported on trapeze hangers. Hangers shall be spaced far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside the trapeze. Duct hangers shall not penetrate the vapor-sealed facing.

Where trapeze hangers are used, the bottom of the duct shall be supported on angles sized as follows:

WIDTH OF DUCT, MILLIMETE	MINIMUM BOTTOM ANGLE SIZE, MILLIMETER
760 and smaller	32 by 32 by 3.2
761 to 1200	38 by 38 by 3.2
1201 to 1830	38 by 38 by 4.8
1831 to 2440	50 by 50 by 6.4
2441 and wider	75 by 75 by 6.4

Where ductwork system contains heavy equipment, excluding air-diffusion devices and single-leaf dampers, such equipment shall be hung independently of the ductwork by means of rods or angles of sizes adequate to support the load.

Ducting, when supported from roof purlins, shall not be supported at points greater than one-sixth of the purlin span from the roof truss. Load per hanger shall not exceed 875 kilogram when support is from a single purlin or 1750 kilogram when hanger load is applied halfway between purlins by means of auxiliary support steel provided under this section. When support is not halfway between purlins, the allowable hanger load shall be the product of 400 times the inverse ratio of the longest distance to purlin-to-purlin spacing.

When the hanger load exceeds the above limits, reinforcing of purlin(s) or additional support beam(s) shall be provided. When an additional beam is used, the beam shall bear on the top chord of the roof trusses, and bearing shall be over gusset plates of top chord. Beam shall be stabilized by connection to roof purlin along bottom flange.

Purlins used for supporting fire-protection sprinkler mains, electrical lighting fixtures, electrical power ducts, or cable trays shall be considered fully loaded, and supplemental reinforcing or auxiliary support steel shall be provided for these purlins.

3.3.10 Flexible Connectors for Steel Metal

Air-handling equipment, ducts crossing building expansion joints, and fan inlets and outlets shall be connected to upstream and downstream components by treated woven-cloth connectors.

Connectors shall be installed only after system fans are operative and all vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkles caused by misalignment or fan reaction. Width of surface shall be curvilinear.

3.3.11 Insulation Protection Angles

Galvanized 1 millimeter thick sheet, formed into an angle with a 50 millimeter exposed long leg with a 10 millimeter stiffening break at outer edge, and with a variable concealed leg, depending upon insulation thickness, shall be provided.

Angles shall be installed over all insulation edges terminating by butting against a wall, floor foundation, frame, and similar construction. Angles shall be fastened in place with blind rivets through the protection angle, insulation, and sheet metal duct or plenum. Angles shall be installed after final insulation covering has been applied.

3.3.12 Duct Probe Access

Holes shall be provided with neat patches, threaded plugs, or threaded or twist-on caps for air-balancing pitot tube access. Extended-neck fittings shall be provided where probe access area is insulated.

3.3.13 Openings in Roofs and Walls

Building openings are fixed and equipment shall be provided to suit.

3.4 FIELD QUALITY CONTROL

3.4.1 Fire Damper Tests

Operational tests shall be performed on each fire damper in the presence of the Contracting Officer by enervating fusible link with localized heat. New links shall be provided and installed after successful testing.

3.4.2 Ductwork Leakage Tests

Contractor shall conduct complete leakage test of new ductwork in accordance with Section 15950, "Testing, Adjusting and Balancing." Tests shall be performed prior to installing ductwork insulation.

3.4.3 Inspection

Ductwork shall be inspected in accordance with SMACNA-09.

3.5 DUCTWORK CLEANING PROVISIONS

Open ducting shall be protected from construction dust and debris in a manner approved by the Contracting Officer. Dirty assembled ducting shall be cleaned by subjecting all main and branch interior surfaces to airstreams moving at velocities two times specified working velocities, at static pressures within maximum ratings. This may be accomplished by: filter-equipped portable blowers which remain the Contractor's property; wheel-mounted, compressed-air operated perimeter lances which direct the compressed air and which are pulled in the direction of normal airflow; and other means approved by the Contracting Officer. Compressed air used for cleaning ducting shall be water- and oil- free. After construction is complete, and prior to acceptance of the work, construction dust and debris shall be removed from exterior surfaces. SMACNA-09.

3.6 OPERATION AND MAINTENANCE

Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 days prior to testing the medium/high pressure ductwork systems. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

-- End of Section --

SECTION 15840

AIR TERMINAL UNITS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AIR DIFFUSION COUNCIL (ADC)

ADC-01	(1984; 10th Edition) Directory of ADC Certified Products

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S12.23	(1989) Method for the Designation of Sound Power Emitted by Machinery and Equipment

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(1996) Standard for the Installation of Air Conditioning and Ventilating Systems

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Materials, Equipment, and Fixture Lists and Records of Existing Conditions shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Fabrication drawings shall be submitted for the following items consisting of fabrication and assembly details to be performed in the factory.

Terminal Reheat Units
Variable Constant-Volume Boxes
Spare Parts

Installation drawings shall be submitted for the following items in accordance with paragraph entitled, "Installation," of this section.

Terminal Reheat Units
Variable Constant-Volume Boxes

Outline drawings for the following shall indicate overall physical features, dimensions, ratings, service requirements, and equipments weights.

Terminal Reheat Units
Variable Constant-Volume Boxes

As-Built Drawings shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-03 Product Data

Equipment and performance data shall be submitted for the following items consisting of use life, system functional flows, safety features, and mechanical automated details. Curves indicating tested and certified equipment responses and performance characteristics shall also be submitted.

Terminal Reheat Units
Variable Constant-Volume Boxes
Spare Parts

Manufacturer's catalog data shall be submitted for the following items:

Terminal Reheat Units
Variable Constant-Volume Boxes
Spare Parts

SD-04 Samples

Manufacturer's standard color charts shall be submitted for the following items showing the manufacturer's recommended color and finish selections.

Terminal Reheat Units
Variable Constant-Volume Boxes

SD-06 Test Reports

Test reports shall be submitted showing the following:

High-Pressure Ductwork
Low Pressure Ductwork
Variable and Constant Volume Boxes
Terminal Reheat Units

SD-07 Certificates

Listing of Product Installations for the following items shall be submitted in accordance with paragraph entitled, "Installation,"

of this section.

Duct Mixing Boxes
Terminal Reheat Units

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Terminal Reheat Units
Variable Constant-Volume Boxes

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section.

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Materials, Equipment, and Fixture Lists shall be submitted for all materials, equipment, and fixtures to be incorporated in the work. Lists shall include manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

As-Built Drawings shall be submitted providing current factual information, including deviations and amendments to the drawings, and concealed and visible changes in the work.

Units shall be provided with the configuration, capacity, and static-pressure characteristics indicated.

Where dimensional data are given, these shall constitute nominal sizing, which shall be adjusted by the manufacturer when necessary to accommodate acoustic material thickness.

Units identical to the proposed units shall have at least 2 years of proven satisfactory field service.

Units and spare parts shall be certified as having been ADC-01 tested and rated.

PART 2 PRODUCTS

2.1 SINGLE DUCT, CONSTANT VOLUME, TERMINAL REHEAT UNITS

Units shall include a casing, volume regulators, sound attenuating thermal insulation, and heating coils.

2.1.1 Casing

Unit casings shall be constructed of 1 millimeter aluminum or mill-galvanized steel and shall contain removable panels for access to interior parts. Units shall be insulated internally with 13 millimeter thick mineral-fiber thermal and acoustic insulation, conforming to NFPA 90A.

Unit shall contain sound-attenuation provisions including baffles to minimize unit-created noise.

2.1.2 Regulators

Units shall contain a mechanical constant-air volume control designed to operate by inlet air pressure without outside power. Regulators shall be constructed of nonferrous parts and shall be guaranteed to maintain delivered air volume at plus or minus 5 percent of unit rating.

2.1.3 Coils

Water coils shall be constructed of not less than DN10 outside diameter seamless copper tubing with copper- or aluminum-plate fins mechanically bonded or soldered to the tubes, and with not less than DN18 outside diameter female solder connectors and manual air vent on return. Provisions shall be made for coil removal in field.

Distance between coil and upstream inlet valve shall ensure uniform air velocities over face of coil.

2.1.4 Controls

Reheat output shall be controlled by a room thermostat designed to modulate the water flow in the coil by positioning a three-way valve.

2.2 VARIABLE CONSTANT-VOLUME BOXES

Casing shall be fabricated from galvanized steel and shall have internal thermal and acoustic insulation. Insulation shall be coated to prevent erosion and shall conform to NFPA 90A.

Sound baffles shall be provided within the box to provide sound levels within the limits scheduled. Sound levels shall be tested in accordance with ANSI S12.23. An 8-dB room attenuation shall be used in determining the NC level. Allowances shall be made for multiple outlets (power division) and duct attenuation.

Casing internal leakage shall be limited to 2 percent of nominal box capacity when the internal pressure is 250 pascal.

Casing shall be fitted with rigid, airtight access panels, easily removable, and of ample size to give free access to all interior parts.

Each box shall be labeled with building location and factory-set air volume or field-set calibration curve.

2.2.1 Low Velocity Boxes

Inlet valve shall be self-seating, and leakage in full closed position shall not exceed 2 percent of unit rated capacity against inlet pressure of 250 pascal.

2.2.2 Medium and High Velocity Boxes

Box shall be supplied with variable constant-volume regulator consisting of aluminum and coated-steel frame with aluminum vanes, corrosion-resistant steel adjusting spring, and neoprene pulsation snubber.

Volume reset shall be by pneumatic operator mounted directly on the variable constant-volume regulator.

Variable constant-volume regulator shall be factory set for an air capacity within plus 5 percent of the indicated maximum and minimum air quantities, regardless of variations in inlet static pressure from minimum to 1500 pascal.

Minimum air capacity shall be a percentage of the maximum air capacity indicated and shall be easily changed in the field.

A calibration chart indicating 100 percent air capacity versus adjusting screw shall be furnished with each box.

2.2.3 Control Requirements

Valve operator shall be provided by the automatic temperature control manufacturer and installed by the unit manufacturer, unless field installation for specific construction is approved. Operator shall be controlled by a thermostat.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as shown on the drawings and in accordance with the manufacturer's recommendations.

Listing of Product Installations for the following items shall include identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. List shall include purchaser, address of installation, service organization, and date of installation.

3.2 TESTS

Coils shall be tested under water at 150 percent of the working pressure or 2050 kilopascal for 1400 kilopascal working pressure.

Reports for High-Pressure Ductwork, Duct Mixing Boxes, Low Pressure Ductwork and Variable and Constant Volume Boxes shall include sound ratings submitted in terms of discharge sound-power levels in each of the second through sixth octave bands for specified or indicated inlet pressure ranges. A nominal space Noise Criteria (NC) index shall be shown for at least three operating points, including ratings at design, maximum, and minimum volume operation.

Reports for Terminal Reheat Units shall include sound-power levels, decibel reference 10 to the minus 12 power watts for each of the second through seventh octave bands, and for inlet pressures of 250 through 1500 pascal for all operating conditions. A nominal space NC sound-pressure level index shall be shown for each of at least three volume ratings, including minimum and maximum. Index shall be the highest point of NC rating after deducting 18-decibel; (dB) room attenuation from the sound-power level in each octave band.

3.3 OPERATION AND MAINTENANCE

Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 days prior to testing the following items. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

-- End of Section --

SECTION 15852

DIFFUSERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 113	(1990) Method of Testing for Room Air Diffusion
ASHRAE-04	(1997) Handbook, Fundamentals (SI Edition)
ASHRAE-07	(1997) Handbook, HVAC Systems and Equipment (SI Edition)

1.2 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Material, Equipment, and Fixture Lists shall include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

Fabrication Drawings shall be submitted for air-diffusion devices consisting of fabrication and assembly details to be performed in the factory.

Manufacturer's Standard Color Chart shall indicate the manufacturer's standard color selections and finishes for air-diffusion devices.

1.3 PERFORMANCE REQUIREMENTS

Air diffusion devices shall be certified as having been tested and rated in accordance with ASHRAE-07, Chapter 17; ASHRAE-04, Chapter 31, and ASHRAE 113, where such certification is required.

Equipment and Performance Data shall be submitted for air-diffusion devices consisting of sound data in terms of Noise Criteria (NC) index for the capacity range of the device.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

The following shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

Material, Equipment, and Fixture Lists

SD-02 Shop Drawings

Fabrication Drawings shall be submitted for air-diffusion devices in accordance with paragraph entitled, "General Requirements," of this section.

Installation Drawings shall be submitted for air-diffusion devices in accordance with the paragraph entitled, "Installation," of this section.

SD-03 Product Data

Equipment and Performance Data shall be submitted for air-diffusion devices in accordance with paragraph entitled, "Performance Requirements," of this section.

SD-04 Samples

Manufacturer's Standard Color Chart shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-10 Operation and Maintenance Data

Operation and maintenance manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

PART 2 PRODUCTS

2.1 AIR-DIFFUSION DEVICE CONSTRUCTION

Air-diffusion device construction and mounting shall preclude flutter, rattle, or vibration. Refer to Section 15072, "Vibration Isolation for Air Conditioning Equipment," for vibration isolation considerations. Devices shall have the modifications and accessories necessary for mounting in indicated surface construction.

Color selection shall be from manufacturer's standard color chips.

Color selection shall be as indicated.

Supply diffusers shall be provided with combination damper and equalizing grid. Dampers shall be extracting-splitter type, except as otherwise indicated.

Air-diffusion device volume and pattern adjustments shall be made from the face of the device. Volume adjustments shall be made by removable key.

Gaskets shall be provided for supply-terminal air devices mounted in finished surfaces.

2.2 TYPES OF AIR-DIFFUSION DEVICES

2.2.1 Type DP Series

Type DP series supply diffuser shall have a square or rectangular, perforated, hinged, face plate with opposed blade volume control, white baked enamel exterior finish, and black matte finish on exposed-to-view interior surface.

2.2.2 Type DSA

Type DSA supply diffuser shall be square with four expanding flared members to provide radially diffused discharge air. Flared members shall be arranged to provide a minimum of four air paths which simultaneously diffuse air at 6 to 15 meter per minute. Pattern adjustments shall include horizontal, vertical projection, and an intermediate position or range.

Finish shall be baked enamel.

Antismudge ring shall be provided.

Integral extended surface to fit into module of lay-in ceiling shall be provided.

2.2.3 Type GS

Type GS supply grille shall be double deflection type with adjustable face bars parallel to short dimension and adjustable rear bars parallel to long dimension.

Finish shall be baked enamel.

Integral extended surface to fit into module of lay-in ceiling shall be provided.

2.2.4 Type GR

Type GR return grilles shall be single deflection type with fixed face bars.

Grilles installed in vertical surfaces shall have horizontal face bars set downward at 35 degrees from vertical.

Grilles installed in horizontal surfaces shall have face bars straight and parallel to short dimension.

Finish shall be baked enamel.

Integral extended surface to fit into module of lay-in ceiling shall be provided.

2.2.5 Type GCA

Type GCA shall have an individually adjustable, horizontal, curved-blade grille and a one-way pattern.

Finish shall be baked enamel.

2.2.6 Type GCB

Type GCB shall have an individually adjustable, vertical, curved-blade grille and a one-way pattern.

Finish shall be baked enamel.

2.2.7 Type GCD

Type GCD shall have an individually adjustable, vertical, curved-blade grille and a two-way pattern.

Finish shall be baked enamel.

2.2.8 Type GCE

Type GCE shall have an individually adjustable, vertical and horizontal, curved-blade grille and a three-way pattern.

Finish shall be baked enamel.

2.2.9 Type GCF

Type GCF shall have an individually adjustable, vertical and horizontal, curved-blade grille and a four-way pattern.

Finish shall be baked enamel.

2.2.10 Type RS

Type RS shall be supply register, double-deflection type, with adjustable face bars parallel to short dimension and adjustable rear bars parallel to long dimension. Dampers shall be opposed-blade type.

Finish shall be baked enamel.

Integral extended surface to fit into module of lay-in ceiling shall be provided.

2.2.11 Type RR

Type RR shall be return register, single-deflection type, and shall have fixed face bars with opposed-blade dampers.

Registers installed in vertical surfaces shall have horizontal face bars set downward at approximately 35 degrees from vertical.

Registers installed in horizontal surfaces shall have face bars set straight and parallel to short dimension.

Finish shall be baked enamel.

2.2.12 Type RCA

Type RCA shall have an individually adjustable, horizontal, curved-blade register and a one-way pattern with opposed-blade damper.

Finish shall be baked enamel.

2.2.13 Type RCB

Type RCB shall have individually adjustable, vertical, curved-blade register and a one-way pattern with opposed blade damper.

Finish shall be baked enamel.

2.2.14 Type RCC

Type RCC shall have an individually adjustable, horizontal, curved-blade register and a two-way pattern with opposed blade damper.

Finish shall be baked enamel.

2.2.15 Type RCD

Type RCD shall have an individually adjustable, vertical, curved-blade register and a two-way pattern with opposed blade damper.

Finish shall be baked enamel.

2.2.16 Type RCE

Type RCE shall have an individually adjustable, vertical and horizontal, curved-blade register and a three-way pattern with opposed-blade damper.

Finish shall be baked enamel.

2.2.17 Type RCF

Type RCF shall have an individually adjustable, vertical and horizontal, curved-blade register and a four-way pattern with opposed-blade damper.

Finish shall be baked enamel.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated and specified and in accordance with manufacturer's recommendations.

Wall-mounted supply registers shall be mounted 150 millimeter below ceiling.

Installation Drawings shall be submitted for air-diffusion devices. Drawings shall indicate overall physical features, dimensions, ratings, service requirements, and equipment weights.

-- End of Section --

SECTION 15950

TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE-05	(1995) Handbook, HVAC Applications (SI Edition)

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(1989; 5th Ed) National Standards for Testing and Balancing, Heating, Ventilating, and Air Conditioning Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS NATIONAL ASSOCIATION (SMACNA)

SMACNA-07	(1993) HVAC Systems - Testing, Adjusting and Balancing

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Records of Existing Conditions shall be submitted in accordance with paragrap entitled, "General Requirements," of this section.

SD-03 Product Data

Equipment and Performance Data shall be submitted in accordance with paragrap entitled, "General Requirements," of this section.

SD-06 Test Reports

Test Reports shall be submitted in accordance with paragrap entitled, "General Requirements," of this section.

SD-07 Certificates

Certificates shall be submitted in accordance with paragrap entitled, "General Requirements," of this section.

1.3 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work specified in this section.

Equipment and Performance Data shall be submitted for instruments and equipment to be used during testing.

Test Reports shall be submitted to the Contracting Officer for approval. Six bound copies of the testing, adjusting, and balancing report shall be provided.

Certificates shall be submitted by the Contractor showing independent laboratory certification of test-apparatus calibration data, dated after the award of the contract.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 WATER SYSTEM TESTING

Prior to acceptance of the work, systems shall be tested in the presence of the Contracting Officer.

Tests shall be performed prior to insulation of surfaces, painting, and concealment of work. Systems containing repaired defects shall be retested to original criteria for acceptance, except when waived by the Contracting Officer.

Tests shall be hydrostatic, unless otherwise specified. Water used for testing shall be potable.

Government will supply testing water, but the Contractor shall provide for approved disposal of contaminated water.

Tests may be pneumatic when freezing conditions may occur and upon prior approval by the Contracting Officer. Only oil-free compressed air shall be used for testing.

Contractor may conduct tests for his own purposes, but the acceptance test shall be conducted as specified herein.

If the test demonstrates that leakage rate exceeds specified limits, the source(s) of leakage shall be determined, defective materials and workmanship shall be repaired or replaced, and the system shall be retested until specified requirements are met.

Other than standard piping flanges, plugs, caps, and valves, only commercially manufactured expandable-elastomer plugs shall be used for sealing off piping for test purposes. Safe test-pressure rating of any

plug used shall be not less than two times the actual test pressure being applied.

Precautions shall be taken to vent the expansive force of compressed air trapped during high-pressure hydrostatic testing to preclude injury and damage.

Contracting Officer may require the removal of system components, such as plugs or caps, to ascertain that the water has reached all parts of the system if purging or vent valves are not provided.

Piping system components such as valves shall be checked for functional operation under system test pressure. Components that could sustain damage due to test pressure shall be removed from piping systems prior to hydrostatic testing.

Leaking gasket joints shall be remade with new gaskets. Leaking copper joints shall be remade with new fittings and new tube ends.

Temperature of water used for testing shall not cause condensation on system surfaces.

Test media shall not be added to a system during a test for a period specified or to be determined by the Contracting Officer.

Duration of a test will be determined by the Contracting Officer and shall be for a minimum of 2 hours, with a maximum of 24 hours. Test may be terminated by direction of the Contracting Officer at any time during this period after it has been determined that the permissible leakage rate has not been exceeded.

Test records of piping systems tests shall be prepared and maintained. Records shall show test personnel responsibilities, dates, test gage identification numbers, ambient and test water temperatures, pressure ranges, rate of pressure drop, leakage rates, and other system characteristics.

3.1.1 Test Gages

Test gages shall have a 115 millimeter or larger dial, be accurate to plus or minus one-half of 1 percent of full-scale range, and have dial graduations and pointer width compatible with readability and one-half the accuracy extremes. Maximum permissible scale range for a given test shall be such that the pointer shall have a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 days prior to use, test gage number, and project number.

3.1.2 Test and Acceptance Criteria

Aboveground water systems shall be tested at 1050 kilopascal and the applied test pressure shall be maintained without further addition of test media for not less than 2 hours. Maximum allowable pressure drop shall be 14 kilopascal, or as approved.

Underground rubber-jointed ferrous-pipe water systems shall be tested at 1380 kilopascal and the applied test pressure shall be maintained for not less than 2 hours. Where no thrust blocks are to be provided, piping shall be tested at an approved pressure. After satisfactory hydrostatic testing, the piping shall be tested for leakage as follows:

Duration of each leakage test shall be not less than 2 hours. During the test, the main shall be subjected to 1380 kilopascal pressure, based on the elevation of the lowest section under test and corrected to the elevation of the test gage.

Leakage is defined as the additional quantity of water supplied into the laid pipe, or any valved section thereof, that is necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

Maximum allowable leakage for the piping installation (liter per hour) shall be indicated by not more than a 5 percent drop of total system pressure.

Hydrostatic tests shall be applied only to piping with concrete thrust blocking that has cured for a minimum of 7 days.

Backflow prevention devices in potable water systems and other water system devices shall be tested for proper functioning under conditions normal to their application.

3.2 AIR-HANDLING SYSTEMS TESTING

Structural integrity and leakage testing of air-handling systems shall be performed by system or by duct mains and branches.

Tests shall be performed prior to insulation of surfaces, painting, or concealment of work. Unless waived by the Contract Officer, systems containing repaired defects shall be retested to original criteria for acceptance.

DUCT PRESSURE-VELOCITY CLASSIFICATION

DUCT CLASS	STATIC PRESSURE RATING SEAL (pascal)	PRESSURE	CLASS	VELOCITY (mps)
High Pressure	2500	Positive	A	10 Up
Medium Pressure	1500	Positive	A	10 Up
Medium Pressure	1000	Positive	A	10 Up
Medium Pressure	750	Positive/ Negative	A	20 Down
Low Pressure	500	Positive/ Negative		10 Down

DUCT PRESSURE-VELOCITY CLASSIFICATION

DUCT CLASS	STATIC PRESSURE RATING (pascal)	SEAL CLASS	VELOCITY (mps)
Low Pressure	250	Positive/ Negative	10 Down
Low Pressure	125	Positive/ Negative	7.5 Down

Seal Class A: All seams, joints, fastener penetrations and connections sealed.

3.2.1 Low Pressure Duct Systems

Portions of systems shall be inspected and tested to positive or negative pressures, or both, whichever is normal to the portion of system under test, in accordance with the following:

There are no visible mechanical defects.

There is no audible leakage at any point when area ambient noise is at normal-occupancy level.

No leakage is perceptible to the hand, when placed within 150 millimeter of a joint.

Measured total system leakage shall not exceed 1 percent of total system cubic meter per second (mps) when tested in accordance with "Leak Tests."

3.2.2 Medium/High Pressure Duct Systems

High-velocity, high-pressure duct systems shall be structurally tested at static pressures 50 percent in excess of total fan pressure. Leakage testing shall be at a pressure 25 percent higher than normal operating pressure, and, in dual duct systems at maximum pressure at mixing box, when inlet valve is shut off. System will be acceptable provided:

a. There are no visible mechanical defects.

b. Measured total system leakage does not exceed 1 percent of total system cubic meter per second (mps) capacity when tested in accordance with "Leak Test."

c. There is no audible leakage at any point when area ambient noise is at normal-occupancy level.

High-velocity, medium-pressure duct systems shall be structurally tested at static pressures 25 percent in excess of air-handling apparatus discharge pressure. Leakage testing shall be at a pressure 25 percent higher than

normal operating pressure, and, in dual-duct systems at maximum pressure at mixing box, when inlet valve is shut off. System will be acceptable provided:

a. There are no visible mechanical defects.

b. Measured total system leakage does not exceed 1 percent of total system cubic meter per second capacity when tested in accordance with "Leak Test."

c. There is no audible leakage at any point when area ambient noise is at normal-occupancy level.

3.2.3 Leak Tests

Test apparatus and procedures shall be similar in all respects to those defined in SMACNA-07. Filtered blower inlet and automatic safety relief device shall be provided to protect system. Accuracy of measurement of leakage flow rate shall be certified to be within 1 percent of total system flow.

3.2.3.1 Test Apparatus

Test apparatus shall consist of:

a. A source of high pressure air - a portable rotary blower or tank type vacuum cleaner.

b. A flow measuring device usually an orifice assembly consisting of straightening vanes and an orifice plate mounted in a straight tube with properly located pressure taps. Each orifice assembly shall be accurately calibrated to its own calibration curve. Pressure and flow readings are usually taken with U-tube manometers.

3.2.3.2 Test Procedures

Test for audible leaks as follows:

a. Close off and seal openings in the duct section to be tested. Connect the test apparatus to the duct by means of a flexible duct section.

b. Start the blower with its control damper closed (some small blowers popularly used for testing ducts may damage the duct because they can develop pressures up to 6250 pascal).

c. Gradually open the inlet damper until the duct pressure reaches 500 pascal in excess of designed duct operating pressure. Test pressure is read on manometer No. 1. Note that the pressure is indicated by the difference in level between the two legs of the manometer and not by the distance from zero to the reading on one leg only.

d. Survey joints for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealants have set.

After all audible leaks have been sealed, the remaining leakage should be measured with the test apparatus orifice section as follows:

a. Start blower and open damper until duct pressure reaches 25 percent in excess of designed duct operating pressure.

b. Read the pressure differential across the orifice on manometer No. 2. Leakage rate in cubic meter per second is read directly from the calibration curve. If leakage does not occur, the pressure differential will be zero.

c. Total allowable leakage should not exceed 1 percent of the total system design air flow rate. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.

d. If all audible leaks have been corrected, it is unlikely that the measured leakage will exceed one percent of capacity. If it does, the leaks shall be located by careful listening or feeling along the joint.

e. It should be noted that even though a system may pass the measured leakage test, a concentration of leakage at one point may result in a noisy leak that shall be corrected.

3.2.4 Smoke-Test Apparatus and Procedures

System shall be tested with smoke bombs while under structural-integrity testing, with 5-minute, ignitable-wick, titanium-tetrachloride smoke bombs. A sufficient number of bombs shall be provided to produce the same smoke density for all portions tested. Testing shall be conducted under substantially draft-free conditions, and the area shall be free of smoke of any nature. Smoke bombs shall be placed inside air-handling unit or duct and ignited. Care shall be exercised in placing smoke bombs to ensure that no surface is damaged by the burning candle. Bombs shall be placed inside sand-filled buckets. After the bombs have burned for approximately 3 minutes, the system shall be pressurized until the exterior surfaces and all joints have been inspected for signs of smoke. Pressurization shall be done with a test fan started at less than 10 percent maximum-volume flow. Prior to starting testing, system shall be purged at various extremities until detectable smoke appears. Test pressure-relief device shall be tested for proper operation. All joints from extremities to source of smoke shall be checked.

3.2.5 Test Report Criteria

A test report shall be provided for each system tested, identified by system or section thereof, and containing leak-test curves for apparatus used and data pertinent to acceptance requirements.

3.3 AIR AND HYDRONIC SYSTEMS TESTING AND ADJUSTMENT

Operational balancing and adjustment of air-handling and hydronic systems shall be performed under the direction of an independent balancing agency whose field representative is a registered professional engineer. All work shall be done in accordance with ASHRAE-05, AABC MN-1 or SMACNA-07, where applicable, the requirements of the contract documents, and in the presence of the Contracting Officer.

Government reserves the right to require recalibration of any or all test apparatus in accordance with the frequency recommended by the component manufacturer, or when reasonable doubt of accuracy exists.

Hydronic systems structural and leakage testing shall be performed in accordance with requirements specified herein under "Water Systems Testing."

Air-handling systems structural and leakage testing shall be performed in accordance with requirements specified herein under "Air-Handling System Testing."

Components of the various air systems shall be adjusted to operate within the design and operating characteristics published by the equipment manufacturer. Government will require the services of an authorized representative of the manufacturer if the Contractor is unable to adjust any equipment.

Equipment shall not be operated until properly lubricated and brought into specified service condition.

Air- and hydronic-system final adjustments shall be permanently marked to be readily restorable if disturbed.

Systems acceptance is predicated upon successful completion of specified work, receipt by the Contracting Officer of certified data summarizing the performance of all systems within design intent, and approval thereof. Data shall be arranged by system and identified by apparatus and item, using standard forms, where possible, and supplementing with reasonable facsimiles, where necessary.

3.3.1 Air-Handling Systems

3.3.1.1 Balancing, Adjustment, and Acceptance Criteria

Final volume conditions for all systems shall be within the following limits:

Primary air delivery: Plus or minus 5 percent of design cubic meter per second at design temperature

3.3.1.2 Balancing and Adjustment, Apparatus and Procedures

Balancing and adjustment apparatus and procedures shall be in accordance with SMACNA-07 aqnd ASHRAE-05.

Balancing and adjustment apparatus and procedures shall be in accordance with ASHRAE-05 and AABC MN-1.

Instrumentation shall be provided to record air movement data, motor kilowatt (kW) input, and power factor. If motor identification plate current value is exceeded, the next size larger motor, starter, and wiring (if necessary) shall be provided.

3.3.1.3 Test Reports

Test reports shall be provided on all systems tested together with test-apparatus data and air-diffusion device flow coefficients, and the following:

Air-handling apparatus data

Exhaust-fan data

Air-diffusion devices data

Duct-traverse data for the following:

Main supply duct
Main exhaust duct
Outside air-intake duct
Other ducts as indicated

Duct zone-traverse data for the following:

All zones
Air-handling apparatus
Air-diffusion devices data
Each main duct, exhaust duct, and outside intake data

Filter apparatus data, including visual condition, inlet pressure, and differential pressure for each filter installation

Coil data, including visual condition, inlet pressure, and differential pressure for each coil installation

Pressure at inlet to face zone duct on multizone units

3.3.2 Hydronic Systems

3.3.2.1 System Balancing, Adjustment, and Acceptance Criteria

Systems final flow conditions shall be within the following limits:

Flow station delivery: Plus or minus 5 percent of design liter per second at design temperature

3.3.2.2 Test Apparatus and Procedures

Test apparatus shall consist of devices required for hydronic systems flow

measuring and balancing including:

Pressure gages and fittings

Dry bulb thermometers

Wet bulb thermometers

Pyrometers

Balancing-cock adjustment wrenches

Differential-pressure gages or manometers

Thermometer wells, where necessary for balancing, but where permanent installation of thermometers is not indicated or required

Complete air balance shall have been accomplished before water balance begins.

3.3.2.3 Hydronic Systems Preparation

Hydronic systems shall be prepared in the following manner:

Proper installation of valves and balancing devices shall be verified.

Valves shall be opened to full-open position, including coil-stop valves, bypass valves, and return-line balancing cocks.

Strainer screens shall be removed and cleaned.

Water in each system shall be examined to determine that it has been treated.

Rotation of pumps shall be checked only after obtaining approval.

Expansion tanks shall be checked to determine that they are not air-bound and that system is full of water.

Air vents shall be checked at high points to verify proper installation and operation.

Temperature controls shall be set so that coils are on full cooling. Automatic bypass valves at coils and liquid chiller should close. Follow the same procedure when balancing heating coils are set on full heating.

Water-circulating pumps shall be set to proper liter per second delivery.

Leaving-water and return-water temperatures through boilers and convertors shall be checked.

Water temperature shall be checked at inlet side of heating coils.

Note rise or drop of temperature from source.

Next, each coil shall be balanced.

Upon completion of flow reading and adjustment of coils, all settings shall be marked and all data recorded.

After adjustments to coils have been made, settings at pumps, boilers, and convertors shall be rechecked and readjusted if required.

Pressure drop through coils shall be measured at set flow rate on call for full heating.

Pressure drop across bypass valve shall be set to match coil full-pressure drop to prevent unbalanced flow conditions when coils are on full bypass.

Instrumentation shall be provided to record apparatus motor kW input and power factor. If motor identification plate current capacity and larger starter is exceeded, next-size larger motor and wiring shall be provided, as necessary.

3.3.2.4 Operational Test Report

Operational test report shall provide data on systems tested, test apparatus data, and orifice or Venturi data, and shall include:

For each heating element:

Inlet water temperature

Leaving water temperature

Inlet air temperature

Leaving air temperature

Pressure drop across each element

Pressure drop across bypass valve

Calculated and measured flow rates through coils and radiation elements

For each pump:

Balanced-condition suction and discharge pressures

Flow rate

Mechanical specifications of unit

Rated and actual kW input and power factor

3.3.3 System and Temperature-Control Adjustment

3.3.3.1 Adjustment and Acceptance Criteria

After balance and adjustment operations have been completed, the system shall be tested as a whole to see that components perform as an integral part of the system and that temperature and conditions are evenly controlled. Corrections and adjustment shall be made as necessary to meet the specified design requirements.

3.3.3.2 System Test Report

Test report shall be provided on the system and shall include:

Outdoor temperature

Room-by-room temperature and humidity conditions (center of cooled area at table top)

Calculation for total wattage cooling required, including time of day and dry bulb outside temperature

Calculation for total wattage heating required, including time of day and dry bulb outside temperature

3.4 DRAINAGE AND VENTING SYSTEM TESTING

Drainage and venting system piping shall be tested before the fixtures are installed. Soil and waste piping installed underground shall be tested before backfilling. Testing shall be applied to the system in its entirety or in sections. If the entire system is tested, openings in pipes, except the highest opening, shall be tightly closed and the system shall be filled with water to the point of overflow.

If the system is tested in sections, each opening, except the highest opening of the section under test, shall be tightly plugged and each section shall be filled and tested with not less than a 3000 millimeter head of water. In testing successive sections, at least the upper 3000 millimeter of the next preceding section shall be tested so that each joint or pipe in the system, except the uppermost 3000 millimeter, has been submitted to a test with not less than a 3000 millimeter head of water. Water shall be kept in the system, or the portion under test, for at least 15 minutes before the inspection starts. System shall be tight at all joints.

-- End of Section --

SECTION 15971

DIRECT DIGITAL CONTROL SYSTEM

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions", applies to work specified in this section.

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01300, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Microprocessor
Microprocessor Components
Control Devices
Temperature Sensors
Interface Components
Electric/Pneumatic Control Devices
Pneumatic/Electric Control Devices
Cabinetry/Enclosures

SD-04 Drawings

CONTROL SCHEMATICS

Schematic drawings shall be submitted for Control and Instrumentation systems showing the relative location of all sensors and control output devices, control diagrams, and final terminations.

Sequence of Operations shall be shown on the Control Diagram drawings.

Submit a complete written Sequence of Operations for all portions of the system to be controlled by the Direct Digital Control System. Sequence of operation to be in English Language and following approximately the written Sequence of Operation as shown on the drawings.

Upon completion of the job any corrections necessary due to field programming changes will be incorporated into this Sequence of Operation and resubmitted as an AS-BUILT copy.

WIRING DIAGRAMS

Installation drawings shall be submitted, showing the complete wiring diagrams with all component devices labeled to reflect field wiring numbers.

SD-06, Instructions

Operating Instructions shall be submitted for Control and Instrumentation consisting of standard operating procedures and shall include start up, shutdown, programming and software use instructions and emergency operation procedures.

Submit a complete Printout of all software, including all control algorithms, calculations, and entire control sequence. The program print out shall be in English Language source code, and each line shall be annotated with remark describing the action of that line. The remarks may be printed out as part of the program or may be added by hand to a copy of the actual print out.

The Contractor shall provide classroom and Field Instructions in operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor using the manufacturer's factory trained personnel or qualified representative. The Contracting Officer's Technical Representative (C.O.T.R.) shall be given fourteen calendar days materials belonging to the manufacturer or vendor; e.g., lists, static exhibits, visual aids shall be made available to the C.O.T.R.

SD-07 Schedules

Submit a list of all input and output points to the microprocessor including port numbers, description and location of the device, and English language character designation for the device with all variables, set points, flags, and alarms.

Material, Equipment, and Fixture Lists shall be submitted for complete system including manufacturers style or catalog numbers, specification and drawing reference numbers, warrantee information, and fabrication site information

Submit a list of recommended spare parts.

Final submittal of schedule to include all items as noted above with all schedules in AS-BUILT form.

SD-09 Reports

FINAL REPORTS (SYSTEM TESING)

Test Reports shall be submitted for the DDC System in accordance with the paragraph entitled, "Testing, Calibration, and

Acceptance" of this section.

SD-19 Operation and Maintenance Manuals

The Contractor shall submit 6 copies of the Operation and Maintenance Manuals 14 calendar days prior to final testing the DDC Systems. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals shall have 3/8 inch holes and be bound in a 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose leaf binder. The binder shall lie flat with printed sheets that are easy to read. Caution and warning labels shall be clearly labeled. Equipment catalog cuts shall be clearly marked to indicate the item furnished.

In addition, prior to final approval all Manufacturers Software Packages including floppy disks and package manuals, one back up copy of the software, and two copies of programs incorporating all field changes shall be submitted to the C.O.T.R. All software and programs submitted shall be on floppy disk and compatible with existing Government hardware and software.

1.3 DESCRIPTION OF SYSTEM

The Direct Digital Control (DDC) System, referred to herein shall be a complete and total, "turn key" system incorporating a microprocessor unit with all of its software and hardware components, all portions of the necessary pneumatic control and sensing devices, and all portions of the electrical system including all control and limited power wiring. All necessary hardware, software, electronic, electrical and pneumatic components, training, testing, calibration as defined herein, on the drawings, or the sequence of operation to be considered as part of the "complete system".

The DDC System shall be a fully automated field monitoring and control system capable of performing its assigned control and energy management functions as a stand alone unit. It shall be capable of being incorporated into the Energy Management Control System (EMCS) for communication with or management
by the EMCS. See Part 1.3.1.1 for information on existing EMCS. As necessary additional slave units as dictated by the scope of work, sequence of operation, and spare capacity requirements shall be included.

All portions of the "complete" DDC System to be supplied by and to be the responsibility of the Temperature and Controls (TC) Contractor.

1.3.1 Direct Digital Control System

The Direct Digital Control System shall be fully integrated into the existing EMCS as follows:

1.3.1.1 Existing System

The NASA Glenn EMCS is composed of distributed microprocessor-based field panel configured in four (4) peer-to-peer networks that are supervised by a host computer. The host computer provides database management and operator interface through five (5) PC-based workstations: System vendor is Siemens, Cleveland, Ohio --(216) 447-1343.

1.3.1.2 Building Network

All new master microprocessors shall be configured as unique node(s) on the existing EMCS peer to peer network. Network transmission shall be RS-485 via twisted shielded cable. All communication hardware, software, database and start-up shall be provided to accomplish seamless integration with the existing EMCS building network including (1) high speed data transfer rates for alarm reporting, report generation, data up-line/down-line loading, two (2) message and alarm buffering, three (3) error detection, correction, and retransmission to guarantee data integrity, and four (4) synchronization of real-time clocks.

1.3.1.3 Floor Networks

New or existing Master DDC panels shall support up to three (3) local floor-level networks for bi-directional communication with the Master DDC. Each floor network may support a family of Application Specific Controllers (ACSs) or other point expansion panels. See the sequence of operation for specific configuration requirements.

PART 2 PRODUCTS

2.1 MICROPROCESSOR UNITS

2.1.1 Stand Alone Capability

The master microprocessor shall have the capability to function as a stand alone unit. Each additional slave unit (as and if required) need to have stand alone capability provided that each slave panel is tied to the master
panel as a true slave with a hard wired communication and power link.

2.1.2 Communication Capability

Each master microprocessor (and slave unit through the master or as stand alone unit) shall be capable of being interfaced with the existing Government EMCS with the addition of communication hardware and all required programming such that the master panel (and all slave panels) can communicate with and be supervised by the EMCS.

The microprocessor shall be capable of performing its full control and

energy management functions, regardless of the condition of the communication link with the EMCS.

2.1.3 Quantity of Microprocessor Units

The TC Contractor shall be responsible for providing the quantity of microprocessor units to satisfy all of the following conditions:

Microprocessor unit(s) must have capacity to fully implement the requirements contained within the specifications for both control and energy management as well as having capacity for memory to accomplish all historical, time clock, and field programmable programs as defined herein.

Microprocessor unit(s) must be capable of fully implementing all portions of the sequence of operations including all sensing, read only, and control output points as defined within the body of the sequence of operation and by the drawing schematics.

Microprocessor unit(s) must have a minimum of 25 additional (spare) capacity based on the required quantity of digital and analog inputs and outputs utilized to completely implement the system. As necessary to complete the spare capacity requirements, an additional slave panel(s) shall be installed including all power and communication links and have battery backup capacity. The system shall have a minimum spare capacity of not less than 8 inputs and 8 outputs.

Regardless of the number of panels indicated on the drawings (or elsewhere), the number provided shall accommodate the above capacity criteria.

2.1.4 Application Specific Controllers (ACSs)

2.1.4.1 General

Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs). Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time, digital control processor. The spare point requirement, unless specified elsewhere, shall not apply to ASCs.

Each ASC shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.

ASCs shall be configured on floor networks in a functional relationship manner with Master DDC controllers. For example, a VAV terminal unit controller shall be on a floor originating from the DDC Controller that is controlling its corresponding air handling unit.

2.1.4.2 Unitary Controllers (UCs)

Provide UCs where indicated by the sequence of operation. Each UC shall

have sufficient memory to accommodate its point database and operating programs. All databases shall be stored in non-volatile memory. Programs shall be fully customized to meet the exact sequence.

Controllers that utilize pre-packaged or "canned" programs shall not be acceptable where unitary controller is used.

2.1.4.3 Terminal Equipment Controllers (TECs)

Provide for control of each piece of equipment, including, but not limited to the following:

Fan Coil Units
VAV Boxes

Controller shall include all point inputs and outputs necessary to perform the control sequences. Control shall be based on pre-tested and approved manufacturer provided applications.

Where controllers are specified to be factory-installed by HVAC equipment manufacturers, the TC Contractor shall furnish the appropriate controller and related equipment as necessary to the manufacturer for his installation.

2.1.5 Expandability

The DDC System shall be expandable in the future by the installation of additional slave panels. Total system capacity shall be expandable to at least 180 input and 180 output points.

2.1.6 Battery Backup

The microprocessor shall incorporate a battery backup system capable of retaining the programs Random Access Memory (RAM)for all units for not less than 30 hours.

The battery backup shall incorporate an automatic battery charger.

2.1.7 Hand/Off/Auto Capability

Each and every output point of the microprocessor shall have a manual three position switch marked "Hand/Off/Auto" (HOA) which is capable of overriding the microprocessor output signal when in the "hand" or "off" positions. The microprocessor shall be capable of interpreting the HOA switch position and communicating the position of this switch.

Switching the output signal of any single output point to "Hand" or "Off" shall not affect the signal of any other output point, except as necessary by program function or logic.

All HOA switches shall be contained within the microprocessor cabinet and not be accessible without opening the panel cover.

All HOA switches shall be viewable through a clear plexiglass viewing window in the cabinet cover panel.

All HOA switches shall be coupled with pilot lights (also viewable through the plexiglass window) indicating the position of the HOA switch.

2.1.8 Control Functions

2.1.8.1 Control

Control Algorithms shall be available and resident in the digital system controller to permit Proportional, Integral and Derivative control modes in any combination to meet the needs of the applications. Other control modes such as incremental, floating or two position shall be available to adopt to job needs.

All control shall be performed in a digital manner using the digital signal from the microprocessor based controller converter through electronic circuitry for modulation through transducers to produce the pneumatic signal for actuation of pneumatic actuators.

2.1.8.2 Energy Management

The digital system controller shall be capable of performing all the energy management functions, whether or not required at this time, necessary to reduce energy consumption. These programs shall include but not be limited to:

Supply air reset using space load demand and outside air temperatures

Economizer control.

Time of Day Scheduling

Optimal start using an adaptive algorithm to prevent the need for manual adjustment of parameters.

Client tailored programs. The library of routines available in firmware must be capable of generating additional programs as may be required for specific requirements. These should include but not be limited to:

Chiller Efficiency
Boiler Efficiency
Intermediate Seasonal (dead band) Control
VAV Fan Matching and Supply Fan Control
Trending of Variables
Totalizing

Specific program requirements shall be as needed to completely accomplish the requirements of the sequence of operations as defined on the construction drawings, and to accomplish the requirements of this specification.

2.1.9 Historical Data Storage

The microprocessor must be capable of storing all input and output values in its Random Access Memory. For each variable stored the length of time between samples shall be adjustable via software. The microprocessor shall be capable of retaining at least 24 samples of each input/output in its memory. The amount of memory required for storage of historical data shall be in addition to the amount of memory required for other functions defined herein.

2.1.10 Off Hour Programming and Override Capability

The microprocessor shall be capable of "off hour" programming both for evening and weekends. The instructions for "off hour" timing are defined in the Sequence of Operation.

As denoted in the Sequence of Operation and on the drawings the microprocessor may be required to respond to several override switches each of which governs its own system and area. The microprocessor shall be programmed to respond to each of those areas independently of other areas. All switches are to be timed out switches with a minimum override time of two hours and a maximum override time of eight hours. Unless otherwise specified, override to be adjustable turn knob.

2.1.11 Holiday Programming

The microprocessor shall operate on a "real time" calendar. As such it shall be capable of responding to at least ten pre-programmed holidays including New Years Day, Martin Luther King Day, Presidents Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day, and Christmas Day. In addition the microprocessor shall have the capability of having at least six additional "off" days programmed into it and further have the capability of adding these additional days to its "real time" calendar for permanent storage.

2.1.12 Field Programmable

The controller shall contain all necessary mathematic, logic, utility functions and all standard energy calculations and control functions in Read Only Memory (ROM) to be available in any combination for field programming the unit. These routines shall include but not be limited to:

Math Routines:
- Basic Algebra
- Binary Logic
- Relational Logic
- Fixed Formulas for Psychometric Calculations

Utility Routines for:
- Process entry and exit
- Variable adjustments and output
- Alarm indication
- Restart

Control Routines for:
- Signal compensation

Loop control
Energy conservation
Timed programming

2.1.13 Calibration Compensation

To maintain long term analog accuracy in the controller sensing circuits, the DDC System shall sense the voltage being supplied to the resistance sensing element and through firmware compensate for power supply changes due to long term drift or drift due to ambient temperature changes at the power supply.

2.1.14 Diagnostics

The DDC System shall contain in its program a self test procedure for checking the indication lights on the digital display, and by means of nondestructive memory, check the computer.

2.1.15 Default Operating Procedure and Alarms

All variables shall be identified as being reliable or unreliable. When a calculation is required to use a value (sensed or calculated), which is being identified as being unreliable, the unreliable data shall flash. The calculation will use a default value programmed into the unit.

All alarms (for example, a fan did not start) and all deviation alarms (for example, temperature out of range of programmed set point) shall send an alarm signal and light a red light. A scan can then identify all alarms conditions and their identifier.

2.1.16 UL Approval

The DDC microprocessor shall be an approved U.L. system, with U.L. listing as a signaling system.

2.2 SOFTWARE

2.2.1 Language

The software shall be written in an easily understood computer language. A sample of the language to be used shall be submitted for approval by the C.O.T.R.

Terminology used shall be in accordance with ASHRAE 85.

2.2.2 Software Accessibility

The software shall be written such that field changes and general accessibility to the microprocessor unit are limited by password protection.

There shall be a minimum of 3 password protected levels, as follows, with the most accessible (least protected) level listed first.

The least protected level shall allow access with "read only" and "print" (if it does not compromise other levels) capability. At this level, through a field connected IBM compatible PC unit (or, if available, through a phone modem), the user shall have the ability to recall program variables and view them. Further, the user shall have the capability of printing screen and historical data programs previously written and stored in the microprocessor RAM. No other accessibility beyond "read and print" only is requested or desired and any capability beyond this for this level is to be identified in writing for approval.

The next level shall allow all as identified in the first (lowest) level listed above plus the following:

It shall allow access to change variables and set points previously installed in the program and identified in the Sequence of Operation as "adjustable".

It shall allow the user to define and extrapolate historical data parameters.

It shall allow the user to recognize and acknowledge any alarms and flags.

It shall allow the user to make changes to the real time clock and will allow the user to change holiday and off hour scheduling.

It shall allow the user to override the program and enable or disable control input or outputs. NOTE THAT WHEN ANY OF THE PROGRAM INPUT OR OUTPUTS ARE IN THE DISABLE MODE THIS SHALL CLEARLY AND BOLDLY BE RECOGNIZED WHEN READING VARIABLE AND SET POINT VALUES.

The highest level shall allow the user to do all as identified in the first two levels listed above plus the following:

It shall allow the user to enter and modify the program logic and further shall allow the user to incorporate changes into the permanent memory of the microprocessor.

It shall allow the user to assign new passwords and to reject previously assigned passwords.

2.2.3 Software Programming

The software program shall be written to fully implement the Sequence of Operation, as shown on the drawings, and to accommodate all requirements as defined herein.

In addition the software program shall accommodate the following:

The software program shall be written such that changes to variables and setpoints can be made without accessing the program logic statements.

All inputs, outputs, variables, and setpoints shall be referenced throughout the software by an "alphanumeric" designation. This

designation shall be consistent as possible in character, shall be as descriptive as possible of the physical device, and as much as possible define the physical location of the device (for example **I.RMSEN.** could be used to define the Input of the **o** . **SE** sor located in microprocessor number). Further, these designations shall be consistent between the program statements and all submitted lists, drawings, and schedules. A list of designations shall be submitted to the C.O.T.R. for approval prior to installation in the microprocessor.

All displayed units (historical or point in time data) shall be in standard English units such as Degrees Fahrenheit, Pounds-per-square Inch, Inches-of-Water Column.

Final values for all variables and set points, including alarm ranges, shall be approved by the C.O.T.R. and changes to these variables, up until the time of final acceptance, shall be made at no cost to the Government.

2.2.4 Alarms

2.2.4.1 Preset Alarm Requirements

Alarm values shall be preset for all input points to the microprocessor. If the alarm value is exceeded a flag shall denote the alarm. The flag shall remain denoted until the flag is acknowledged.

2.2.4.2 Future Considerations for Alarms

The TC Contractor shall provide an alarm management application program inherent to the DDC Controller(s) that will update the existing building network and host computer and support existing host-level alarm management functions such as custom messaging, graphical displays, archiving functions, and destination routing. The TC Contractor shall implement and demonstrate the local alarm management program and its compatibility to the host-level alarm software. All host-level alarm management additions or modifications for this project's work shall be by the TC Contractor (See also Part 2.6 of this Section).

2.2.5 Software Loading and Downloading Capability

Approved programs shall be loaded into the microprocessor via owned IBM compatible PC with a floppy disk.

At completion of the job, after all final debugging has occurred, and the program has been proven to be operational the TC Contractor shall provide the Government with two (2) copies of the final program and software to run the program. Copies shall be provided on floppy disks and shall be compatible with government owned hardware and software.

Software shall allow for future downloading and reloading of the program, including all permanent changes made to the program by authorized government personnel, from and into the microprocessor.

2.2.6 Trend Logging

TC Contractor shall demonstrate the use of trend logging for all equipment, alarms, variable, set points, and historical data collected. The TC Contractor shall trend variables/setpoints (20 as defined by COTR) to prove operation as specified.

2.3 CENTRAL CONTROL CABINET

2.3.1 General

Control cabinet, for housing of control devices such as transducers and read out gages, shall consist of an enclosed wall mounted modular cabinet section. The front face shall be a hinged cover complete with incorporated cabinet type key lock **NOTE: All locked cabinets to be keyed such that one key is capable of opening all lockable cabinets, including the microprocessor cabinet, regardless of quantity used** Four keys shall be provided to the C.O.T.R. at completion of the project.

Control cabinets damaged in shipment shall be replaced. Microprocessor Cabinets shall be replaced entirely including all internal components and boards. Control Device Cabinets shipped with control components installed shall have all components replaced also. Control Device Cabinets shipped without control devices installed can have damaged parts (door, tub, back plates) replaced.

2.3.2 Microprocessor Control Cabinet(s)

Cabinet for the microprocessor shall incorporate all requirements as shown on the drawings and as specified herein. Microprocessor cabinet can be manufacturers standard unit provided that it meets or exceeds all requirements stated herein for "Control Cabinets" and provided that all requirements for switches, visibility of switches, and indicator lighting are also satisfied.

Finish for the microprocessor control cabinet to be manufactures standard finish.

NOTE: All finish and painting of the microprocessor cabinet shall be done in the manufacturers shop prior to the installation of any components.

2.3.3 Control Device Cabinet(s)

Control Device Cabinet(s) are cabinets supplied by the Controls Contractor to house devices such as transducers, readout gauges, control air gauges, etc.

Cabinets shall be made of steel or aluminum and shall provide a flat faced, rigid front panel. Finish shall be manufacturer's standard.

Surfaces shall be free of scale, welding slag, and dirt, and shall be flat without waves. Handling during installation shall not distort the cabinet.

Cutouts shall be square with panels to ensure that instruments can be

installed level and square. Finished cutouts and holes shall be free of burrs and sharp edges.

Where multiple cabinets are required, cabinets shall be made up of modular or fabricated sections and no individual section shall exceed 915 millimeters
wide by 1220 millimeters high. Cabinet section joints shall be aligned to each
other and installed with bottom parallel to the floor. Each cabinet shall be anchored to the wall or floor as required.

Exterior hardware (screws, hinges, latches) shall be a high grade steel with a polished-nickel or chrome plated finish.

Interior hardware (screws, nuts) shall be cadmium plated steel.

Access door shall be provided with hinges, latches, and locks. Use of right or left side hinges to be as shown on drawings or to fit application if not shown. Cabinet frame shall be reinforced to prevent doors from sagging when open.

NOTE: All locked cabinets to be keyed such that one key is capable of opening all lockable cabinets, including the microprocessor cabinet regardless of quantity used.

Field touch up of Control Cabinets shall only be done after all internal components have been removed. Covering these components prior to touch up is not acceptable alternative. An alternative for field touch up of doors is to remove the door from the cabinet, cover the cabinet with plastic to prevent construction dust from entering the cabinet, and make necessary touch up to door away from the cabinet.

NOTE: All finish and painting of the Control Device Cabinet shall be done in the Control's Contractors shop (or in the field) prior to the installation of any components.

2.4 SENSORS

2.4.1 General

All electronic sensors shall have characteristics compatible to the device to which they are connected.

All analog sensors shall utilize industry standard signals (4 to 20 milliamps or 0 to 20 volts D.C.) to facilitate future expansion. Sensors based on proprietary equipment **are no** acceptable.

All sensors shall be isolated from environments which could adversely affect their ability to accurately perform their function. For example, thermostats installed on exterior walls shall be thermally isolated from the affect of outdoor conditions.

All sensors shall be placed such that they can accurately measure the conditions of the environment being sampled. If the appropriate location

differs from that shown on the drawing, it is the responsibility of the TC Contractor to inform the C.O.T.R. of the suggested location prior to installation of wiring or conduit for the sensor.

2.4.2 Room or Duct Temperature Sensors/Thermostats

Temperature sensor signals shall be directly proportional to the variations in the measured temperature. The linearity shall be within plus or minus 1/2 of 1 percent for a 93 degree C span, and plus or minus 1 percent for a 10 degree C span, throughout the scale range.

Thermostats shall have adjustable knob for set point and thermometer included.

2.4.3 Room or Duct Humidity Sensors

Humidity sensor signals shall be directly proportional to the variations in the measured humidity. The linearity shall be within plus or minus 1 percent for the 70 percent humidity span. When the humidity sensor is duct mounted downstream from a cooling coil, the element shall be capable of withstanding a 98 percent relative humidity without loss of calibration.

2.4.4 Temperature Sensors for Water Service

Well type temperature sensors shall have the same degree of accuracy as room type sensors for a given temperature span.

Wells shall be extended into at least 75% of the total depth of the inside diameter of the pipe and shall not impede the flow of fluid in the pipe. Where insulated piping is being installed the sensor shall be furnished with an extension such that the sensor connection is outside the insulation.

Where a question exists the C.O.T.R. is to be contacted for a final decision on well style, depth, and location.

The water temperature sensor shall be inserted in a non-ferrous separable socket well.

2.4.5 Building or Air Handling Unit Static Pressure Transmitter

Building static-pressure controller shall be a double-bell, differential type with temperature compensation. Scale range shall be minus 124 to plus 124 pascals, and sensitivity shall be within plus or minus 12.0 pascals. The controller shall be supplied with an adjustable setpoint over the full scale range, an adjustable throttling range (proportional band), and electronic output.

Total system accuracy shall not be less than 12.0 pascals.

2.4.6 Building or Air Handling Unit Static Pressure Controller

Building static-pressure controller shall be a slack diaphragm type, with an adjustable set point and adjustable throttling range. Controller

range shall be 0.25 to 150 millimeters WG. Throttling range shall be adjustable
from 0.05 to 1.3 millimeters WG. Output shall be electronic.

2.4.7 Air, Water or Steam Pressure Transmitters

Pressure transmitters shall be the indicating type for gas, liquid, or steam service. Transmitter range shall be selected for system operating characteristics. Output shall be proportional to system pressure and shall be electronic.

Total system accuracy shall not be less than 1/2 percent of the system range.

2.5 CONTROL DEVICES

2.5.1 Transducers

Electric to pneumatic (EP) transducers shall be used on all outputs to pneumatic actuators, positioners, operators, or other pneumatic control devices.

Transducers shall have the capability of linearly converting the microprocessors 4 to 20 milliamp output signal to a 21 to 103 kilopascals pneumatic
signal with a 2% accuracy.

Device shall be capable of bleeding the excess pneumatic air pressure on a fall in the electronic signal while maintaining required accuracy.

Each and every transducer shall be fitted with an air service, 38 millimeter dial type 0 to 206 kilopascals pressure gauge to sense the transducer output signal. See Section 15970, "Control Systems" for gage product description. Gauge shall be mounted on the transducer.

2.5.2 Pneumatic and Electric System Accessories

The Contractor is responsible for all items in this section as well as all items in Section 15970, "Control Systems" as necessary for a complete and total job. In as much as is possible, all items shall be from a single manufacturer. Refer to the drawings, sequence of operation and Section 15970, "Control Systems", for pneumatic control devices required as part of a complete system.

Pneumatic/electric control devices and equipment necessary for a complete and total system shall include but not be limited to:

Dampers and Damper Operators
Control Valves and Valve Operators
Sensors (pneumatic)
Panel Mounted Gauges
Temperature and Pressure Gauges (field mounted)
High and Low Temperature Sensors and Controllers
Smoke Detectors

Air Pressure Reducing Station
Refrigeration Dryer
Control Tubing

Contractor is responsible for complete electrical installation as is necessary for a complete and total turn key system. The scope of this work shall include but not be limited to:

Installation of wiring, both control and limited power between microprocessor units, between microprocessor units and control devices, between all electronic sensing units and the microprocessors, all communication wiring, and any direct wiring between field sensing/control units and their respective control devices.

All electrical accessories as defined in Division 16 (such as conduit, electrical boxes) necessary to support the DDC System.

NOTE: REFER TO INSTALLATION, PART 3 OF THIS SECTION, FOR FURTHER DEFINITION OF THE "LIMITED POWER WIRING" REOUIRED OF THE TC CONTRACTOR.

Refer to Division 16, "Electrical," for parts and installation procedures as is necessary for a complete and total job.

The TC Contractor shall coordinate with the Electrical Contractor to finalize who is responsible for power wiring to eliminate duplication of installation, and to insure that all work is included to provide an operational system. Any questions shall be brought to the C.O.T.R. for clarification.

2.6 DATABASE MODIFICATIONS

The TC Contractor shall provide all database additions and modifications to the central host computer to operate the EMCS, including databases for alarm management, historical archiving, time-of-day programming, building equipment and floor plan graphical presentations. The Temperature Controls (TC) Contractor shall insure that the equipment and software provided under this project is fully compatible with the existing ECMS operating software and file structure. Floor plan graphical presentations shall be approved by the COTR.

2.7 SERVICE CONTRACT

TC Contractor shall provide a one year service contract including but not limited to a complete checkout of controls, including confirmation of transducer accuracy, system program operation, and calibration of all operator devices and sensors. Service to be provided twice (one-summer and one-winter) per full year following final acceptance. TC Contractor to submit a written report within 30 calendar days of inspection.

PART 3 EXECUTION

3.1 INSTALLATION

Special tools shall be provided as required for the operation and adjustment of controllers, instruments, or other control system devices.

Installation of the complete DDC System, including all portions of this section, all portions of the pneumatic Section 15970, "Control Systems," and all control and limited power wiring (as defined below) shall be by a single TC Contractor.

All control components shall be done by a qualified control and instrumentation specialist, working under the direction of the manufacturer's representative.

Installation shall conform to the published or written instructions of the manufacturer, except as otherwise specified herein.

Installation of electrical work to be performed by the TC Contractor shall conform to the specifications in Division 16 unless specified differently herein.

Installation of pneumatic control components shall be as specified in Section 15970, "Control Systems," unless specified differently herein.

3.2 MICROPROCESSOR AND CONTROL DEVICE CABINET INSTALLATION

Microprocessors shall be installed in locations as indicated on the drawings. All portions of the cabinetry including related components and control devises in separate cabinets shall be mounted adjacent to each other.

A minimum of 1 meter clear space shall be provided in front of the face of the hinged cabinet door. For cabinet installations with doors greater than three feet wide, clear space shall be provided in front of the panel to open the door 105 degrees from a closed position.

Cabinets shall be mounted such that the center of the panel is 1.5 meters above finished floor. In no case shall the top of a panel exceed 2.2 meters above finished floor.

Stacking of panels is prohibited unless specifically shown otherwise on the drawings, or approved by the C.O.T.R..

CONTRACTOR TO COORDINATE THE INSTALLATION OF CONTROL PANELS SUCH THAT ALL BUILDING MATERIAL FINISHES ARE COMPLETE ENOUGH THAT THERE WILL BE NO SPRAY PAINTING IN ROOMS AFTER THE MICROPROCESSOR CONTROL CABINET OR CONTROL DEVICE CABINET (WITH CONTROLS INSTALLED IN CABINET) HAVE BEEN INSTALLED. IF TOUCH UP PAINTING IS REQUIRED AFTER INSTALLATION IT SHALL BE BY BRUSH ONLY OR THE MICROPROCESSOR AND/OR CONTROL CABINET (WITH CONTROLS INSTALLED IN CABINET) SHALL BE REMOVED.

3.3 SOFTWARE

"Approved" software packages shall be entered into the microprocessor in the field and debugged after all necessary components (such as air handlers, room sensors, control components) have been installed and proven operational. Work on portions of the system is allowed where all components of that portion can function as a stand alone system.

Prior to on-line operation a complete demonstration and readout of the computer real time responsibilities of sensing and control shall be demonstrated in the presence of the C.O.T.R. and project managers representative.

3.4 ELECTRICAL AND ELECTRONIC EQUIPMENT INSTALLATION

The following requirements shall supersede any requirements as shown in the Electrical portion of this specification (Division 16).

3.4.1 Limited Power Wiring Requirements

The Contractor is responsible for providing sufficient power to a junction box within 1.8 meters of the microprocessor master panel. Appropriate circuit
breakers shall be provided by the Electrical Contractor. The exact power requirements are to be determined by the TC Contractor.

The Contractor is responsible for providing a clean and direct ground at the above junction box. By "clean" and "direct" it is meant that one of the following two methods of grounding shall be provided.

Preferred method is a direct ground line to a properly installed ground rod.

Option is a ground wire "Cad-Welded" to a building ground wire which is directly connected to a building ground. Note that it is not acceptable to connect to building steel as a ground source.

Power wiring from junction box (as defined above) to the microprocessor shall include the following:

- -Connection devices, including any terminal strips required
- -Surge protection devices
- -Ground system (see definition below)
- -Any and all power wiring between microprocessor and control devises including linking wiring.
- -Any and all power wiring necessary for the operation of motorized dampers, control valves, control devices, controlled directly and/or indirectly by the microprocessor.

NOTE: THE TERM "POWER WIRING" USED ABOVE SHALL BE CONSTRUED TO MEAN ALL WIRE, CONDUIT, FITTINGS, JUNCTION BOXES AS IS NECESSARY FOR A COMPLETE AND TOTAL SYSTEM. FURTHER ALL "POWER WIRING" SHALL BE DONE IN FULL COMPLIANCE WITH DIVISION 16 "ELECTRICAL," HEREIN UNLESS SPECIFICALLY EXCEPTED ABOVE.

3.4.2 Control Wiring

Contractor shall be responsible for the complete installation of the entire control wiring package including higher voltage (110 volt thermostat) control wiring.

All control wiring to be as required in division 16 of this specification.

NOTE: THE TERM "CONTROL WIRING" USED ABOVE SHALL BE CONSTRUED TO MEAN ALL WIRE, CONDUIT, FITTINGS, JUNCTION BOXES AS IS NECESSARY FOR A COMPLETE AND TOTAL SYSTEM.

3.4.3 Grounding System

All grounded devices, relative to and including the microprocessor unit shall be individually grounded with a direct tie to the "clean" and "direct" ground line as defined in above paragraph entitled, "Limited Power Wiring Requirements."

The use of grounding terminal strips is permitted provided that each strip is tied directly to the "clean" and "direct" ground line.

NO DAISY CHAIN GROUNDING SHALL BE PERMITTE .

The only exception to the requirements for grounding shall be that grounding done at and by the manufacturer's factory shall be per the manufacturers standards. Note that components assembled by the TC Contractor, whether in his shop or in the field shall not be considered to be factory installed.

All panels including the microprocessor and control device cabinets shall be individually grounded back to the "clean" and "direct" line described above.

3.5 SURGE SUPPRESSION

All surge suppression devices are to be sized, furnished and installed by the TC Contractor.

All surge suppression devices to be direct grounded to the "clean" and "direct" ground line provided by the Electrical Contractor.

All surge protection devices to be fuse protected at the device.

3.5.1 Surge Suppression for Power Wiring

All power wiring to the microprocessor and control cabinet to be protected by a surge suppression device. Devices to be selected such that they fully protect the microprocessor and all down stream equipment based on the manufacturers recommendation.

Where multiple power line inputs are used with multiple microprocessors or control device cabinets a separate surge protection device will be used for each device.

3.5.2 Surge Suppression for Communication and/or Phone Connection

The surge suppression device for the microprocessor shall be equipped with phone line class surge protection regardless of whether or not a communication card or phone modem system is provided.

If a separate surge protection device is used for the phone, it shall be

direct connected to the "clean" and "direct" ground line.

3.6 ELECTRO MAGNETIC FIELD INTERFERENCE

Manufacturer's recommendations are to be followed relative to the placement of microprocessor units, field routing of sensing, control, and communication wiring, and required shielding as necessary to prevent interference from Electro-Magnetic Fields (EMF) inherent in electrical power equipment.

If not specified in the manufacturers literature the following minimum guidelines shall be followed:

No microprocessor, control cabinet, or exposed control wiring shall he placed within 6.1 meters of an electrical power source (for example, transformer-feed side voltage rating, switch gear, motor) that is operating at higher than 500 volts.

No microprocessor, control cabinet, or exposed control wiring shall be placed within 3.1 meters of an electrical power source (for example, transformer-feed side voltage rating, switch gear, motor) that is operating between 300 and 500 volts.

No Control wiring, installed in conduit, shall be run within 4.6 meters of
power wiring, not encased in metal conduit, operating above 500 volts.

No control wiring, installed in conduit, shall be run within 2.2 meters of
power wiring, not enclosed in metal conduit, operating between 300 and 500 volts.

No Control wiring, installed in conduit, shall be run within 3.1 meters of
power wiring, encased in metal conduit, operating above 500 volts.

No control wiring, installed in conduit, shall be run within 1.5 meters of
power wiring, encased in metal conduit, operating between 300 and 500 volts.

Sensing equipment shall follow the same guidelines as noted for the control wiring installed in conduit.

EXCEPTION: AS NECESSARY SENSORS WILL BE ALLOWED CLOSER WHERE THERE FUNCTION DICTATES SUCH. (i.e. Pressure transmitter around filters on air handling units may necessarily be installed inside the minimum distances noted above because of proximity of filters to motor, however every effort should be made to maximize the distance between the sensor and voltage source.)

3.7 INSTALLATION OF PNEUMATIC PORTIONS OF THE COMPLETE SYSTEM

All installation of Pneumatic equipment such as sensors, operators, tubing,

etc. are covered in Section 15970, "Control Systems." TC Contractor is instructed to review this section to fully understand the requirements for a complete and total system.

3.8 TESTING, CALIBRATION, AND ACCEPTANCE (COMMISSIONING)

After the inspection has been completed, all systems shall be checked for continuity. All control equipment shall be tested and adjusted, relative to design, function, and performance, and shall otherwise be made ready for air handling system acceptance tests. A report showing set points and final adjustments of all equipment and controls shall be submitted to the Government C.O.T.R.

After air handling system acceptance and after systems have operated in normal service for two weeks, The adjustments on all equipment and devices shall be checked and a report submitted indicating all items tested. All items found to be out of order shall be corrected. When all HVAC systems are in specified operating condition and when all other pertinent specification requirements have been met, and when training is complete the Temperature and Control package will be accepted.

Equipment necessary to check the calibration of the control system components shall be provided by the contractor. Components not in calibration shall be corrected or replaced.

3.9 OPERATING INSTRUCTION

Written and verbal operating instructions on sequence of operations and controls shall be provided. Training shall be completed within two weeks of the final test and calibration. Time for training shall be coordinated through the Contracting Officer.

3.10 SPECIAL TOOLS

Special tools shall be provided as required for the operation and adjustment of controllers, instruments, or other control system devices.

-- End of Section --

SECTION 16003

GENERAL ELECTRICAL PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1989; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

FEDERAL STANDARDS (FED-STD)

FED-STD 595	(Rev B) Colors Used in Government Procurement

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(1993) National Electrical Safety Code

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA Z 535	(1991) Safety Color Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL-05	(1995) Electrical Construction Materials Directory

1.2 SUBMITTALS (Not Applicable)

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements that may be required for proper installation of the work. Such work shall be verified at the site. Additional bends and offsets, and conduit as required by vertical and horizontal equipment locations or other job conditions, shall be provided to complete the work at no additional cost to the Government.

Except where shown in dimensional detail, the locations of switches, receptacles, lights, motors, outlets, and other equipment shown on plans are approximate. Such items shall be placed to eliminate interference with ducts, piping, and equipment. Exact locations shall be determined in the field. Door swings shall be verified to ensure that light switches are properly located.

Equipment sizes indicated are minimum. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and shall install wire, conduit, disconnect switches, motor starters, heaters, circuit breakers, and other items of the correct size for the equipment actually installed. Wire and conduit sizes shown on the drawings shall be taken as a minimum and shall not be reduced without written approval.

1.4 CODES AND STANDARDS

Equipment design, fabrication, testing, performance, and installation shall, unless shown or specified otherwise, comply with the applicable requirements of NFPA 70 and IEEE C2.

1.5 COORDINATION

Installation of the electrical work shall be coordinated with the work of other trades.

1.6 APPROVAL REQUIREMENTS

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories (UL), Inc., the label of, or listing with re-examination, in UL-05 will be acceptable as sufficient evidence that the items conform to the requirements.

Where materials or equipment are specified to be constructed or tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized standards, a manufacturer's certificate of compliance indicating complete compliance of each item with the applicable NEMA, ANSI, ASTM, or other commercial standards specified will be acceptable as proof of compliance.

1.7 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given a rust-inhibiting treatment and the standard finish by the manufacturer. Aluminum shall not be used in contact with earth. Dissimilar metals in intimate contact shall be protected by approved fittings, barrier material, and treatment. Ferrous metals such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123 for exterior locations.

1.8 HAZARDOUS AREA

Electrical work within any hazardous location shall meet the applicable

requirements of NFPA 70, Chapter 5, Articles 500 through 517. The following definitions apply:

Explosionproof: A receptacle, fixture, device, or equipment enclosure that is designed to withstand explosion of a specified liquid, gas, vapor, or dust within the enclosure and to prevent the ignition of a specified gas, vapor, or dust surrounding the enclosure by sparks, flashes, or explosions of the specified liquid, gas, vapor, or dust that may occur within the enclosure. Enclosure shall be capable of operating at an external temperature that will not ignite a surrounding flammable atmosphere.

Hazardous location: An area where ignitable vapors or dust may cause a fire or explosion created by energy emitted from lighting or other electrical equipment or by electrostatic generation.

NFPA 70, Article 500-2 lists chemical atmospheres by groups A, B, C, and D. In addition, although not defined as a hazardous material by the NEC, oxygen concentrations (liquid and gaseous) are considered to provide a hazard because of the increased flammability of materials exposed to oxygen. Therefore, oxygen concentrations shall be classified under Group D.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES (EQUIPMENT OPERATING AT 600V OR LESS)

In addition to manufacturer's standard identification plates, engraved laminated phenolic identification plates shall be provided for each motor starter, disconnect switch, panelboard, transformer, and each piece of electrical equipment provided under this contract. Identification plate designations shall be in accordance with construction documents. The designations shall be submitted for approval with the shop drawings.

Identification plates shall beengraved laminated phenolic,with white surface and black core (black lettering on white background). Identification plates 40 millimeter high and smaller shall be 2 millimeter thick. Identification plates larger than 40 millimeter high shall be 3 millimeter thick and shall have all edges beveled 45 degrees.

Identification plates shall have uppercase lettering centered horizontally and vertically. Equipment such as switchgear, unit substations, switchboards, panelboards, motor control centers, and transformers shall have identification plates with 13 millimeters high lettering. All other electrical equipment identification plates shall have 6 millimeters high lettering unless indicated otherwise in equipment specifications or construction documents.

2.1.1 WARNING SIGNS

Each item of electrical equipment operating at 480 volts and above shall be provided with conspicuously located warning signs conforming to the requirements of Occupational Safety and Health Agency (OSHA) standards.

Safety color coding for identification of warning signs shall conform to NEMA Z 535.

2.2 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or slabs.

2.3 SEISMIC ANCHORAGE

Electrical equipment, except communications, emergency, and standby equipment, shall be anchored to withstand a lateral force of 0.3 times the weight of the equipment.

Communications, emergency, and standby equipment shall be anchored to withstand a lateral force of 0.6 times the weight of the equipment.

The following standard anchoring should be adequate for equipment not classified as communications, emergency, or standby:

Dry transformers - floor-mounted with four anchor bolts

	BOLT DIAMETER
Under 150 kVA	M10
150 to 500 kVA	M14
Over 500 kVA	M16

Panels - floor-mounted with four M14 diameter anchor bolts

2.4 PAINTING

Enclosures of the following listed items shall be cleaned, primed, and factory-painted inside and outside.

ITEM	FINISH COLOR
Circuit Breakers	No. 61 gray (FED-STD 595)
Substations	No. 61 gray (FED-STD 595)
Switchgear	No. 61 gray (FED-STD 595)
Transformers	No. 61 gray (FED-STD 595)
Safety Switches	Manufacturer's standard
Panelboards	Manufacturer's standard
Electric Heaters	Manufacturer's standard
Motors	Manufacturer's standard
Limit Switches	Manufacturer's standard
Control Components	Manufacturer's standard

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

3.2 PAINTING APPLICATION

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks, if not factory painted, shall be thoroughly cleaned and painted as specified in Section 09915, "Painting," unless otherwise noted. Work shall be left in a neat and clean condition at final completion of the contract.

Emergency equipment, such as fire-alarm boxes, shall be cleaned, primed, and painted red. Color shall conform to FED-STD 595, Color 11105.

3.3 IDENTIFICATION PLATE INSTALLATION

Identification plates for outdoor equipment shall be fastened by means of self-tapping stainless steel screws. Identification plates for indoor equipment shall be fastened with adhesive. Hand lettering, marking, or embossed self-adhesive tapes are not acceptable.

3.4 EQUIPMENT PADS

Equipment pads shall be constructed with a minimum 100 millimeter margin around the equipment and supports.

3.5 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching on the building structure.

Holes in or through existing masonry walls and floors in exposed locations shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

3.6 DAMAGE TO WORK

Required repairs and replacement of damaged work shall be done as directed by and subject to the approval of the Contracting Officer, and at no additional cost to the Government.

3.7 CLEANING

Exposed surfaces of wireways, conduit systems, and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish or painting or are enclosed within the building structure.

Before final acceptance, electrical equipment, including lighting fixtures

and glass, shall be clean and free from dirt, grease, and fingermarks.

3.8 FIELD TESTING AND TEST EQUIPMENT

All Field testing specified in Divisions 16 electrical specification shall be made with test equipment specially designed and calibrated for the purpose. Test equipment used shall be calibrated and certified by an approved testing laboratory. Date of last calibration and certification shall not be more than 90 days old at the time of field testing.

-- End of Section --

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

COUNCIL OF AMERICAN BUILDING OFFICIALS (CABO)

CABO A117.1	(1992) American National Standards for Buildings and Facilities Providing Accessibility and Usability for Physically Handicapped People

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA 480	(1981) Toggle Switches

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electric Equipment (1000 Volts Maximum)
NEMA FB 1	(1993) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
NEMA KS 1	(1996) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA OS 1	(1989) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA PB 1	(1990) Panelboards
NEMA RN 1	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 13	(1993) Electrical Nonmetallic Tubing (ENT)
NEMA VE 1	(1991) Metallic Cable Tray Systems
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional

	Requirements
NEMA Z 535	(1991) Safety Color Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(1993) UL Standard for Safety - Flexible Metal Conduit
UL 1242	(1996; 2nd Ed) UL Standard for Safety - Intermediate Metal Conduit
UL 489	(1991; 8th Ed; May 1, 1992; Bulletin Feb 11, 1992; Bulletin Mar 16, 1992) UL Standard for Safety Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
UL 506	(1994) UL Standard for Safety Specialty Transformers
UL 6	(1997; 11th Ed) UL Standard for Safety - Rigid Metal Conduit
UL 797	(1993; 6th Ed) UL Standard for Safety - Electrical Metallic Tubing
UL 870	(1995; 7th Ed) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the following:

Conduits, Raceway sand Fittings
Wire and Cable
Splices and Connectors
Switches
Receptacles
Outlets, Outlet Boxes, and Pull Boxes
Circuit Breakers
Panelboards
Lamps and Lighting Fixtures

Dry-Type Distribution Transformers

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Conduits, Raceway sand Fittings
Wire and Cable
Splices and Connectors
Switches
Receptacles
Outlets, Outlet Boxes, and Pull Boxes
Circuit Breakers
Panelboards
Lamps and Lighting Fixtures
Dry-Type Distribution Transformers
Spare Parts

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted.

1.3 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall have the standard finish by the manufacturer. Aluminum shall not be used in contact with earth and, where connected to dissimilar metal, shall be protected by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

1.4 GENERAL REQUIREMENTS

Material, Equipment, and Fixture Lists shall be submitted for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Manufacturer's Instructions shall be submitted including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

2.1.1 Rigid Steel Conduit

Rigid steel conduit shall be in accordance with UL 6 and shall be galvanized by the hot-dip process. Where underground and in corrosive areas, rigid steel conduit shall be polyvinylchloride (PVC) coated in accordance with NEMA RN 1 or shall be painted with bitumastic.

Fittings for rigid steel conduit shall be threaded.

Gaskets shall be solid. Conduit fittings with blank covers shall have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers shall have captive screws and shall be accessible after the work has been completed.

2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be in accordance with UL 797 and shall be zinc coated steel. Couplings and connectors shall be zinc-coated, raintight, gland compression with insulation throat. Crimp, spring, or setscrew type fittings shall not be acceptable.

2.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall be in accordance with UL 1 and shall be galvanized steel.

Fittings for flexible metallic conduit shall be specifically designed for such conduit.

Liquidtight flexible metallic conduit shall be provided with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Fittings for liquidtight flexible metallic conduit shall be specifically designed for such conduit.

2.1.4 Intermediate Metal Conduit

Intermediate metal conduit shall be in accordance with UL 1242 and shall be galvanized.

2.1.5 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall be in accordance with NEMA TC 13 and shall be PVC with wall thickness not less than Schedule 40.

2.1.6 Wireways and Auxiliary Gutters

Wireway and auxiliary gutters shall be a minimum 100 by 100 millimeter trade size conforming to UL 870.

2.1.7 Surface Raceways and Assemblies

Surface metal raceways and multi-outlet assemblies shall conform to NFPA 70. Receptacles shall conform to NEMA WD 1, Type 5-20R.

2.1.8 Cable Trays

Cable trays shall be ladder type conforming to NEMA VE 1.

2.2 WIRE AND CABLE

Conductors installed in conduit shall be copper 600-volt type THHN/THWN. All conductors 3.15 millimeter diameter (AWG No. 8) and larger, shall be stranded. All conductors smaller than 3.15 millimeter diameter (AWG No. 8) shall be solid.

Flexible cable shall be Type SO and shall contain a grounding conductor with green insulation.

Conductors installed in plenums shall be marked plenum rated.

2.3 SPLICES AND CONNECTORS

Splices in 3.15 millimeter diameter (AWG No. 8) and smaller shall be made with approved insulated electrical type.

Splices in 4.1 millimeter diameter (AWG No. 6) and larger shall be made with indentor crimp-type connectors and compression tools. Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

2.4 SWITCHES

2.4.1 Safety Switches

Safety switches shall be in accordance with NEMA KS 1, and shall be the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, with the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and shall be so constructed that an external tool must be used to open the cover. Provisions shall be made to lock the handle in the "OFF" position, but the switch shall not be capable of being locked in the "ON" position.

Switches shall be of the quick-make, quick-break type. Terminal lugs shall be approved for use with copper conductors.

Safety color coding for identification of safety switches shall conform to NEMA Z 535.

2.4.2 Toggle Switches

Toggle switches shall be in accordance with EIA 480, and shall control incandescent, mercury, and fluorescent lighting fixtures and shall be of the heavy duty, general purpose, noninterchangeable flush-type.

Toggle switches shall be commercial grade toggle type, single-pole, three-way two-position devices rated 20 amperes at 277 volts, 60 hertz alternating current (ac) only.

All toggle switches shall be products of the same manufacturer.

2.5 RECEPTACLES

Receptacles shall be commercial grade, 20A, 125 VAC, 2-pole, 3-wire duplex conforming to NEMA WD 6, NEMA 5-20R.

2.6 OUTLETS, OUTLET BOXES, AND PULL BOXES

Outlet boxes for use with conduit systems shall be in accordance with NEMA FB 1 and NEMA OS 1 and shall be not less than 40 millimeter deep. Pull and junction boxes shall be furnished with screw-fastened covers.

2.7 PANELBOARDS

Lighting and appliance branch circuit panelboards shall be the circuit-breaker type in accordance with NEMA PB 1. Circuit breakers shall be bolted to the bus. Plug-in circuit breakers shall not be acceptable. Buses shall be copper of the rating indicated, with main lugs or main circuit breaker as indicated. Panelboards for use on grounded ac systems shall be provided with a full-capacity isolated neutral bus and a separate grounding bus bonded to the panelboard enclosure. Panelboard enclosures shall be NEMA 250, Type 1, in accordance with NEMA PB 1. Enclosure fronts shall have latchable hinged doors.

2.8 CIRCUIT BREAKERS

Circuit-breaker interrupting rating shall be not less than those indicated and in no event less than 10,000 amperes root-mean-square (rms) symmetrical at 208 volts, respectively. Multipole circuit breakers shall be the common-trip type with a single handle. Molded case circuit breakers shall be bolt-on type conforming to UL 489.

2.9 LAMPS AND LIGHTING FIXTURES

Manufacturers and catalog numbers shown are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, will be acceptable. Lamps of the proper type and wattage shall be provided for each fixture.

Ballasts shall be high power factor and be energy efficient. Ballasts shall have a Class P terminal protective device for 120-volt operation as indicated and shall be rapid-start fluorescent. Ballasts shall be "A" sound rated. Fluorescent lamps shall be standard reduced wattage type.

High intensity discharge (HID) lighting fixtures shall have prewired integral ballasts and cast aluminum housings complete with tempered glass lenses suitable for installation in damp or wet locations. Fixtures and

lamps shall be provided.

2.10 DRY-TYPE DISTRIBUTION TRANSFORMERS

General purpose dry-type transformers with windings 600 volts or less shall be two-winding, 60 hertz, self-cooled in accordance with UL 506. Windings shall have a minimum of two 2-1/2-percent taps above and below nominal voltage.

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall contain not more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Crushed or deformed conduit shall not be installed. Trapped conduit runs shall be avoided where possible. Care shall be taken to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clogged conduit shall be cleared of obstructions or shall be replaced.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilinigs 1470 millimeter or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

3.1.1 Rigid Steel Conduit

Field-made bends and offsets shall be made with approved hickey or conduit bending machine. Conduit elbows larger than 65 millimeter shall be long radius.

Conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, shall be provided with a flush coupling when the floor slab is of sufficient thickness. Otherwise, a floor box shall be provided and set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.1.2 Electrical Metallic Tubing (EMT)

EMT shall be grounded in accordance with NFPA 70, using pressure grounding connectors especially designed for EMT.

3.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall be used to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

Bonding wires shall be used in flexible conduit as specified in NFPA 70,

for all circuits. Flexible conduit shall not be considered a ground conductor.

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit.

Liquidtight flexible metallic conduit shall be used in wet and oily locations and to complete the connection to motor-driven equipment.

3.1.4 Intermediate Conduit

Field-made bends and offsets shall be made with approved hickey or conduit bending machine. Intermediate metal conduit shall be used only for indoor installations.

3.1.5 Rigid Nonmetallic Conduit

Rigid PVC conduit shall be direct buried.

A green insulated copper grounding conductor shall be in conduit with conductors and shall be solidly connected to ground at each end. Grounding wires shall be sized in accordance with NFPA 70.

3.1.6 Wireway and Auxiliary Gutter

Straight sections and fittings shall be bolted together to provide a rigid, mechanical connection and electrical continuity. Dead ends of wireways and auxiliary gutters shall be closed. Unused conduit openings shall be plugged.

Wireways for overhead distribution and control circuits shall be supported at maximum 1500 millimeter intervals.

Auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure shall contain no switches, overcurrent devices, appliances, or apparatus and shall be not more than 9000 millimeter long.

3.1.7 Surface Raceways and Assemblies

Surface raceways shall be mounted plumb and level, with the base and cover secured. Minimum circuit run shall be three-wire with one wire designated as ground.

3.1.8 Cable Trays

Cable trays shall be supported from ceiling hangers, equipment bays, or floor or wall supports. Cable trays may be mounted on equipment racks. Support shall be provided when the free end extends beyond 900 millimeter. Maximum support spacing shall be 1800 millimeter. Trays 250 millimeter wide or less shall be supported by one hanger. Trays greater than 250 millimeter wide shall be supported by two hangers. Cable trays shall be bonded at splices.

3.2 WIRING

Feeder and branch circuit conductors shall be color coded as follows:

CONDUCTO	COLOR AC
Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Equipment Grounds	Green

Conductors up to and including 6.5 millimeter diameter (AWG No. 2) shall be manufactured with colored insulating materials. Conductors larger than 6.5 millimeter diameter (AWG No. 2) shall have ends identified with color plastic tape in outlet, pull, or junction boxes.

Splices shall be in accordance with the NFPA 70. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification shall match as indicated.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.

3.3 SAFETY SWITCHES

Switches shall be securely fastened to the supporting structure or wall, utilizing a minimum of four 6 millimeter bolts. Sheet metal screws and small machine screws shall not be used for mounting. Switches shall not be mounted in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be 1500 millimeter above floor level, when possible.

3.4 WIRING DEVICES

3.4.1 Wall Switches and Receptacles

Wall switches and receptacles shall be so installed that when device plates are applied, the plates will be aligned vertically to within 2 millimeter.

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.4.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets shall be suitably marked, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Required marking shall consist of a self-adhesive label having 6 millimeter embossed letters.

Device plates for convenience outlets shall be similarly marked indicating the supply panel and circuit number.

3.5 BOXES AND FITTINGS

Pullboxes shall be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 30 meter or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be in accordance with CABO A117.1 and as follows, unless otherwise noted on drawings:

LOCATIO	MOUNTING HEIGHT
Receptacles in offices	450 millimeter
Receptacles in corridors	450 millimeter
Receptacles in shops & laboratories	1200 millimeter
Receptacles in rest rooms	1200 millimeter
Switches for light control	1200 millimeter

3.6 LAMPS AND LIGHTING FIXTURES

New lamps of the proper type and wattage shall be installed in each fixture. Fixtures and supports shall be securely fastened to structural members and shall be installed parallel and perpendicular to major axes of structures.

3.7 PANELBOARDS

Panelboards shall be securely mounted so that the top operating handle does not exceed 1800 millimeter above the finished floor. Directory card information shall be complete and legible.

3.8 DRY-TYPE DISTRIBUTION TRANSFORMERS

Dry-type transformers shall be connected with flexible metallic conduit.

3.9 IDENTIFICATION PLATES AND WARNINGS

Identification plates shall be furnished for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, door bells, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Process control devices and pilot lights shall have identification plates.

Identification plates shall be furnished for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

3.10 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks shall be thoroughly cleaned and painted as specified in Section 09915, "Painting."

3.11 FIELD TESTING

After completion of the installation and splicing, joints, and terminations, and prior to energizing the conductors, wire and cable shall be given continuity and insulation tests before the conductors are energized.

Insulation tests on circuits with conductor sizes 6.5 millimeter diameter (AWG No. 2) and larger, shall be conducted using a 1,000-volt insulation resistance test set. Readings shall be taken after 1 minute or until the reading is constant for 15 seconds. Resistance between phase conductors and ground shall be not less than 25 megohms.

Phase-rotation tests shall be conducted on three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to connected equipment shall be A, B, C left to right, or top to bottom facing the equipment.

Final acceptance will depend upon the satisfactory performance of equipment. No conductor shall be energized until the installation has been approved.

-- End of Section --

SECTION 16065

SECONDARY GROUNDING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 3	(1995) Standard Specification for Soft or Annealed Copper Wire

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

MILITARY STANDARDS (MIL-STD)

MIL-STD 889	(Rev B, Notice 2) Dissimilar Metals

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(1993; 7th Ed) UL Standard for Safety Grounding and Bonding Equipment

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, equipment, and fixture lists shall be submitted for Grounding Systems including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

SD-02 Shop Drawings

As-Built Drawings shall be submitted in accordance with paragraph entitled, "Drawings," of this section.

SD-03 Product Data

Equipment and performance data shall be submitted for the following items including life, test, system functional flows, safety features, and mechanical automated details.

Manufacturer's catalog data shall also be submitted for the following items:

Ground Rods
Ground Wires
Connectors and Fasteners
Bonding

SD-06 Test Reports

Test Reports shall be submitted for the following tests on grounding systems in accordance with the paragraph entitled, "Field Tests," of this section. Report shall include certified record of ground-resistance tests on each driven ground rod, ground rod assembly, and other grounding electrodes. Record shall include the number of rods driven and their depth at each location to meet the required resistance-to-ground measurements specified. A statement shall be included describing the condition of the soil at the time of measurement.

Bond Resistance Test
Ground Resistance Tests
Ground Isolation Test
Continuity Isolation Test

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for the Grounding Systems including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

1.4 DRAWINGS

As-Built Drawings shall indicate the location of ground rods, mats, grids, building ground bus, supplementary grounding electrodes, steel building columns, and other metal structures connected to the grounding system.

Location of each ground rod and ground-rod assembly and other grounding electrodes shall be identified by letter in alphabetical order and keyed to the record of ground-resistance tests.

PART 2 PRODUCTS

2.1 GROUND RODS

Ground rods shall conform to the requirements of NFPA 70.

Ground rods shall be copper-clad steel rods not less than 20 millimeter in diameter and not less than 3000 millimeter long per section. Ground rods shall be clean and smooth and have a cone-shaped point on the first section and shall be die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in millimeter.

2.2 GROUND WIRES

Ground wires shall be in accordance with Section 16145, "Standard Wiring Systems."

Ground and bond wires for substations, main panels and distribution points, and ground rod connections shall be annealed bare copper conforming to ASTM B 3, stranded, with 98 percent conductivity. Wire size shall be in accordance with the grounding requirements of NFPA 70.

Ground wires for equipment receptacles for noncurrent carrying hardware, installed in conduit shall be soft drawn copper, in accordance with ASTM B 3, stranded, with green insulation. Wire size shall be as noted.

2.3 CONNECTORS AND FASTENERS

Grounding and bonding fasteners and connectors shall conform to the requirements of UL 467, and Section 16145, "Standard Wiring Systems."

Grounding and bonding fasteners shall be copper.

Bonding straps and jumpers shall be copper and shall have a cross-sectional area of not less than 4.12 millimeter diameter (No. 6 AWG). Bonding straps and jumpers for shock-mounted devices with hinged joints shall be made of flexible stranded wire.

PART 3 EXECUTION

3.1 BONDING AND GROUNDING

Bonding and grounding requirements shall be in accordance with NFPA 70.

3.2 GROUNDING ELECTRODES

Grounding electrodes shall include ground rods installed expressly for grounding systems.

Minimum ground rod section shall be 3000 millimeter. Sections shall be threaded together and exothermically fusion welded.

Ground rods shall be installed so that the top of the rod is 100 millimeter above grade.

Ground rods shall be installed so that the top of the rod is not less than 450 millimeter below finished grade.

3.3 GROUND GRIDS

Ground grids shall consist of a series of ground rods installed with interconnecting grounding conductors between ground rods. Ground rods shall be spaced as noted.

Ground grid shall be buried not less than 750 millimeter below the finish grade. Grounding conductors shall be not less than 11.7 millimeter diameter (No. 4/0 AWG) and shall be exothermically fusion welded together at crossover points and to ground rods.

3.4 EQUIPMENT GROUNDING

Metallic raceway systems shall have electrical continuity with equipment individually and directly connected to the building ground, independent of the raceway system.

Enclosures for panelboards shall be individually and directly connected to the building ground. Grounding conductor shall be not less than 6.54 millimeter diameter (No. 2 AWG) and shall be connected from the building equipment ground bar to a copper ground-bus terminal strip located in each panelboard.

Polarized receptacles, lighting fixtures, and equipment enclosures shall be grounded with an identified (green color) insulated conductor, not smaller than 2.03 millimeter diameter (No. 12 AWG), connected to the branch circuit ground-bus terminal strip. Ground-bus terminal strip in each panelboard enclosure shall be isolated and independent of the system neutral terminal strip.

Indoor substations, transformers, switchboard frames, switchgear assemblies, motors, motor control centers, air compressors, air handlers, refrigerated air dryers, generators, frames and tracks of cranes, and shall be individually and directly connected and grounded to the building equipment ground bar. Current-carrying capacity of the grounding conductor shall be the same as the current-carrying capacity of the power conductors for circuits utilizing power lines size 6.54 millimeter diameter (No. 2 AWG) and smaller. For circuits with power wiring larger than 6.54 millimeter diameter (No. 2 AWG), the grounding conductor shall be in accordance with NFPA 70, except that the grounding conductor shall be not smaller than 6.54 millimeter diameter (No. 2 AWG).

Noncurrent carrying metallic parts of electrical equipment, including metallic cable sheaths, conduit, raceways, and electrical structural members, shall be bonded together and connected to the ground grid or ground connection rods.

Secure ground systems shall be installed for power and instrumentation. Each system shall be independently connected to the building counterpoise as shown.

Secure ground systems shall consist of unspliced ground wires in individual welded or epoxied conduit runs from the secure area to the building counterpoise. Welding and epoxying shall conform to Section 16145, "Standard Wiring Systems."

3.5 GROUNDING CONNECTIONS

Ground connections shall be bonded connections in accordance with paragraph entitled, "Bonding."

Ground connections that are buried or in inaccessible locations shall be welded.

Ground connection surfaces shall be cleaned and greased and foreign matter removed. Clad material shall not be penetrated in the cleaning process. Connection shall be made between like metals where possible. Where dissimilar metals are welded, brazed, or clamped, the weld kit manufacturer's instructions shall be followed. Connections between dissimilar metals shall not produce galvanic action in accordance with MIL-STD 889.

3.6 BONDING

3.6.1 Type of Bonds

Bonding of metal surfaces shall be accomplished by welding.

3.6.1.1 Welding

Welding shall be by the exothermic process. Welding procedure shall include the proper mold and powder charge and shall conform to the manufacturer's recommendations.

Welding processes shall be of the exothermic fusion type that will make a connection without corroding or loosening. Process shall join all strands and shall not cause the parts to be damaged or weakened. Completed connection or joint shall be equal or larger in size than the conductors joined and shall have the same current-carrying capacity as the largest conductor. Buried ground connections shall be painted with a bitumastic paint.

3.6.2 Cleaning of Bonding Surfaces

Surfaces that comprise the bond shall be thoroughly cleaned before joining. An appropriate abrasive shall be applied with a gentle and uniform pressure to ensure a smooth and uniform surface. Excessive metal shall not be removed from the surface. Clad metals shall be cleaned in such a manner that the cladding material is not penetrated by the cleaning process. Bare metal shall then be cleaned with an appropriate solvent to remove any grease, oil, dirt, corrosion preventives, and other contaminants. Cleaned area shall be made within one hour after cleaning. Joint shall be sealed and the exposed surfaces refinished within two hours to prevent oxidation. When additional time is required, a corrosion preventive compound shall be

applied until the area can be refinished.

3.6.3 Bonding Straps and Jumpers

Jumpers shall be installed such that the vibration by the shock-mounted device shall not change its electrical characteristics.

Bonds shall be welded for outdoor locations unless a disconnect type of connection is required. When a disconnect is required, clamping with bolts shall be used. A tooth-type lockwasher shall be inserted between the strap and metallic member for each bolt.

Straps shall be bonded directly to the basic structure and shall not penetrate any adjacent parts. Straps shall be installed in an area that is accessible for maintenance.

Single straps shall be used for the bonds and shall be installed such that they will not restrict movement of structural members. Two or more straps shall not be connected in series.

Straps shall be installed such that they will not weaken structural members to which they are attached.

3.6.4 Equipment and Enclosure Bonding

Each metallic enclosure and all electrical equipment shall be bonded to ground. At least one copper connection shall be made from the system ground point to one or more enclosures in the area such that all enclosures and equipment provide a low-impedance path to ground when properly bonded together.

3.6.5 Bonding of Conduit and Raceway Systems

Metal conduit, fittings, junction boxes, outlet boxes, armored and metal sheathed cable, and other raceways shall be bonded as listed below. Care shall be taken to ensure adequate electrical contact at the joints and terminations.

3.6.5.1 Rigid Metal Conduit and Terminations

Threaded connections must be wrench-tight and there shall be no exposed threads. All ends of the conduit shall be reamed to remove burrs and rough edges. Conduits entering boxes and enclosures shall be bonded to the box with locknuts and grounding-type bushings. Locknuts that gouge into the metal box when tightened are not acceptable.

Conduit systems that are interrupted by PVC dielectric links shall be bonded separately on either side of the link. Dielectric link shall not be jumpered.

3.6.5.2 Flexible Metal Conduit

Flexible conduit shall have an integral grounding conductor.

3.6.6 Cable Tray Bonding

Cable tray sections shall be bonded together. Cable tray sections in tandem assembly shall be considered as having electrical continuity when these sections are bonded with the appropriate bolts. Bond straps shall be installed across expansion joints. Cable trays shall be bonded to the building ground system.

3.6.7 Protection of Finished Bonds

Finished bonds shall be protected by painting to match the original finish after the bond is made.

3.7 FIELD TESTS

The following tests shall be performed by the Contractor in the presence of the Contracting Officer.

3.7.1 Bond Resistance Test

Resistance of any bond connection shall not exceed 0.5 milliohm. Bonds that exceed this resistance shall be reworked by the Contractor at no additional cost to the Government.

3.7.2 Ground Resistance Tests

Grounding systems shall be tested for ground resistance. Total resistance from any point on the ground network to the building counterpoise shall not exceed 50 milliohms.

Ground resistance and counterpoise tests shall be made during dry weather, and no sooner than 48 hours after rainfall. Tests shall be conducted using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Measurements shall be performed in accordance with IEEE Std 81.

Indicating instrument shall be self-contained and shall include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Direct-reading ohmmeter shall be calibrated for ranges of 0 to 20 ohms and 0 to 200 ohms.

Auxiliary grounding electrodes shall be placed in accordance with instrument manufacturer's recommendations but not less than 15,000 millimeter apart, in accordance with IEEE Std 81.

3.7.3 Ground Isolation Test

Ground systems shall be tested for isolation from other ground systems.

3.7.4 Continuity Isolation Test

Continuity test shall be performed on all power receptacles to ensure that

the ground terminals are properly grounded to the facility ground system.

-- End of Section --

SECTION 16135

CABLE TRAYS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

Fabrication Drawings
Installation Drawings

SD-03 Product Data

Manufacturer's product data shall be submitted for the following items:

Cable Trays
Supports

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for cable trays in accordance with paragraph entitled, "Manufacturer's Instructions," of this section.

PART 2 PRODUCTS

2.1 CABLE TRAYS

Ladder cable trays shall consist of two longitudinal side members connected by individual transverse members.

2.2 MATERIAL AND FABRICATION

Cable trays shall be high-strength corrosion-resistant aluminum Alloy No. 5052-H32.

Fabrication drawings shall be submitted for cable trays consisting of fabrication and assembly details to be performed in the factory.

Prior to assembly, contact surfaces of trays shall be coated with an antioxidant compound. Edges, fittings, and hardware shall be finished free from burrs and sharp edges. Cable trays shall include splice and end plates, dropouts, and miscellaneous hardware.

2.3 SUPPORTS

Supports and hangers shall permit both vertical and horizontal adjustment, where possible. Horizontal and vertical tray supports shall provide an adequate bearing surface for the tray and shall have provisions for holddown clamps or fasteners. Vertical tray supports shall provide a secure means other than friction for fastening cable trays to supports.

Cable trays shall be supported at not more than 1800 millimeter intervals. Supports for horizontal-elbow tray fittings shall be placed within 600 millimeter of each fitting extremity and as recommended by the cable-tray manufacturer.

When supported at 1800 millimeter intervals, the cable trays shall be capable of carrying not less than 225 kilogram per meter. Tray fittings shall have not less than the load-carrying ability of straight tray sections and shall have the manufacturer's minimum standard radius.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

Manufacturer's instructions shall be submitted for Cable Trays including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

3.2 INSTALLATION DRAWINGS

Thirty days prior to shipment, installation drawings shall be submitted to the Contracting officer for approval. Drawings shall be coordinated with all other work in the immediate area that could come in conflict with the installation. Drawings shall include layout of cable tray work, including details of both horizontal and vertical supports. Both horizontal and vertical supports shall be as specified in paragraph entitled, "Supports," of this section.

3.3 GROUNDING

Cable trays shall be properly grounded by means of a low-resistance conductor of sufficient capacity, but in no case smaller than AWG No. 1/0

copper for aluminum trays. Grounding conductor shall be bonded to cable-tray sections and fittings by compatible bolted connections. Effective grounding shall be permanent and continuous with an impedance sufficiently low to limit the potential above ground and to facilitate operation of overcurrent devices in the circuit. Grounding and bonding cable trays shall be in accordance with NFPA 70.

-- End of Section --

SECTION 16145

STANDARD WIRING SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.3	(1991) Electrical Metallic Tubing - Zinc-Coated
ANSI C80.5	(1990) Rigid Aluminum Conduit

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123	(1989; Rev A) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM D 2301	(1988; R 1993) Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 383	(1974; R 1992) Standard for Type Test Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electric Equipment (1000 Volts Maximum)
NEMA FB 1	(1993) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
NEMA KS 1	(1990) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA PR 4	(1983; R 1989) Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve

	Type for Industrial Use
NEMA RN 1	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 3	(1990) PVC Fittings for Use With Rigid PVC Conduit and Tubing
NEMA WC 5	(1992) Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WD 1	(1983; Rev 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(1993) UL Standard for Safety - Flexible Metal Conduit
UL 1242	(1983; 1st Ed, June 26, 1991) UL Standard for Safety - Intermediate Metal Conduit
UL 1581	(1991; 2nd Ed; Dec 17, 1991) UL Standard for Safety - Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 20	(1986; 10th Ed; July 12, 1993, Errata - 1988) UL Standard for Safety General-Use Snap Switches
UL 486C	(1991; 2nd Ed; Oct 10, 1991) UL Standard for Safety Splicing Wire Connectors
UL 50	(1995; 11th Ed) UL Standard for Safety - Enclosures for Electrical Equipment
UL 514A	(1991; 8th Ed) UL Standard for Safety - Metallic Outlet Boxes
UL 514B	(1989; 2nd Ed; Aug 9, 1990; Errata 1991; Bulletin Sept 16, 1991; Bulletin Jan 20, 1992) UL Standard for Safety Fittings for Conduit and Outlet Boxes

UL 6	(1993; 10th Ed) UL Standard for Safety - Rigid Metal Conduit
UL 651	(1995; 6th Ed; Dec 4, 1989) UL Standard for Safety Schedule 40 and 80 Rigid PVC Conduit
UL 797	(1993; 6th Ed) UL Standard for Safety - Electrical Metallic Tubing
UL 83	(1991; 10th Ed) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 870	(1995; 7th Ed) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 884	(1994; 9th Ed) UL Standard for Safety Underfloor Raceways and Fittings

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Conduit, Raceways and Fittings
Wire and Cable
Safety Switches
Flush Wiring Devices
Boxes and Fittings
Communication Cabinets

SD-04 Drawings

Fabrications Drawings shall be submitted for the Standard Wiring Systems consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents.

SD-07 Schedules

Material, Equipment, and Fixture Lists shall be submitted for the following items showing manufacturer's style or catalog numbers,

specification and drawing reference numbers, warranty information, and fabrication site.

Conduit, Raceways and Fittings
Wire and Cable
Safety Switches
Flush Wiring Devices
Boxes and Fittings
Communication Cabinets

SD-09 Reports

Test Reports shall be submitted for Standard Wiring Systems in accordance with the paragraph entitled, "Field Testing," of this section.

SD-18 Records

Test Readings, including the method of testing and the environmental conditions of the test, shall be recorded and submitted to the Contracting Officer.

PART 2 PRODUCTS

2.1 CONDUITS, RACEWAYS, AND FITTINGS

Conduit shall be15 millimeter diameter minimum.

Conduit, connectors, and fittings shall be approved for the installation of electrical conductors.

2.1.1 Intermediate Metal Conduit

Intermediate metal conduit, including couplings, elbows, bends, and nipples, for use as a raceway for wire and cables in an electrical system shall conform to the requirements of UL 1242 as amended for thin or thick-wall types and shall also conform to NFPA 70. Interior and exterior surfaces of the conduit shall be protected with a metallic zinc coating.

2.1.2 Rigid Steel Conduit

Rigid steel conduit, including couplings, elbows, bends, and nipples, shall conform to the requirements of UL 6 and ANSI C80.5 Steel fittings shall be galvanized by the hot-dip process. Where indicated, and in corrosive areas, rigid steel conduit shall be polyvinylchloride (PVC) coated and conform to NEMA RN 1, Type 20.

Fittings for rigid steel conduit shall be threaded and shall conform to NEMA FB 1.

Gaskets shall be solid for fittings sized 40 millimeter and less. Conduit fittings with blank covers shall have gaskets except in clean, dry areas or

at the lowest point of a conduit run where drainage is required.

Covers shall have captive screws and shall be accessible after the work has been completed.

2.1.3 Rigid Plastic Conduit

PVC conduit shall be not lighter than Schedule 40. Rigid PVC shall be the slip-joint solvent-weld type, and fittings shall be unthreaded solid PVC. Conduit and fittings shall conform to UL 651 and NEMA TC 3.

2.1.4 Electrical Metallic Tubing (EMT)

EMT shall be rigid metallic conduit of the thinwall type in straight lengths, elbows, or bends and shall conform to ANSI C80.3 and the requirements of UL 797.

Couplings and connectors shall be hex-nut expansion-gland type, zinc -plated. Crimp, spring, or setscrew type fittings are not acceptable. Where EMT enters outlet boxes, cabinets, or other enclosures, connectors shall be the insulated-throat type, with a locknut. Fittings shall meet the requirements of NEMA FB 1.

2.1.5 Flexible Metallic Conduit

Flexible metallic conduit shall meet the requirements of UL 1.

Liquidtight flexible metallic conduit shall be provided with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Fittings for flexible metallic conduit shall meet the requirements of UL 514B, Type I box connector, electrical, Type III coupling, electrical conduit, flexible steel, or Type IV adapter, electrical conduit.

2.1.6 Wireways and Auxiliary Gutters

Wireways and auxiliary gutters for use in exposed, dry locations shall be a prefabricated channel-shaped sheet metal trough with hinged or removable covers, associated fittings, and supports for housing, and protecting electrical wires and cables in accordance with UL 870.

Straight sections of trough, elbows, tees, crosses, closing plates, connectors, and hanging brackets shall be constructed from sheet steel of commercial quality not less than 1.6 millimeter. Sheet metal component parts shall be cleaned, phosphatized, and coated with a corrosion-resistant gray paint.

Straight sections of wireways and auxiliary gutters shall be solid or have knockouts as indicated in both sides and bottom, 75 millimeter on center.

Straight sections shall be not more than 1500 millimeter long, with covers held closed with screws.

2.1.7 Surface Metal Raceways

Surface metal raceways shall conform to the requirements of NFPA 70. Minimum size shall equal or exceed the capacity of 15 millimeter trade size conduit.

2.1.8 Surface Multiple-Outlet Assemblies

Surface multiple-outlet assemblies shall conform to the requirements of NFPA 70 and shall be provided with receptacles conforming to NEMA WD 1, NEMA PR 4 and NEMA WD 6, Figure 5-15R.

2.1.9 Underfloor Raceways

Underfloor raceways shall conform to UL 884 and NFPA 70.

2.2 WIRE AND CABLE

Insulated current-carrying wire and grounding conductors shall be copper and shall conform to NFPA 70 and UL 1581. Wire bundles with cable ties shall be secured to the enclosure with sheet-metal screws. Self-sticking adhesive attachments are not acceptable.

2.2.1 Building Wire

Building wire for use in conduits, raceways, and wireways shall be single-conductor, 600-volt, heat- and moisture-resistant insulated wire suitable for use in wet or dry locations.

Conductors AWG No. 10 and smaller shall be solid round copper wire. Conductors AWG No. 8 and larger shall be standard concentric stranded copper wire. Conductors shall be not less than AWG No. 12, except that AWG No. 14 shall be stranded copper wire and shall be used for control wiring.

Building wire shall be Type THHN/THWN with insulation of PVC and nylon jacket, with a minimum temperature rating of 90/75 degrees C.

2.2.2 Lighting-Fixture Wiring

Lighting-fixture wire for use in fluorescent fixture wiring channels shall be flexible seven-strand or solid copper wire conforming to NFPA 70.

2.2.3 Cable Tray Wire

Power and control wire installed in cable trays shall be Type TC cable 600 volts, with current-carrying capacity as determined by NFPA 70. Cable shall also comply with UL 83 and IEEE Std 383.

2.2.4 Standard Flexible Cable

Flexible multiconductor cable shall conform to UL 1581 for control and power below 600 volts, noninstrumentation type. Cable shall contain one (green) grounding conductor and shall utilize a thermosetting or thermoplastic overall jacket in accordance with NEMA WC 5. A white

conductor shall be included for the power neutral or grounded current-carrying conductor. Cable conductor insulation shall conform to NEMA WC 5.

2.2.5 Splices and Connectors

Splices in building wire AWG No. 8 and smaller and multiple conductor cables shall be made with insulated Scotchlock, or equal, connectors or with indentor crimp-type connectors and compression tools to ensure a satisfactory mechanical and electrical joint.

Splices in building wire AWG No. 6 and larger and single-conductor cables shall be made with indentor crimp-type connectors and compression tools or with bolted clamp-type connectors to ensure a satisfactory mechanical and electrical joint.

Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

Vinyl-plastic electrical insulating tape shall meet the requirements of ASTM D 2301. Where pressure-sensitive tape is used, the surface shall be cleaned free of dust, sand, or other foreign material and a primer recommended by the tape manufacturer shall be applied prior to taping.

For building wire AWG No. 14 and larger, terminations shall utilize set-screw pressure terminal lugs.

Solid wiring shall be terminated with terminal blocks specifically designed for solid wire. Crimp type shall not be used on solid wire for termination.

Stranded wire shall use crimp spade type lugs for termination on terminal blocks.

2.3 SAFETY SWITCHES

Switches shall comply with NEMA KS 1.

Safety switches shall be the heavy-duty type with voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, with the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and shall be so constructed that an external tool (screwdriver) must be used to open the cover. Provisions shall be made to lock the handle in the "OFF" position, but the switch handle shall not be capable of being locked in the "ON" position.

Switches shall be the quick-make, quick-break type. Terminal lugs shall be approved for use with copper conductors.

2.4 FLUSH WIRING DEVICES

2.4.1 Wall Switches

Snap switches installed for the control of incandescent, metal halide, and

fluorescent lighting fixtures shall be heavy-duty, general-purpose, noninterchangeable flush devices conforming to UL 20 and NEMA WD 1, as indicated.

Snap switches shall be the toggle type: single-pole, double-pole, three-way or four-way two-position devices rated 20 amperes at 277 volts, 60 hertz, ac only, meeting the requirements of UL 20.

All snap switches shall be made by the same manufacturer.

All snap switches shall be ivory in color unless otherwise indicated on the contract drawings.

Where two or more snap switches are to be installed at the same location, they shall be mounted in one-piece ganged switch boxes, with a gang cover plate.

Combination snap switch and single or duplex receptacles shall be mounted in two-gang switch boxes, with a combination two-gang cover plate.

Combination snap switch and flush pilot light shall be interchangeable devices mounted in a one-gang switch box with a one-gang, two-opening cover plate. Pilot-light cover opening shall be fitted with a rectangular-shaped ruby-red plastic jewel in a metal frame.

2.4.2 Receptacles

Receptacles shall be 20-ampere, 125-volt ac, 2-pole, 3-wire, single or duplex grounded, conforming to NEMA PR 4, NEMA WD 1 and to the 5-20R configuration in NEMA WD 6.

Bodies of 20-ampere receptacles shall be phenolic compound supported by a mounting yoke having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Each receptacle shall be side or back wired with two screws per terminal, shall be provided with a third grounding pole, and shall be capable of receiving 2-wire, 3-pole parallel-blade caps. Third grounding pole shall be connected to a metal mounting yoke and shall be provided with a green-colored screw for grounding.

Power outlets for connection to 208 or 480 volt, single or three -phase, ac circuits shall consist of single locking receptacles in industrial cast-metal enclosures with cast-aluminum bodies, angle adapters, and receptacle housings with spring-loaded hinged lift covers, conforming to NEMA 250 for the indicated voltage and current rating. Springs and hinge pins shall be corrosion-resistant steel. Screws and spring covers shall be chromium-plated brass. Neoprene gaskets shall provide a positive seal against the entrance of dust, lint, fibers, and oil or coolant seepage.

Locking receptacles shall conform to NEMA WD 6. One plug shall be furnished with each locking receptacle.

Receptacles shall meet the requirements for retention of plugs, overload,

temperature, and assembly security in accordance with NEMA WD 1.

Receptacle bodies shall be ivory in color unless specifically indicated otherwise on the contract drawings.

2.4.3 Weatherproof Outlets

Convenience outlets installed in outdoor damp or wet locations for connection to 120-volt ac single-phase circuits shall consist of single or duplex Ground Fault Circuit Isolation (GFCI) receptacles enclosed in weatherproof outlet boxes, with gasketed cast-aluminum plates and spring-loaded hinged lift covers. Springs and hinge pins shall be corrosion-resistant steel. Screws and spring covers shall be chromium -plated brass. Rubber or neoprene gaskets shall provide a positive seal against the weather.

2.4.4 Device Plates

Wall plates for flush snap switches and receptacles shall be the appropriate type and size and shall match the wiring devices for which they are intended. Dimensions for openings in wall plates shall be in accordance with NEMA WD 1.

Wall plates for flush snap switches and receptacles shall be molded ivory-colored phenolic or urea compounds, with rounded or beveled edges. Mounting screws shall have oval countersunk heads finished to match the plate.

2.5 BOXES AND FITTINGS

Boxes shall have sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NFPA 70 and UL 514A. Boxes that are exposed to the weather or that are in normally wet locations shall be cast-metal with threaded hubs. Surface-mounted boxes on interior walls shall be cast-metal. Boxes in other areas shall be zinc-coated sheet metal.

2.5.1 Sheet Metal Boxes and Outlets

Outlet, switch, and junction boxes flush-mounted in walls or ceilings shall be octagon, square or rectangular shaped gang boxes as appropriate, with extension rings and covers.

Ceiling outlet boxes, from which surface- and pendant-mounted lighting fixtures are supported, shall be not less than 100 millimeter octagonalor square, with plaster rings 40 millimeter deep and shall be capable of withstanding a vertical downward force of 890 newton for 5 minutes. All boxes in spaces above suspended ceilings shall be installed in accessible locations. Boxes in otherwise inaccessible locations shall be accessible from ceiling space access panels. Ceiling-mounted outlet boxes for lighting fixtures, fittings, and wiring devices shall be symmetrical, except as otherwise indicated, and shall not interfere with the work of other trades.

Wall outlet boxes for single or two gang flush wiring devices shall be not less than 100 millimeter square and 40 millimeter deep. Wall outlet boxes for multiple-gang flush wiring devices shall be not less than 115 millimeter wide and 65 millimeter deep. Wall-mounted outlet boxes for lighting fixtures and flush devices shall be capable of withstanding a vertical downward force of 225 newton for a period of 5 minutes.

Boxes shall be formed from carbon-steel sheets of commercial quality, not less than 1.9 millimeter. Boxes shall be one-piece construction, zinc- or cadmium-plated in accordance with UL 514A. Boxes and box extension rings shall be provided with knockouts. Boxes shall be designed for mounting flush wiring devices.

Exposed surface junction boxes shall be installed only in equipment rooms and other utility areas.

Surface-mounted boxes shall be outside flange type with a matching solid flat cover. Flush-mounted boxes in walls and floors shall be the outside flange type with a matching recessed solid walkway cover. Box bodies and covers shall be galvanized by the hot-dip process in accordance with ASTM A 123, Class A.

2.5.2 Cast-Metal Boxes

Cast-metal pull and junction boxes having an internal unobstructed air space of more than 0.0016 cubic meter for connection to galvanized rigid steel conduits embedded in concrete or surface mounted shall be watertight rectangular boxes in accordance with UL 50 and NEMA FB 1.

Box bodies and covers shall be cast or malleable iron with a wall thickness not less than 3 millimeter at every point, of greater thickness at reinforcing ribs and cover edges, and not less than 6 millimeter in thickness at tapped holes for rigid steel conduit. Box bodies shall be provided with integral threaded conduit openings, as required. Mounting lugs shall be provided at the back or at the bottom corner of the box body. Boxes shall be provided with neoprene cover gaskets that will prevent the entrance of water into the enclosure. Covers shall be secured to box bodies with 4.1 millimeter diameter (AWG No. 6) or larger brassor bronze flathead screws.

2.5.3 Pull and Junction Boxes

Pull and junction boxes shall be fabricated from carbon steel and shall conform to UL 50. Box dimensions and conduit connections shall conform to NFPA 70.

Boxes shall be welded construction with flat removable covers fastened to the box with machine screws. Seams and joints at corners or back edges of the box shall be closed and reinforced with flanges formed of the same material from which the box is constructed or by other means such as continuous welding which provides a construction equivalent to integral flange construction.

Boxes intended for outdoor use shall be cast with threaded hubs and neoprene-gasketed covers.

Boxes intended for use in dry locations shall be sheet steel hot-dipped galvanized after fabrication conforming to UL 514A.

2.6 COMMUNICATION CABINETS

Cabinets shall conform to UL 50.

Cabinets for signal systems shall have boxes constructed of code-gage, zinc-coated sheet steel with interior dimensions not less than those indicated. Each box shall be fitted with a hinged door with a flush catch. Doors shall provide the maximum sized openings to the box interiors. Boxes shall be provided with a 16 millimeter plywood backboard having a two-coat insulating-varnish finish.

Cabinets for electrical controls with volume greater than 0.0016 cubic meter shall be hot-dip galvanized, aluminum, or code-gage sheet steel with corrosion-resistant baked enamel finish.

PART 3 EXECUTION

3.1 INSTALLATION

Power, lighting, control emergency light and power, and special-service systems and all related components shall be installed in accordance with NFPA 70, and shall be enclosed in separate conduit or separate conduit systems.

Any run of EMT, intermediate, or rigid conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall contain not more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting. Installed conduit and fittings shall be free of dirt and trash and shall not be deformed or crushed. Empty conduit shall have a pull rope stalled.

Conduit shall be installed with a minimum of 75 millimeter of free air space separation from mechanical piping.

Conduit in finished areas shall be installed concealed. Conduit passing through masonry or concrete walls shall be installed in sleeves.

Conduit shall be securely clamped and supported at least every 3000 millimeter vertically and 2400 millimeter horizontally. Galvanized pipe straps shall be fastened to structure with bolts, screws, and anchors. Wooden masonry plugs shall not be used.

Conduit and boxes shall not be supported from T-bar ceiling wires.

All recessed outlet boxes in non-combustible walls or ceilings shall be installed flush, such that the outlet box is set back less than 2 millimeter or protrudes less than 2 millimeter from the face of the ceiling or wall.

Conduit connections to boxes and fittings shall be supported not more than 900 millimeter from the connection point. Conduit bends shall be supported not more than 900 millimeter from each change in direction. Conduit shall be installed in neat symmetrical lines parallel to the centerlines of the building construction and the building outline. Multiple runs shall be parallel and grouped whenever possible on common supports. All conduits which terminate at cable tray shall be securely fastened to the tray using approved fittings.

Conduit and raceway runs in or under concrete, in damp, corrosive, or outdoor locations, in hazardous areas, where subject to mechanical damage, or intended for conductors rated over 600 volts, shall be rigid steel conduit. Conduit joints in corrosive areas shall be painted with corrosionor acid-inhibiting compounds.

Ends of conduit extending from the interior to the exterior of the building and portions of interior conduit exposed to widely varying temperatures shall be sealed to prevent the passage of air within the conduit. Conduit shall be sloped to drain and shall be provided with drainage fittings at the lower end of the run. Curved portion of conduit bends shall not be visible above the finished floor. Underground service entrance and feeder conduit entering or leaving the building above the ground floor shall be terminated in a pull box.

Expansion fittings with flexible ground strap shall be provided in conduit runs crossing building expansion joints.

Underground portions of conduit runs shall be painted with bitumastic or shall be provided with a factory-applied coating of PVC not less than 5 millimeter thick. Underground conduit encased in concrete does not require a protective coating of PVC. When the factory-applied coating is chosen by the Contractor, any nicks, cuts, or other abrasions shall be wrapped with a single layer of 0.254 millimeter thick pressure-sensitive PVC tape, half-lapped to obtain a minimum thickness of 5 millimeter. Couplings shall be wrapped with pressure-sensitive tape, as described above, over the coupling and for 50 millimeter on each side of the coupling. When precoated couplings designed for the purpose are used, taping may be omitted provided the manufacturer's adhesive is used between the coating on the coupling and the coating on the conduit. Field bends shall be made in accordance with the manufacturer's recommendations, which normally require use of a one-size-larger bender than would be required for uncoated conduit. Depth of buried conduit shall be in accordance with NFPA 70 or as indicated on the contract drawings.

Exposed ends of conduit without conductors shall be sealed with watertight caps or plugs.

Bushings shall be provided on the open ends of conduit containing conductors. Insulated bushings shall be provided for conduits containing conductors AWG No. 4 or larger with an insulating ring an integral part of the bushing.

Flexible metallic conduit shall be used to connect recessed fixtures from outlet boxes in ceilings, metallic transformers, and other approved

assemblies. Sections of flexible steel conduit shall be not more than 1800 millimeter long and shall be installed only in exposed or accessible locations. Interior surfaces of conduit shall be free from burrs and sharp edges which might cause abrasion of wire and cable coverings. Ends of flexible steel conduit shall be provided with grounding bushings and approved fittings.

Bonding wires shall be used in flexible conduit for all circuits. Flexible conduit shall not be considered a ground conductor.

Liquidtight flexible metallic conduits shall be used in wet and oily locations and to complete the connection to motor-driven equipment.

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit in a manner that will not impair the function of the equipment.

Wire or cable shall not be installed in conduit until the conduit system is completed; the inner surfaces of conduit shall be clean and dry.

A nylon or polypropylene pull rope with a tensile strength not less than 580 newton shall be installed in empty conduit.

3.1.1 Installation of Rigid Metal Conduit and Intermediate Metal Conduit

Ends of conduit shall be cut square, reamed and threaded, and joints shall be brought butt-to-butt in the couplings. Joints shall be mechanically tight. Conduit shall be protected against damage and the entrance of water or foreign material during construction.

Ninety-degree bends of conduit with a diameter larger than 25 millimeter shall be made with factory-made elbows. Conduit elbows larger than 65 millimeter shall be long radius. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Changes in directions of runs shall be made with symmetrical bends or cast-metal fittings.

At connections to sheet metal enclosures and boxes, a sufficient number of threads shall project through to permit the bushing to be drawn tight against the end of the conduit, after which the locknut shall be pulled up sufficiently tight to draw the bushing into firm electrical contact with the box. Conduit shall be fastened to sheet metal boxes and cabinets with two locknuts where required by NFPA 70 where insulating bushings are used, where bushings cannot be brought into firm contact with the box, and where indicated.

Conduit joints shall be made with tapered threads set firmly. Each length of conduit cut in the field shall be reamed before installation. Where conduit is threaded in the field, each threaded end shall consist of at least five full threads. Corrosion-inhibitive compound shall be used on conduit threads in exterior areas.

Conduit stubbed-up through concrete floors for connections to free-standing equipment except motor-control centers, cubicles, and other such items of

equipment shall be provided with a flush coupling if the floor slab is of sufficient thickness; if not, a floor box shall be provided and set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.1.2 Installation of Rigid PVC Conduit

Rigid PVC conduit for underground work shall be encased in a concrete envelope unless otherwise indicated on the contract drawings.

A continuous, bare, soft-drawn copper ground wire shall be run in conduit with conductors and shall be solidly connected to ground at each end. Ground wires shall be sized in accordance with NFPA 70.

Rigid PVC conduit shall be stored on a flat surface and shall be protected from the direct rays of the sun.

3.1.3 Installation of EMT

EMT shall be cut square and reamed to remove burrs and rough surfaces.

Field-made bends and offsets shall be avoided where possible but, where necessary, shall be made with an approved hickey or conduit-bending machine. Changes in direction of runs shall be made with symmetrical bends or approved metal fittings.

3.1.4 Installation of Wireways and Auxiliary Gutters

Straight sections and fittings shall be bolted together to provide a rigid mechanical connection and electrical continuity. Dead ends of wireways and auxiliary gutters shall be closed. Unused conduit openings shall be plugged.

Wireways for overhead distribution and control circuits shall be supported at maximum 1500 millimeter intervals.

Auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure shall not contain switches, overcurrent devices, appliances, or apparatus and shall be not more than 9000 millimeter long.

3.1.5 Installation of Flexible Metallic Conduit

Flexible metallic conduit shall be installed only in exposed, accessible locations in accordance with NFPA 70. A grounding green conductor shall be installed in all runs. Connections to motors and vibrating equipment shall be made with flexible metallic conduit.

3.2 INSTALLATION OF WIRING

Raceways shall be completely installed, with interiors protected from the weather, before proceeding with the installation of wires and cables. Conductors of special-service systems and emergency light and power systems shall not occupy the same enclosure with light and power conductors or the

same enclosure with each other. Conductors shall be continuous with splices and connections made in outlet, junction, or pull boxes only. All control wiring shall be continuous between components and/or terminal boards.

Phase conductors and the neutral conductor of each branch or feeder circuit shall be contained in a single enclosure or paralleled in separate enclosures to avoid overheating the raceway by electromagnetic induction. Conductors and conduit in parallel shall be the same length and size, shall have conductors of the same type of insulation, shall be terminated at both ends in a manner to ensure equal division of the total current among conductors, and shall have a separate neutral conductor in each conduit.

Sharing of a common neutral between single phase circuits, connected to different phases, shall not be permitted.

Conductors installed in rigid metal conduit and EMT shall have allowable current-carrying capacity and ampere ratings in accordance with NFPA 70. Larger-sized conductors shall be used to compensate for derating factors when more than three current-carrying conductors are installed in raceways and when conductors are installed in wet locations.

Conductors 600 volts and below shall be color coded in accordance with the following:

CONDUCTO	120/208 COLO	480/277 COLOR
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	White/Gray
Equipment Grounds	Green	Green

Conductors up to and including AWG No. 6 shall be manufactured with colored insulating materials. Conductors larger than AWG No. 6 shall have ends identified with colored plastic tape in outlet, pull, or junction boxes and at terminations. Control circuit conductors shall be identified at each connection point.

Connectors and splices shall conform to UL 486C and shall be made in approved enclosures utilizing solderless pressure connectors and adequate insulation with vinyl-plastic electrical insulating tape. Conductors and materials used in a splice, tap, or connection shall be thoroughly cleaned prior to makeup to ensure good electrical and mechanical connections. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable. Control-circuit terminals of equipment shall be properly identified by

color-coded insulated conductors, number-coded plastic self-sticking printed markers, or permanently attached metal-foil markers. Cable fittings shall conform to UL 514B; insulating tape shall conform to ASTM D 2301.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.Tags shall be engraved laminated phenolic, with black lettering (1/8 inch high) on white background, fastened to cables by means of tie wrap through a hole drilled at one end of the tag.

Grounding shall be provided in accordance with NFPA 70. Noncurrent-carrying parts of electrical equipment shall be bonded and grounded together.

3.3 DIRECT-BURIAL CABLE

Direct-burial cable shall comply with the following requirements:

Minimum width and depth of trenches shall be as indicated on the drawings.

Minimum depth of cable rated 600 volts and under shall be 600 millimeter.

Minimum depth of cable rated 600 volts and under in conduit shall be 460 millimeter.

Direct-burial cable shall be placed in the trench on top of a 75 to 100 millimeter layer of screened sand or fill dirt.

A layer of screened sand or fill dirt 150 to 200 millimeter thick shall be laid on top of the cable and tamped tightly.

A bright yellow PVC ribbon, minimum 50 millimeter wide, continuously marked CAUTION -- ELECTRICAL SERVICE BELOW shall be placed on the trench approximately 200 millimeter below surface ground level and run continuously parallel with and above the cable.

Where trenches cut roadways or other existing paved areas used for vehicular traffic, the existing pavement shall be sawcut prior to excavation, the pavement removed, and the trench excavated to the required depth. After the cable or conduit has been laid, the trench shall be backfilled and compacted in accordance with Section 02312, "Excavation, Backfilling, and Compacting for Utilities." Backfill shall be free of roots, trash, debris, and stones.

3.4 SAFETY SWITCHES

Switches shall be securely fastened to the supporting structure or wall utilizing a minimum of four 6 millimeter bolts. Sheet metal screws and small machine screws shall not be used for mounting. Switches shall not be mounted in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be 1500 millimeter above floor level, when possible.

3.5 WIRING DEVICES

3.5.1 Wall Switches and Receptacles

Wall switches and receptacles shall be so installed that when device plates are applied, the plates will be aligned vertically to within 2 millimeter.

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper.

3.5.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably marked with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets shall be suitably marked, showing the panelboard, circuit number, voltage, frequency, phasing, and amperage available at the receptacle; for example: RP1-12, 208 VOLTS, 60 HERTZ, 3-PHASE, 30 AMPERES.

Device plates for convenience outlets shall be similarly marked by circuit number and panelboard.

Suitable marking shall consist of minimum 3 millimeteruppercase lettering on transparent adhesive tape as manufactured by Kroy or equal.

3.6 BOXES AND FITTINGS

Pullboxes shall be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 30 meter or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Bonding jumpers shall be used around concentric or eccentric knockouts.

Approximate mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be as follows, unless otherwise noted on drawings:

LOCATIO	MOUNTING HEIGHT
Receptacles in offices and corridors	460 millimeter
Receptacles in shops and laboratories	1220 millimeter
Receptacles for clocks	2440 millimeter

LOCATIO	MOUNTING HEIGHT
Switches for light control	1220 millimeter
Thermostats	1675 millimeter

3.7 FIELD TESTING

After completion of the installation and splicing, and prior to energizing the conductors, wire and cable shall be given continuity and insulation tests as herein specified before the conductors are energized.

Necessary test equipment, labor, and personnel shall be provided by the Contractor to perform the tests, as herein specified. Continuity tests shall be conducted using a dc device with bell or buzzer.

Wire and cable in each voltage classification shall be completely isolated from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices shall be used to isolate the circuits under test.

Insulation tests on circuits rated 480 volts and less shall be conducted using a 500 or 1,000 volt insulation-resistance test set. Readings shall be taken every minute until three equal and consecutive readings are obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Insulation tests on circuits rated 240 volts or less, with conductor sizes 2 AWG and larger, shall be conducted using a 500 or 1,000 volt insulation-resistance test set. Readings shall be taken after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Phase-rotation tests shall be conducted on all three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to connected equipment shall be clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. No conductor shall be energized until the installation is approved.

-- End of Section --

SECTION 16225

MOTORS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 112	(1991) Standard Test Procedure for Polyphase Induction Motors and Generators

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1	(1993) Motors and Generators

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for Motors consisting of use life, system functional flows, safety features, efficiency, and mechanical automated details. Curves indicating tested and certified equipment response and performance characteristics shall also be submitted.

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Motors
Enclosures

SD-04 Drawings

Outline Drawings for Motors shall indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

SD-06 Instructions

Manufacturer's Instructions and maintenance procedures shall be submitted for Motorsincluding special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

SD-12 Field Test Report

Test data shall be organized, dated, and signed by the Contractor's representative.

PART 2 PRODUCTS

2.1 EQUIPMENT

Design, fabrication, testing, and performance of motors shall be in accordance with NEMA MG 1.

Testing and performance of polyphase induction motors shall be in accordance with IEEE Std 112, Method B.

Efficiency labeling shall be in accordance with NEMA MG 1.

2.2 MOTOR TYPES

Induction motors with a power rating 3.7 to 185 kilowatt shall be the energy-efficient type and efficiencies shall be as high as those shown below. Motor shall be marked to show the index letter, which shall be the letter shown or a letter that indicates a higher efficiency.

Energy Efficiency Chart

KILOWAT	RP	NEMA INDEX LETTE	MINIMUM EFFICIENC	NOMINAL EFFICIENCY
4	1,800	G	86.5	88.5
	1,200	G	86.5	88.5
5.6	1,800	F	88.5	90.2
	1,200	G	86.5	88.5
7.5	3,600	G	86.5	88.5
	1,800	F	88.5	90.2
	1,200	F	88.5	90.2
7.5	3,600	F	88.5	90.2
	1,800	E	90.2	91.7
	1,200	F	88.5	90.2
15	3,600	F	88.5	90.2
	1,800	E	90.2	91.7

Energy Efficiency Chart

KILOWAT	RP	NEMA INDEX LETTE	MINIMUM EFFICIENC	NOMINAL EFFICIENCY
	1,200	E	90.2	91.7
19	3,600	F	88.5	90.2
	1,800	E	90.2	91.7
	1,200	E	90.2	91.7
22	3,600	E	90.2	91.7
	1,800	D	91.7	93.0
	1,200	E	90.2	91.7
30	3,600	E	90.2	91.7
	1,800	D	91.7	93.0
	1,200	D	91.7	93.0
37	3,600	E	90.2	91.7
	1,800	C	93.0	94.1
	1,200	D	91.7	93.0
45	3,600	D	91.7	93.0
	1,800	C	93.0	94.1
	1,200	D	91.7	93.0
56	3,600	C	93.0	94.1
	1,800	C	93.0	94.1
	1,200	C	93.0	94.1
75	3,600	C	93.0	94.1
	1,800	B	94.1	95.0
	1,200	C	93.0	94.1
93	3,600	C	93.0	94.1
	1,800	B	94.1	95.0
	1,200	C	93.0	94.1
112	3,600	C	93.0	94.1
	1,800	B	94.1	95.0
	1,200	C	93.0	94.1
150	3,600	B	94.1	95.0
	1,800	B	94.1	95.0
	1,200	B	94.1	95.0
190	3,600	B	94.1	95.0
	1,800	C	93.0	94.1]

Motors shall be of the following types:

250 watt rating and smaller, single phase - capacitor start, with integral automatic reset type overload protection

375 watt and larger, three-phase - induction squirrel-cage type, NEMA Design B, having normal starting torque and low starting current

Motors shall be designed for across-the-line starting and shall be designed with torque characteristics to carry the specified rated starting load.

Motors shall have factory-sealed ball bearings.

2.3 SIZES OF MOTORS

2.3.1 Motors

Motors shall be a sufficient size for the duty to be performed and shall not exceed the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions.

2.3.2 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, adjustments shall be made to the motor size, wiring and conduit systems, disconnect devices, and circuit protection to accommodate the equipment actually installed, at no additional cost to the Government. Control and protective devices shall be in accordance with Section 16286, "Overcurrent Protective Devices."

2.4 VOLTAGE RATINGS

Motors shall have the following minimum voltage ratings:

MOTOR SIZE			MOTOR
MOTOR TYP	WATTAGE RATIN	SERVIC	VOLTAGE RATING
Single-phase	250 and smaller	120/208-volt, 3-phase, 4-wire	115-volt, 60-hertz
3-phase	375 and larger	120/208-volt, 3-phase, 4-wire	200-volt, 3-phase 60-hertz
3-phase	375 and larger	480-volt, 3-phase, 3-wire	230/460-volt, 3-phase, 60-hertz

2.5 TEMPERATURE RATING AND INSULATION

Motors shall be designed for continuous operation at the rated full load in an ambient temperature of 40 degrees C.

Insulation level shall be at least Class B.

2.6 MOTOR ENCLOSURES

Motors installed in indoor, clean, dry, nonhazardous locations shall have open-type drip-proof enclosures.

Motors installed in hazardous locations shall be totally enclosed with enclosures designed to prevent the free exchange of air between the inside and outside of the case and ignition of the surrounding atmosphere from within the case. Type of enclosure shall be approved for the class and group of hazard in which the motors are located.

2.7 SERVICE FACTOR

Service factor of general purpose and other open ac motors shall be in accordance with NEMA MG 1.

Totally enclosed ac motors shall have a service factor of 1.15.

2.8 FACTORY TESTS

Motors shall be factory-tested in accordance with the requirements of NEMA MG 1. Polyphase induction motors shall be factory-tested in accordance with IEEE Std 112, Method B. Tests shall consist of routine testing, including measurements of voltage, frequency, speed, and current under no-load conditions; voltage, frequency, and current under locked-rotor conditions; and efficiency, noise, power factor, and thermal protection. Routine tests on wound-rotor induction motors shall include the measurement of wound-rotor open-circuit voltage across the slip rings under locked-rotor conditions. Routine tests on all motors shall include high-potential tests.

PART 3 EXECUTION

3.1 INSTALLATION

Motors shall be installed, aligned, and connected in accordance with the equipment manufacturer's instructions.

Alignment of motors shall be rechecked and adjusted as required after the motor has been in operation for not less than 48 hours.

3.2 SITE TESTING

Motors on motor-driven equipment shall be given continuity and insulation tests after the installation is completed and before the equipment is energized. Motors shall be inspected for damage, moisture, alignment, proper lubrication, oil leaks, phase identification, and cleanliness before conducting tests. Motors shall be completely isolated from the source of supply before conducting the tests.

Test equipment, labor, and personnel shall be provided to perform the tests required.

Insulation tests:

Insulation tests on 480-volt motors shall be conducted using a 1000-volt insulation-resistance test set. Readings shall be recorded every minute until three equal and consecutive readings are obtained. The resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Insulation tests on motors 300 volts or less shall be conducted using a 500-volt minimum insulation-testing instrument. Readings shall be recorded after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Test data shall be recorded and shall include the location and identification of motors and megohm readings versus time.

After the installation has been thoroughly tested and found to be in satisfactory condition, with thermal overload relays in motor controllers properly rated and in place, written authorization shall be obtained from the Contracting Officer prior to energizing the equipment at the system voltage for final operational tests.

Duration of final operational tests to prove satisfactory performance will be determined by the Contracting Officer.

All test data shall be organized, dated, signed and forwarded to the Contracting Officer for approval.

-- End of Section --

SECTION 16275

TRANSFORMERS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C57.12.27	(1982) Conformance Requirements for Liquid-Filled Distribution Transformers Used in Pad-Mounted Installations, Including Unit Substations

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.25	(1992) Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors (34 500-Grd Y/19 920 Volts and Below; Low Voltage, 240/120; 167 kVA and Smaller)

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA ST 1	(1988) Specialty Transformers (Except General Purpose Type)

UNDERWRITERS LABORATORIES (UL)

UL 506	(1994) UL Standard for Safety Specialty Transformers

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Certificates of previous tests on similar units under actual conditions may be submitted for impulse tests, temperature rise tests, sound tests, power-factory tests, bushing tests, and short-circuit tests in lieu of factory tests on actual units furnished.

Equipment and performance data shall be submitted for distribution transformers including resistance measurements, impedance, and voltage and load losses at rated currents.

Equipment foundation data for distribution transformers shall include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-02 Shop Drawings

The following shall be submitted for distribution transformers:

Connection Diagrams
Fabrication Drawings
Installation Drawings

SD-03 Product Data

Equipment and Performance data and Equipment Foundation Data shall be submitted for distribution transformers.

Manufacturer's catalog data shall be submitted for the following items:

Distribution Transformers

SD-06 Test Reports

Test reports shall be submitted for the following tests on distribution transformers in accordance with the paragraph entitled, "Field Testing," of this section.

Insulating Liquid Dielectric Test
Insulation Resistance Tests

SD-07 Certificates

Certificates shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Dry-Type Distribution Transformers

1.4 QUALIFICATION TESTING

Tests on transformers shall comprise the manufacturer's standard tests including resistance measurements of all windings; ratio tests; polarity

and phase-relation tests; no-load loss at rated voltage; impedance; voltage and load loss at rated current and dielectric tests.

1.5 DRAWINGS

Connection diagrams shall be submitted for distribution transformers indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system or portion of system with another, and internal tubing, wiring, and other devices.

Fabrication drawings shall be submitted for distribution transformers consisting of fabrication and assembly details to be performed in the factory.

Installation drawings shall be submitted for distribution transformers in accordance with the paragraph entitled, "Installation," of this section.

PART 2 PRODUCTS

2.1 EQUIPMENT STANDARDS

2.1.1 Dry-Type Distribution Transformers

General-purpose dry-type transformers for connection to low-voltage distribution circuits of 600 volts or less and the supply of current for lighting and power loads shall be two-winding, 60-hertz, self-contained, self-cooled, Class AA in accordance with NEMA ST 1 and UL 506.

Insulation system limiting temperature shall be in accordance with the following table, with a temperature rise of:

Dry-Type Clas	Maximum Rise by Resistanc	Reference Temperature
B	80 degrees C	110 degrees C

2.1.2 Pad-Mounted Dry-Type Distribution Transformers

Pad-mounted dry-type distribution transformers with primary connections to underground high-voltage lines and secondary connections to underground low-voltage distribution feeder circuits shall be two-winding, three-phase, 60-hertz, Class AA dry type, VPE, 80-degrees C temperature rise above 40 degrees ambient, nonventilated, 220-degrees C insulation class, outdoor type, conforming to IEEE C57.12.25 and ANSI C57.12.27. Primary windings of three-phase pad-mounted transformers shall be wye connected. Refer to plan drawings for additional information.

2.2 FACTORY FINISH

Transformers shall be provided with the manufacturer's standard paint finish.

PART 3 EXECUTION

3.1 INSTALLATION

Dry type transformers shall be installed on resilient vibration-isolating mountings and connected with flexible metallic conduit to prevent transmission and amplification of sound.

Pad-mounted distribution transformers shall be installed on precast or poured-in-place concrete pads and shall be grounded to a ground grid.

Each overhead and pad-mounted distribution transformer shall have its kVA rating conspicuously displayed in 75 millimeter high yellow letters on its tank or enclosure in addition to the complete manufacturer's standard identification plate.

3.2 FIELD TESTING

3.2.1 Insulation-Resistance Tests

Transformer windings shall be given an insulation-resistance test using the following test set versus voltage level criteria:

Dry type 480- to 600-volt transformers - 1,000-volt test set

Dry type 240-volt and below transformers - 500-volt test set

Tests shall be applied for not less than 5 minutes and until three equal consecutive readings, 1 minute apart, are obtained. Readings shall be recorded every 30 seconds during the first 2 minutes and every minute thereafter. Minimum acceptable resistance shall be 100 megohms for pad and pole transformers only.

3.2.2 Acceptance

Final acceptance shall depend upon the successful performance of the equipment under test. Transformers shall not be energized until recorded test data have been approved by the Contracting Officer.

-- End of Section --

SECTION 16286

OVERCURRENT PROTECTIVE DEVICES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C78.23	(1989) Electric Lamps - Incandescent Lamps-Miscellaneous Types

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 877	(1987; R 1995) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C12.1	(1988; 8th Ed) Code for Electricity Metering
IEEE C57.13	(1993) Standard Requirements for Instrument Transformers

JOINT INDUSTRIAL COUNCIL (JIC)

JIC-01	(1967) Electrical Standards for Mass Production Equipment

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electric Equipment (1000 Volts Maximum)
NEMA AB 1	(1994) Molded Case Circuit Breakers and Molded Case Switches
NEMA AB 3	(1993) Molded Case Circuit Breakers and Their Application
NEMA ICS 1	(1993) General Standards for Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control Devices and Assemblies

NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 6	(1993) Enclosures for Industrial Control and Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 20	(1995) UL Standard for Safety General-Use Snap Switches
UL 489	(1991; 8th Ed; May 1, 1992; Bulletin Feb 11, 1992; Bulletin Mar 16, 1992) UL Standard for Safety Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
UL 50	(1995; 11th Ed) UL Standard for Safety - Enclosures for Electrical Equipment
UL 508	(1993; 16th Ed) UL Standard for Safety Industrial Control Equipment

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

No change in continuous-current rating, interrupting rating, and clearing or melting time of fuses shall be made unless written permission has first been secured from the Contracting Officer.

SD-02 Shop Drawings

Connection Diagrams and Fabrication Drawings shall be submitted for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Installation drawings shall also be submitted for the following items in accordance with the paragraph entitled, "Installation," of this section.

Control Devices
Protective Devices

SD-03 Product Data

Equipment and performance data shall be submitted for the

following items including use life, system functional flows, safety features, and mechanical automated details.

Manufacturer's catalog data shall also be submitted for the following items:

Motor Control
Instrument Transformers
Enclosures
Circuit Breakers
Fuses
Control Devices
Indicating Lights

SD-06 Test Reports

Test reports shall be submitted for the following tests on control and protective devices in accordance with the paragraph entitled, "Field Testing, of this section.

Operation Tested

SD-07 Certificates

Certificates shall be submitted for Circuit Tests on similar motor-control or motor-circuit protector (MCP) units under actual conditions may be submitted in lieu of factory tests on the actual units provided.

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted for the following items, including special provisions required to install equipment components and system packages. Special notices shall detail, resistance impedances, hazards and safety precautions.

Control Devices
Protective Devices

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Manual Motor Controllers
Magnetic Motor Controllers
Combination Motor Controllers
Circuit Breakers
Indicating Instruments

1.3 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Connection Diagrams shall be submitted showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Fabrication Drawings shall be submitted for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

PART 2 PRODUCTS

2.1 MOTOR CONTROL

Motor controllers shall conform to NEMA ICS 1, NEMA ICS 2, and UL 508. Controllers shall have thermal overload protection in each phase.

2.1.1 Manual Motor Controllers

Manual motor controllers for the control and protection of single-phase 60-hertz ac small wattage rating squirrel-cage induction motors shall be full-voltage, manually operated devices.

Controllers shall be single-throw, single- or double-pole, three-position devices rated not more than 750 watt rated at 115- and 230-volts single phase. Controller shall include a supporting base or body of electrical insulating material with enclosed switching mechanism, yoke, thermal overload relay, and terminal connectors. Controllers shall clearly indicate operating condition: on, off, or tripped.

Manual motor controllers shall be the toggle- or key-operated type as indicated and shall be arranged so that they may be locked with a padlock in the "OFF" position.

Recessed manual motor controllers for single-speed, small wattage rating squirrel-cage induction motors shall include a single controller and indicating light in a 100 millimeter square wall outlet box for flush-wiring devices with matching corrosion-resistant steel flush cover plate. Surface-mounted manual motor controllers for single-speed, small wattage rating squirrel cage induction motors shall include a single controller and indicating light in a NEMA 250, Type 1 general-purpose enclosure.

Recessed and surface-mounted manual motor controllers for two-speed, small wattage rating squirrel-cage induction motors shall include two controllers, two indicating lights, and a selector switch in a multiple-gang wall outlet box for flush-wiring devices with matching corrosion-resistant steel flush-cover plate. Surface-mounted manual motor controllers for two-speed small wattage rating squirrel-cage induction motors shall include two controllers, two indicating lights, and a selector switch in a NEMA 250, Type 1 general-purpose enclosure.

2.1.2 Magnetic Motor Controllers

2.1.2.1 Full-Voltage Controllers

Magnetic motor controllers for the control and protection of single- and three-phase, 60-hertz, squirrel-cage induction motors shall be full-voltage, full magnetic devices in accordance with NEMA ICS 1, NEMA ICS 2, and UL 508.

Operating coil assembly shall operate satisfactorily between 85 and 110 percent of rated coil voltage. Motor control circuits shall be 120 volts, 60 hertz.

Controller shall be provided with two normally open and two normally closed auxiliary contacts rated per NEMA ICS 1 and NEMA ICS 2 in addition to the sealing-in contact for control circuits.

Solderless pressure wire terminal connectors shall be provided for line-and load-connections to controllers.

Overcurrent protection shall include solid state overload protection. Refer to drawings for bases of design.

Enclosure shall be in accordance with NEMA 250, Type 1.

2.1.3 Combination Motor Controllers

Following requirements are in addition to the requirements specified for magnetic motor controller:

Combination motor controllers for the control and protection of single-and three-phase 60-hertz alternating-current squirrel-cage induction motors with branch-circuit disconnecting and protective devices shall be in accordance with NEMA ICS 1, NEMA ICS 2, and JIC-01.

Combination motor controllers shall include magnetic motor controllers and molded-case circuit breakers or MCP in metal enclosures in accordance with NEMA 250 or motor-control center draw-out assemblies with control-power transformers, selector switches, pushbuttons, and indicating lights as follows:

Magnetic motor controllers and enclosures shall be full-voltage, full-magnetic devices as specified in this section under paragraph entitled, "Remote-Control Station Enclosures."

Control-power transformers 120-volt ac maximum selector switches, pushbuttons, and pilot lights shall be as required.

Combination motor controllers shall be identified with identification plates affixed to front cover of the controller.

2.2 INSTRUMENT TRANSFORMERS

2.2.1 Current Transformers

Current transformers shall conform to IEEE C57.13 for installation in metal-clad switchgear. Standard 3-A secondary transformer shall be used.

Transformers shall be window type.

Transformers shall have single secondary winding.

Transformers shall be complete with secondary short-circuiting device.

Window-type current transformers shall be indoor dry type construction with secondary current ratings as indicated. Burden, frequency, and accuracy shall be as specified.

2.2.2 Potential Transformers

Potential transformers shall conform to IEEE C57.13 for installation in metal-clad switchgear. Standard 120-volt secondary transformers shall be used.

Transformers shall have single secondary.

Burden, frequency, and accuracy shall be as required.

Disconnecting potential transformers with integral fuse mountings and current-limiting fuses shall be indoor dry type two-winding construction with primary and secondary voltage ratings as required.

2.3 ENCLOSURES

2.3.1 Equipment Enclosures

Enclosures for equipment shall be in accordance with NEMA 250.

Equipment installed inside, clean, dry locations shall be contained in NEMA Type 1, general-purpose sheet-steel enclosures.

Sheet-steel enclosures shall be fabricated from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.

Ferrous-metal surfaces of electrical enclosures shall be cleaned, phosphatized, and painted with the manufacturer's standard finish.

2.3.2 Remote-Control Station Enclosures

Remote-control station enclosures for pushbuttons, selector switches, and indicating lights shall be in accordance with the appropriate articles of NEMA ICS 6 and NEMA 250.

Remote-control stations installed in Class I, Division I, Group A, B, C, and D, hazardous locations shall be contained in NEMA Type 7 enclosures approved for the specific flammable gas or vapor which is or may be present under normal operating conditions.

Ferrous-metal surfaces of remote-control-station enclosures shall be cleaned, phosphatized, and painted with the manufacturer's standard finish.

Remote-control stations shall be installed with the centerline 1700 millimeter above the finished floor.

2.4 CIRCUIT BREAKERS

Circuit breakers shall conform to UL 489, NEMA AB 1, and NEMA AB 3.

2.4.1 Molded-Case Circuit Breakers

Circuit breakers shall be molded case, manually operated, trip-free, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Circuit breakers shall be completely enclosed in a molded case, with the calibrated sensing element factory-sealed to prevent tampering.

Thermal-magnetic tripping elements shall be located in each pole of the circuit breaker and shall provide inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection. Instantaneous magnetic tripping element shall be adjustable and accessible from the front of the breaker on frame sizes larger than 100 amperes.

Breaker size shall be as required for the continuous current rating of the circuit. Breaker class shall be as required.

Interrupting capacity of the panel and lighting branch circuit breakers shall be sufficient to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Circuit breaker interrupting capacities shall be a minimum of 10,000 amperes and shall conform to NEMA AB 3.

Multipole circuit breakers shall be of the common-trip type having a single operating handle and shall a have two-position on/off indication. Circuit breakers shall have temperature compensation for operation in an ambient temperature of 40 degrees C. Circuit breakers shall have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective type tripping (time delay, magnetic, thermal, or ground fault).

Breaker body shall be of phenolic composition. Breakers shall be capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required.

Circuit breakers used for motor-circuit disconnects shall meet the applicable requirements of NFPA 70 and shall be of the motor-circuit protector type.

Circuit breakers used for service disconnection shall be the enclosed circuit-breaker type with external handle for manual operation. Enclosures shall be sheet metal with a hinged cover suitable for surface mounting.

2.4.2 Enclosed Molded-Case Circuit Breakers

Enclosed circuit breakers shall be thermal-magnetic molded-case circuit breakers in surface-mounted, nonventilated enclosures conforming to the appropriate articles of NEMA 250 and NEMA AB 1.

Enclosed circuit breakers in nonhazardous locations shall be as follows:

Circuit breakers installed inside, clean, dry locations shall be contained in NEMA Type 1, general purpose sheet steel enclosures.

2.5 CONTROL DEVICES

2.5.1 Magnetic Contactors

Magnetic contactors for the control of low-voltage, 60-hertz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the primary windings of low-voltage transformers shall be in accordance with NEMA ICS 1 and NEMA ICS 2 as required.

Core-and-coil assembly shall operate satisfactorily with coil voltage between 85 and 110 percent of its voltage rating.

Contactor shall be designed with a normally open holding circuit auxiliary contact for control circuits. Rating of the auxiliary contact shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

Solderless pressure wire terminal connectors shall be furnished or made available for line-and-load connections to contactors in accordance with NEMA ICS 1 and NEMA ICS 2.

Rating of magnetic contactors shall be in accordance with NEMA ICS 1and NEMA ICS 2.

2.5.2 Control-Circuit Transformers

Control-circuit transformers shall be provided within the enclosure of magnetic contactors and motor controllers when the line voltage is in excess of 120 volts. Transformer shall be encapsulated dry type, single-phase, 60-hertz, with a 120-volt (or 24-volt) isolated secondary winding.

Rated primary voltage of the transformer shall be not less than the rated voltage of the controller. Rated secondary current of the transformer shall be not less than continuous-duty current of the control circuit.

Voltage regulation of the transformer shall be such that, with rated primary voltage and frequency, the secondary voltage shall not be less than 95 percent nor more than 105 percent of rated secondary voltage.

Source of supply for control-circuit transformers shall be the load side of the main disconnecting device. Secondary winding of the transformer and control-circuit wiring shall be protected against overloads and short circuits with fuses selected in accordance with JIC-01. Secondary winding of the control-circuit transformer shall be grounded in accordance with

JIC-01.

2.5.3 Magnetic Control Relays

Magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices in response to variations in the conditions of electric control devices shall be in accordance with NEMA ICS 1, and NEMA ICS 2.

Core-and-coil assembly shall operate satisfactorily with coil voltages between 85 and 110 percent of their voltage rating.

Relays shall be designed to accommodate normally open and normally closed contacts.

Magnetic control relays shall be 120-volt, 60-hertz, Class AIB devices with a continuous contact rating of 10 amperes and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

2.5.4 Pushbuttons and Switches

2.5.4.1 Pushbuttons

Pushbuttons for low-voltage ac full-voltage magnetic controllers shall be heavy-duty oiltight NEMA 250, Type 12, momentary-contact devices rated 600 volts, with pilot light, and with the number of buttons and the marking of identification plates as shown. Color code for pushbuttons shall be in accordance with JIC-01.

Pushbuttons shall be designed with normally open, circuit-closing contacts; normally closed circuit-opening contacts; and two-circuit normally open and normally closed circuit-closing and -opening contacts. Pushbutton-contact ratings shall be in accordance with NEMA ICS 1 and NEMA ICS 2 with contact designation A600.

Pushbuttons in remote control stations shall be identified with identification plates affixed to front cover in a prominent location. Identification plate shall carry the identification of the system being controlled.

2.5.4.2 Selector Switches

Selector switches for low-voltage control circuits shall be heavy-duty oiltight maintained-contact devices with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Selector switches in remote control stations shall be identified with engraved identification plates affixed to front cover in a prominent location. Identification plate shall carry the identification of the system being controlled.

2.6 TIME SWITCHES

Time switches for the control of tungsten-lamp loads, fluorescent-lamp loads, resistive-heating loads, motors, and magnetically operated devices shall consist of a motor-driven time dial and switch assembly in NEMA 250, Type 1 general-purpose enclosure.

Motor drives shall consist of 120-volt, single-phase, 60-hertz, heavy-duty, self-starting synchronous motors directly connected to the time dial through a geartrain operating mechanism. A spring-wound stored-energy source of reserve power shall be provided that will automatically operate the mechanism for a period of not less than 12 hours in case of electric power failure. Spring shall automatically rewind electrically in not more than 3 hours of time after electric power is restored.

Switch mechanism shall include a heavy-duty general-purpose precision snap-action switch in accordance with UL 20. Provision shall be made for manual "OFF" and "ON" operation of the switch.

Time switches for the control of 120/240-volt, 2- and 3-wire, single-phase, 60-hertz circuits and 120/208-volt, three-phase, 4-wire, 60-hertz circuits shall have a continuous-current tungsten-lamp load rating of 35 amperes.

Time dials shall be 7-day type with adjustable on and off trippers for programmed switching operations for each day in the week. Dial shall be calibrated in 2-hour intervals for each day and for each day in the week around its circumference and shall make one revolution in the 7-day period of time. Time dials shall have a minimum "ON" time setting of not more than 2-1/2 hours and shall be fully adjustable upward in 2-hour intervals of time throughout each day.

2.7 INDICATING LIGHTS

2.7.1 General-Purpose Type

Indicating lights shall be oiltight instrument devices with threaded base and collar for flush-mounting, translucent convex lens, candelabra screw-base lampholder, and 120-volt, 6-watt, Type S-6 incandescent lamp in accordance with ANSI C78.23. Color code for indicating lights shall be in accordance with JIC-01.

Indicating lights shall be provided in remote-control stations when pushbuttons and selector switches are out of sight of the controller.

PART 3 EXECUTION

3.1 INSTALLATION

Control devices and protective devices not factory installed in equipment shall be installed in accordance with the manufacturer's recommendations and shall be field adjusted and operation tested. Installations shall conform to NFPA 70, NEMA ICS 1, NEMA ICS 2, and NEMA ICS 3 requirements for installation of control and protective devices.

3.2 FIELD TESTING

Control and protective devices not factory installed in equipment shall be demonstrated to operate as indicated.

Insulating oil in oil circuit breakers shall have dielectric tests performed before the breakers are energized. Oil shall be tested in accordance with ASTM D 877, and breakdown voltage shall be not less than 25,000 volts.

Reduced-voltage starting devices shall be field adjusted to obtain optimum operating conditions. Test meters and instrument transformers shall conform to IEEE C12.1 and IEEE C57.13.

-- End of Section --

SECTION 16409

CONTROL PANELS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA 422-A (1978) Electrical Characteristics of Balanced Voltage Digital Interface Circuits

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for Air Handling Unit Microprocessor Interface consisting of scan rates, and response times to direct commands.

SD-04 Drawings

Connection Diagrams shall be submitted for Air Handling Unit Microprocessor Interface indicating the relation and connection of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

SD-06 Instructions

Operating Instructions shall be submitted for Air Handling Unit Microprocessor Interface consisting of standard operating procedures including startup, shutdown, and emergency operation.

SD-08 Statements

Parts List shall be submitted for Air Handling Unit Microprocessor Interface listing by manufacturer's name, part number, nomenclature, and stock level required for maintenance and repair necessary to ensure continued operation with minimal delay.

SD-18 Records

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

SD-19 Operation and Maintenance Manuals

Contractor shall submit 6 copies of the Operation and Maintenance Manuals 30 days prior to testing the Air Handling Unit Microprocessor Interface. Data shall be updated and resubmitted for final approval no later than 30 days prior to contract completion.

1.3 GENERAL REQUIREMENTS

PART 2 PRODUCTS

2.1 GENERAL

Air handling units which utilize a microprocessor-based control system for monitoring alarms, temperature and humidity and control chilled water flows, heating, and humidification, shall have the capability to communicate directly with a microprocessor-based remote terminal unit (RTU) for data acquisition, alarm monitoring, set point and alarm point adjustment.

2.2 COMMUNICATIONS

Communications port(s) shall be a standard interface in accordance with EIA 422-A. Standard baud rate shall be 9600, on which all performance specifications shall be based. Baud rate shall be switch selectable to 4800.

Each air handling unit microprocessor shall be available for and able to communicate directly with the NASA Utility Control System (UCS) remote terminal unit (RTU).

2.3 DIAGNOSTICS

Microprocessor control shall include a diagnostic routine that can be performed by the user to check the operation of the microprocessor.

Diagnostic routines shall be fully tested by the manufacturer prior to delivery. Diagnostics shall provide two levels of testing.

2.3.1 Automatic Diagnostics

Automatic diagnostics shall be executed upon system start-up and shall include a read/write check to memory for memory testing, minimal instruction execution check, buss and port checks.

2.3.2 Comprehensive Diagnostics

Comprehensive diagnostics shall include:

Microprocessor instructions: All defined functions and their variations

Microprocessor memory testing: Memory testing shall include comprehensive memory test with memory execution characteristic printout. Limits on memory access time, all patterns run, run time, and number of successful executions in worst case pattern shall be included in this printout.

Power supply status

Buss and port checks

Capability to be initiated remotely (through the communication link)

Performance of the diagnostics shall meet the above requirements for final acceptance of the air handling unit.

2.4 ACQUISITION POINT REQUIREMENTS

Air handling unit microprocessor shall monitor and transmit the values of the following points to the remote terminal unit (RTU):

2.5 CONTROL POINT REQUIREMENTS

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated and in accordance with the manufacturer's recommendations.

-- End of Section --

SECTION 16446

PANELBOARDS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

FEDERAL STANDARDS (FED-STD)

FED-STD 595	(Rev B) Colors Used in Government Procurement

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electric Equipment (1000 Volts Maximum)
NEMA AB 1	(1994) Molded Case Circuit Breakers and Molded Case Switches
NEMA PB 1	(1990) Panelboards

UNDERWRITERS LABORATORIES (UL)

UL 67	(1993; 11th Ed) Panelboards

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Panelboards

SD-04 Drawings

Detail Drawings shall be submitted for the Panelboards consisting of fabrication and assembly drawings for all parts of the work in

sufficient detail to enable the Government to check conformity with the requirements of the contract documents. Drawings shall include details of bus layout.

SD-04 Drawings

Outline Drawings for Panelboards shall indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

SD-06 Instructions

Manufacturer's Instructions shall be submitted for Panelboards including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

SD-09 Reports

Test Reports shall be submitted for the following tests in accordance with the paragraph entitled, "Site Testing," of this section. Panelboards shall not be energized until the recorded test data have been submitted to and approved by the Contracting Officer.

Continuity Tests
Insulation Tests

SD-14 Samples

Keys shall then be properly tagged and delivered to the Contracting Officer.

PART 2 PRODUCTS

2.1 PANELBOARDS

Power-distribution panelboards and lighting and appliance branch-circuit panelboards shall be totally enclosed in a steel cabinet, dead-front circuit breaker type with copper buses, surface- or flush-mounted as indicated. Panelboards shall conform to NEMA PB 1 and NEMA AB 1. Branch circuit panels shall have buses fabricated for bolt-on type circuit breakers.

An outer door or cover, hinged on one side, shall be provided on panelboards to provide gutter space access. A center door shall be provided for circuit breaker/switch access only.

Voltage and current rating, number of phases, and number of wires shall be as indicated. Four-wire distribution panelboards and lighting and appliance branch-circuit panelboards shall be provided with an isolated full-capacity neutral bus. Panelboards shall be rated for 240-volt (maximum), single-phase or 120/208-volt, three-phase or 277/480-volt, three-phase, 60-hertz current as indicated on the panelboard schedules or

as indicated on the one-line diagrams.

Three-phase, 4-wire and single-phase, 3-wire distribution lighting and branch circuit panelboards shall be provided with an isolated full-capacity bus for single-pole circuit breakers/switches and spaces .

Panelboards shall be provided with a separate grounding bus bonded to the enclosure. Grounding bus shall be a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Each panelboard, as a complete unit, shall have a short-circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or as indicated.

Panelboards and main lugs or main breaker shall have current ratings as shown on the panelboard schedule.

Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single-phase, three-wire panelboard busing shall be such that any two adjacent single-pole breakers are connected to opposite phases and two-pole breakers can be installed in any location. Three-phase, four-wire busing shall be such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.

Mechanical lugs furnished with panelboards shall be cast copper or copper alloys of sizes suitable for the conductors indicated to be connected thereto.

Panelboard box shall be galvanized code-gage sheet steel without knockouts. Entire panelboard front shall be hinged on one side with a piano hinge for the full height and shall also have captive screws opposite the hinged side. Where panelboards are installed flush with the walls, the installation details shall be such that the hinged front can be opened without damage to the adjacent wall surfaces.

Panelboards shall be finished with baked enamel. Finish color shall be No. 61 gray conforming to FED-STD 595 except that color of the finished coat of trim and front shall match the adjacent walls. Field painting of the trim and front shall be as specified in Section 09915, "Painting".

Panelboard enclosures shall be NEMA 250, Type 1 unless indicated othrwise. Enclosures shall be provided with hinged fronts and corrosion-resistant steel pin-tumbler cylinder locks. Locks shall be keyed alike, and two keys shall be provided for each enclosure.

2.2 CIRCUIT BREAKERS

Circuit breakers shall be the molded-case type as specified in Section 16286,

"Overcurrent Protective Devices." Frame and trip ratings shall be as indicated.

Interrupting rating of circuit breakers shall be as indicated. If not shown, the interrupting rating for circuit breakers in 120/208-volt panelboards shall be not less than 10,000 amperes rms symmetrical, and that for breakers in 277/480-volt panelboards shall be not less than 25,000 amperes rms symmetrical.

Circuit breakers shall be bolt-on type. Plug-in type shall not be acceptable.

Shunt trips shall be provided where indicated.

In branch circuit panelboards, branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the trip rating of the breaker to prevent repeated arcing shorts resulting from frayed appliance cords. Single-pole 15- and 20-ampere circuit breakers shall be UL listed as "SWD"(for switching fluorescent lighting loads, and as "HACR" for use with HVAC equipment) at 120 volts ac or 277 volts ac as indicated. UL Class A (5-milliampere sensitivity) ground fault circuit protection shall be provided on 120-volt ac branch circuit as indicated. This protection shall be an integral part of the branch circuit breaker that also provides overload and short-circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption shall not disturb the feeder circuit to the panelboard. A single-pole circuit breaker with integral ground fault circuit interruption shall require no more panelboard branch circuit space than a conventional single pole circuit breaker.

Connections to the bus shall be bolt-on type.

When multiple wires per phase are specified, the circuit breakers shall be furnished with connectors UL Listed to accommodate multiple wires.

Circuit breaker spaces called out on the drawings shall be complete with mounting hardware to permit ready installation of the circuit breakers.

2.3 DIRECTORY CARD AND HOLDER

A directory card shall be mounted on the inside of hinged fronts and doors in a metal frame, with spaces for circuit numbers, outlets controlled, and room numbers. Directory card shall identify each branch circuit with its respective and numbered circuit breaker.

2.4 FACTORY TESTING

Complete panelboards shall be tested in accordance with UL 67.

PART 3 EXECUTION

3.1 INSTALLATION

Panelboards shall be installed as indicated and in accordance with the

manufacturer's instructions. Panels shall be fully aligned and mounted so that the height of the top operating handle will not exceed 1800 millimeter above the finished floor.

Directory-card information shall be typewritten in capital letters to indicate spares, spaces for future and description of load controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.

3.2 SITE TESTING

Each panelboard enclosure key shall be shown to operate the enclosure locks in the presence of the Contracting Officer.

Panelboards shall be given continuity and insulation tests after the installation has been completed and before the panelboard is energized.

Test equipment, labor, and personnel shall be provided by the Contractor as required to perform the tests as specified. Continuity tests shall be conducted using a dc device with bell or buzzer.

Insulation tests on 480-volt panelboards shall be conducted using a 1,000-volt insulation-resistance test set. Readings shall be recorded every minute until three equal and consecutive readings have been obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Insulation tests on panelboards rated 300 volts or less shall be conducted using a 500-volt minimum insulation-resistance test set. Readings shall be recorded after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Test data shall be recorded and shall include the location and identification of panelboards and megohm readings versus time.

-- End of Section --

SECTION 16511

FLUORESCENT LUMINAIRES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C78.1	(1991; C78.1a-1992) Dimensional and Electrical Characteristics of Fluorescent Lamps - Rapid Start Types
ANSI C82.1	(1985; C82.1a-1990; c82.1b-1990; C82.1c-1990) Ballasts for Fluorescent Lamps
ANSI C82.2	(1984; R 1989) Fluorescent Lamp Ballasts - Methods of Measurement

FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 18	RF Lighting Devices

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA 270	(1988) Procedure for Fluorescent Lamp/Ballast/Fixture Performance Comparison

UNDERWRITERS LABORATORIES (UL)

UL 1570	(1988; 3rd Ed; Rev thru May 25, 1990) Fluorescent Lighting Fixtures
UL 844	(1995; 11th Ed) UL Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations
UL 935	(1995; 9th Ed) Fluorescent-Lamp Ballasts

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Fluorescent fixture performance requirements shall be rated in accordance with NEMA 270.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for the following including life, test, system functional flows, safety features, and mechanical automated details.

Fluorescent Lighting Fixtures
Fluorescent Lamp Ballast
Fluorescent Lamps

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Fluorescent Lighting Fixtures
Fluorescent Lamp Ballast
Fluorescent Lamps
Accessories

SD-09 Reports

Test Reports shall show compliance with the requirements of this specification as follows:

Lighting-Distribution Curves for each type of fixture shall be prepared utilizing the fixture manufacturer's own facilities or those of an independent nationally recognized laboratory, in accordance with the standard procedure developed by the Illuminating Engineering Society.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Fluorescent lighting fixtures shall conform to UL 1570 and as specified. Fixtures in hazardous areas shall conform to UL 844.

Lighting fixtures shall be furnished completely assembled with wiring and mounting devices and ready for installation at the locations indicated. Recessed fixtures in suspended ceilings shall be designed and equipped for installation in the type of ceiling in which the fixture is to be installed. Fixtures shall be designed to be supported independent of the ceiling and shall be equipped with the lamps indicated.

2.2 COMMERCIAL FIXTURES

Commercial fluorescent lighting fixtures shall conform to UL 1570 and include recessed, surface-mounted, and pendant-mounted luminaires as

indicated and herein specified.

Lighting fixtures shall include wiring channel, end plates, end caps, side panels, top reflectors, bottom closures, lampholders, lamps, ballasts, suspension stems, wiring, and other necessary materials and devices.

Ballasts and wiring shall be completely enclosed in the wiring channel and shall be easily accessible. Ballast shall be replaceable without removing the fixture from its mounting. Lamps shall be replaceable without the use of tools and without removal of other lamps and equipment.

Wiring channel, end plates, and other sheet steel enclosure components shall be cold-rolled carbon-steel sheet of commercial quality not less than 1 millimeter.

When two or more fixtures are joined together in continuous rows, the wiring channel shall form an open and continuous wireway.

2.2.1 Surface-Mounted Fixtures

Surface-mounted fixtures shall be designed to be fastened to wall or ceiling flush-mounted outlet boxes. When two or more fixtures are joined together in continuous rows, the wiring channel shall form an open and continuous wireway.

2.2.2 Recessed Fixtures

Recessed fixtures in suspended ceilings shall be equipped with frames, yokes, and adjustable mounting brackets designed for the type of ceiling construction in which the fixture is to be installed. Bottom closure shall be hinge framed with chromium or nickel-plated latching devices.

2.2.3 Pendant-Mounted Fixtures

Pendant-mounted fixtures shall be equipped with stems, swivel, ball-and-socket self-aligning hangers, ceiling canopies, and fixture-leveling devices. Stems shall be not less than 13 millimeter in diameter, made from seamless corrosion-resistant steel tubing. Stem length, material, and finish shall be as required to obtain mounting height indicated.

2.2.4 Combination Light and Air-Handling Troffers

Combination light and air-handling troffers recessed in suspended ceilings shall be in accordance with UL 1570 and shall conform to the requirements for commercial fluorescent lighting fixtures, as indicated.

Electrical equipment, except lamps and lampholders, shall be completely separated from the air path through the fixture and from the air space in the plenum.

Joints in the wiring channel shall be lapped or sealed to prevent air leakage and the infiltration of lint and dirt into the wiring compartment.

Air-handling fixtures shall be equipped with bottom flanges, air trim openings, metal filler strips, and single or double air-diffuser side units. Inlet connections shall be located on the side of single units and on the top or side of double units.

Supply-terminal air devices shall be equipped with adjustable air pattern controllers in outlets and with volume controls in housings. Both controls shall be accessible from the face of the outlet without disturbing the lamp enclosure. Pattern- and volume-control devices shall be positive locking in all positions. Return-air units shall be equipped with volume controls.

Air-diffuser assemblies shall be constructed of mill-galvanized steel. Interior surfaces exposed to view and the metal filler strips shall be finished with a matte-black enamel. Filler strips shall be used to close unused air-trim openings.

2.3 INDUSTRIAL FIXTURES

Industrial fluorescent lighting fixtures shall conform to UL 1570 and shall be as indicated.

Lower edge of the reflector shall be formed into a flange or bead to provide stiffness and shall be completely covered by the finish. Each reflector shall be removable and securely maintained in position with latch fastening devices. Reflector shall form the bottom of the wiring-channel enclosure.

Direct-lighting fixture reflectors shall be so shaped that the ratio of the luminance at 55 degrees nadir to the luminance at nadir shall be not less than 55 percent. Upward component of light shall be a minimum of 8 percent and a maximum of 20 percent of the total light output.

Semidirect lighting-fixture reflectors shall be so shaped that the ratio of the luminance at 45 degrees nadir to the luminance at nadir shall be not less than 60 percent. Upward component of light shall be a minimum of 20 percent and a maximum of 30 percent of the total light output.

Lighting-fixture unit, when viewed at any angle from the minimum shielding angle to the horizontal plane, shall have a brightness no greater than 40 percent of the brightness of the bare lamp.

Pendant-mounted fixtures shall be equipped with straps, brackets, conduit stems, ball-and-socket self-aligning hangers, ceiling canopies, slide-clamp fixture hangers, and leveling devices. Stems shall be not less than 13 millimeter in diameter, seamless brass, steel, or aluminum tubing. Stem length and finish shall be as indicated. When two or more fixtures are joined together, the wiring channel shall form an open and continuous wireway.

Chain-supported fixtures shall be equipped with straps, brackets, ceiling-mounted chain hangers, chain, hooks, and slide-clamp fixture hangers.

2.4 FLUORESCENT LAMP BALLAST

Fluorescent lamp ballasts shall be Class P in accordance with ANSI C82.1, ANSI C82.2, and UL 935.

Ballasts shall be designed for single- or two-lamp operation with line power factor not less than 90 percent. Two-lamp ballasts shall operate the two lamps out of phase with each other.

Fluorescent lighting fixtures with lamps 30 watts or more shall be equipped with instant-start ballasts. All fluorescent lighting fixtures with lamps rated 20 watts or less shall be equipped with trigger-start ballasts. Auxiliary lamp starters shall not be permitted.

Ballasts shall be voltage rated for operation on 120-volt, single-phase, 60-hertz lighting distribution systems as indicated.

Ballasts shall be designed for a maximum ambient temperature of 40 degrees C.

Ballasts for indoor lamps shall be in accordance with UL 935 .

Ballasts for outdoor lamps shall have a minimum starting temperature of -18 degrees C.

2.4.1 Electronic Ballasts

Ballasts shall not contain polychlorinated biphenyls (PCB's).

Ballasts shall operate with a 90 to 110 percent input voltage variation at an input frequency of 60 Hz. Light output shall remain constant for line voltage fluctuations of plus or minus 3 percent. Ballasts shall be instant start type.

Ballasts shall have a minimum power factor of 0.95.

Ballasts shall comply with Class A (20-24 DB) sound rating.

Ballasts shall comply with Electromagnetic Interference (EMI) and Radio Interference (RFI) limits set by the FCC Part 18, CFR, Chapter 18, Part C.

Ballasts shall have less than 10 percent Total Harmonic Distortion.

Ballasts for rapid start T-8 lamps shall be capable of operating remaining lamps if one or more companion lamps fail or are removed.

Ballast size and mounting configuration shall be consistent with standard electromagnetic ballast for same application.

2.4.2 Dimmable Electronic Ballasts

Ballast shall be instant or rapid start designed to operate high efficient T-8 32 watt lamps and provide continuous dimming from 100 to 10 percent. Total harmonic distortions shall be limited to less than 10 percent and third harmonic distortion shall be limited to less than 6 percent. Ballast

shall operate at a frequency greater than 20 kHZ from an input frequency of 60 Hz. The input power factor shall be 95 percent or greater.

2.5 FLUORESCENT LAMPS

Lamps shall conform to ANSI C78.1 and shall be the energy-efficient type with a minimum starting temperature of 16 degrees C.

2.5.1 Rapid Start Lamp

The 32-watt, extra-high efficiency fluorescent lamp shall have a minimum efficiency of 91 lumens per watt and shall be designed to operate on a two -lamp, electronic ballast.

Rapid start lamps shall have bulb designation T-8 and a base configuration of medium bipin contact.

Lamps shall have an average rated life at 3 hours per start of 20,000 hours.

Bulb color temperature shall be 3500K Daylight. Lamp dimensions shall be in accordance with ANSI C78.1.

Acceptable Flourescent Rapid Start 1200 mm (T8) lamps are, unless otherwise noted on drawings:

GTE type F32T8/SPX35, 32W, 2950 Lumens, 3500K, Trimline Series
Sylvania type FBO32/835/6, 32W, 3000 Lumens, 3500K, Octron Series
Philips type F32T8/TL835, 31W, 2800 Lumens, 3500K, TL Series

Acceptable Flourescent Rapid Start U6 (T8) lamps are, unless otherwise noted on drawings:

GTE type F32T8/SPX35/U/6,, 31W, 2800 Lumens, 3500K
Sylvania type FBO32/835/6, 32W, 3000 Lumens, 3500K
Philips type F31T8/TL835, 31W, 2800 Lumens, 3500K

2.6 FLUORESCENT FIXTURE LENS

All 600mm X 1200mm, 600mm X 600mm, and 300mm X 1200mm lensed fluorescent light fixture shall have a diffuser made of clear color stailized "K-12" (32mm) low brightness acrylic material except in areas using video terminals.

PART 3 EXECUTION

3.1 INSTALLATION

Fluorescent fixtures shall be installed in accordance with UL 1570.

A fixture shall be installed at each outlet indicated, and lamps of the proper type and wattage shall be installed in each fixture.

New lamps shall be installed immediately prior to completion of the project.

Fixtures shall be installed parallel and perpendicular to major axes of structures and shall be plumb and aligned to a tolerance of 13 millimeter in 3000 millimeter.

Supports for recessed fixtures shall have a minimum capacity of 670 newtons, and all parts of the support shall be arranged to prevent them from vibrating free.

Supports for recessed fixtures in suspended ceilings shall be so arranged that each corner of each fixture is supported by a hanger wire anchored to a structural member or to the structure to afford adequate seismic anchorage.

Surface-mounted fixtures shall be attached securely to structural members or to metal supports that span structural members. Fixtures shall be fastened near each end and, when over 1200 millimeter long, shall also be fastened at the center. When surface-mounted fixtures are not UL approved for direct mounting on combustible ceilings, suitable spacers shall be installed.

Fixtures located in equipment rooms shall be so installed that they clear all obstructions such as duct, piping, bracing, and supports.

3.2 FIELD TESTING

Fluorescent lighting fixtures shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

-- End of Section --

SECTION 16512

HIGH INTENSITY DISCHARGE (HID) LUMINAIRES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C78.1376	(1990) Metal-Halide Lamp, 1000-watt, M47
ANSI C82.4	(1985; C82.4a-1988) Ballasts for High-Intensity-Discharge and Low Pressure Sodium Lamps (Multiple Supply Type)
ANSI C82.5	(1990) Reference Ballasts - High-Intensity-Discharge and Low Pressure Sodium Lamps
ANSI C82.9	(1988) High-Intensity-Discharge and Low-Pressure Sodium Lamps, Ballasts and Transformers - Definitions

CODE OF FEDERAL REGULATIONS (CFR)

21 CFR 1040	(1995) Performance Standards for Light-Emitting Products

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1572	(1991; 3rd Ed) High Intensity Discharge Lighting Fixtures
UL 844	(1995; 11th Ed) UL Standard for Safety Electric Lighting Fixtures for Use in Hazardous (Classified) Locations

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

Material, Equipment, and Fixture Lists shall be submitted for HID lighting fixtures including manufacturer's style or catalog numbers, specification

and drawing reference numbers, warranty information, and fabrication site information.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittal Procedures," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for HID lighting fixtures in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Installation Drawings shall be submitted for the high intensity lighting fixtures in accordance with the paragraph entitled, "Installation," of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Commercial Lighting Fixtures
Industrial Lighting Fixtures
Lamp Ballasts
Lamps
Lowering Devices
Lighting-Distribution Systems

SD-06 Test Reports

Test reports shall be submitted for Operational Tests on HID lighting fixtures in accordance with the paragraph entitled, "Field Testing," of this section.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

High-intensity-discharge (HID) lighting fixtures shall conform to UL 1572 and as indicated. Fixtures in hazardous areas shall conform to UL 844.

Lighting fixtures shall be furnished completely assembled with wiring and mounting devices and ready for installation at the locations indicated. Recessed fixtures in suspended ceilings shall be designed and equipped for installation in the type of ceiling in which the fixture is to be installed. Fixtures shall be designed to be supported independent of the ceiling. Fixtures shall be equipped with the lamps indicated.

2.2 COMMERCIAL LIGHTING FIXTURES

Commercial HID lighting fixtures shall be of the types and designs indicated, completely assembled, wired, and ready for connection to the building lighting-distribution system.

2.3 INDUSTRIAL LIGHTING FIXTURES

Fixture assembly shall include a nondetachable reflector, gaskets, porcelain lampholder, and cast-aluminum flange and capnut, with a threaded pipe fitting suitable for stem mounting. Reflector shall be seamless aluminum with beaded bottom edge completely covered by the finish. Porcelain lampholder shall be attached to the flange with mounting screws. Reflector shall be rigidly supported between the threaded lower flange and threaded capnut with gaskets to protect the reflector finish. A threaded, molded, porcelain-lampholder cover shall provide access to the lampholder wiring terminals. Lampholder screw shells shall be designed for the lamp indicated on the fixture.

2.4 LAMP BALLASTS

2.4.1 Multiple-Circuit Ballasts

Multiple-circuit ballast shall include a two-winding core-and-coil assembly with a saturated-iron regulating element and capacitors impregnated with an insulating material in accordance with ANSI C82.4, ANSI C82.5, and ANSI C82.9.

Ballast shall maintain correct lamp operation over a voltage-input range of plus or minus 13 percent of rated voltage. Capacitors shall provide a power-factor lamp load not less than 95 percent.

Ballasts shall be voltage rated for operation on 120-volt, single-phase, 60-hertz lighting-distribution systems, as indicated.

Ballasts shall be designed for a minimum lamp starting temperature of minus 29 degrees C and a maximum ambient temperature of 40 degrees C.

2.5 LAMPS

Lamps shall be certified to be automatically self-extinguishing and in conformance with 21 CFR 1040, Section 30, when HID lamps are used in a populated area.

HID lamps shall be metal halide conforming to ANSI C78.1376.

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be performed in accordance with NFPA 70.

HID fixtures shall be installed at each outlet indicated, and lamps of the proper type, voltage, and wattage shall be installed in each fixture.

New lamps shall be installed immediately prior to completion of the project. Lamps shall be installed with the light center at the focal point of the reflector and in the proper burning position.

High-bay fixtures shall be so installed that they clear obstructions such as crane rails, piping, and bracing that could impede operation of lowering devices.

Installation Drawings shall be submitted for the high intensity lighting fixtures. Drawings shall indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

3.2 FIELD TESTING

HID lighting fixtures and their accessories, including lowering devices, shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

Operational tests shall be performed in accordance with referenced standards in this section.

-- End of Section --

SECTION 16535

EMERGENCY LIGHTING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(1994) Code for Safety to Life from Fire in Buildings and Structures
NFPA 70	(2002) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 924	(1995; 8th Ed) UL Standard for Safety Emergency Lighting and Power Equipment

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Emergency Lighting Egress Units

SD-04 Drawings

Installation Drawings shall be submitted for the Emergency Lighting Systems indicating location of installed fixture.

SD-07 Schedules

Material, Equipment, and Fixture Lists shall be submitted showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Emergency lighting units shall conform to UL 924 and NFPA 101.

Emergency lighting units shall be furnished completely assembled with wiring and mounting devices and ready for installation at the locations indicated. Fixtures shall be equipped with lamps. Fixtures shall be Emergi-Lite Series JS, or approved equal.

2.2 EMERGENCY LIGHTING EGRESS UNITS

Emergency lighting units shall be complete self-contained units with batteries, battery charger, one or more local or remote lamp heads with lamps, under-voltage relay, indicator lights, and test switch, in accordance with UL 924 for Type I (emergency light set), Class I (rechargeable storage-battery-powered unit), Style D (nonrefillable lead calcium battery), as indicated. Fixture manufacturer shall maintain a policy to collect, recycle or dispose of spent batteries.

Batteries shall be rated not less than 6 volts.

Battery charger shall include a dry-type full-wave rectifier with two charging rates, one to automatically maintain the battery in a fully charged state under normal conditions and the other to automatically recharge the battery to a fully charged state within 12 hours after continuous discharge of 1-1/2 hours through the connected lampload.

Batteries shall have capacity and rating to supply the lamp load with maintained 87.5-percent power, minimum, for 1.5 hours. Batteries shall be maintenance-free lead calcium type. Minimum normal life shall be 8 years.

Unit enclosure shall be fabricated from sheet steel not less than 1.3 millimeter. Cover shall provide access to the battery and battery-charger compartments and shall be removable. Component parts within the enclosure shall be protected from dust, moisture, and oxidizing fumes from the battery. Interior and exterior surfaces of enclosure shall be coated with a baked-enamel finish.

Lampheads shall be mounted on the top or wall mounted, of the unit enclosure except where otherwise indicated and shall be fully adjustable in the horizontal and vertical planes. The lamphead assembly shall be polycarbonate construction.

Lamps shall be the high intensity incandescent type, rated not less than 9 watts at the specified dc voltage.

An amber "ready-for-use on alternating current" indicating light, a red "recharging on alternating current" indicating light, and a momentary-contact pushbutton test switch shall be mounted on the cover of the unit enclosure. The amber indicating light shall indicate, when illuminated, that the unit is electrically connected to the normal ac

supply source and that the battery is fully charged. The red indicating light shall indicate, when illuminated, that the battery is being recharged. The momentary-contact pushbutton test switch shall transfer unit from normal supply to battery supply and shall test operation of equipment under simulated ac source power failure.

The under-voltage relay shall be the self-clearing type and shall automatically connect the lampload to the battery supply upon failure of the alternating current supply. The relay shall energize when the ac supply falls to 80-85 percent of normal voltage. The battery shall be electronically locked out until the unit is energized with ac power, to prevent battery discharge.

Emergency lighting units shall be suitable for operation on the ac supply circuit to which they are to be electrically connected.

PART 3 EXECUTION

3.1 INSTALLATION

Emergency lighting unit shall be permanently fixed in place and shall have wiring to each unit installed in accordance with NFPA 70. The branch circuit feeding the unit equipment shall be a dedicated night light circuit or the same branch circuit as that serving the normal lighting in the area and connected ahead of area switches. Emergency lamps that are remotely connected to the emergency lighting unit shall have circuit wiring kept independent of all other wiring and equipment and shall not enter the same conduit, cable, box, or cabinet with other wiring.

Mounting heights of emergency lighting units and remote lamps shall be a minimum of 2100 millimeter above the finished floor.

When remote lamps are used the size of circuit wiring shall be such that the voltage drop does not exceed 5%.

3.2 FIELD TESTING

Emergency lighting units shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

-- End of Section --

SECTION 16536

EXIT LIGHTING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(1994) Code for Safety to Life from Fire in Buildings and Structures

UNDERWRITERS LABORATORIES (UL)

UL 924	(1995; 8th Ed) UL Standard for Safety Emergency Lighting and Power Equipment

1.2 GENERAL REQUIREMENTS

Section 16003, "General Electrical Provisions," applies to work specified in this section.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Exit Lighting Units
Accessories

SD-04 Drawings

Installation Drawings shall be submitted for Exit Lighting Systems indicating location of the installed fixture.

SD-04 Drawings

Outline Drawings shall be submitted for Exit Lighting Systems indicating overall physical features, dimensions, ratings, service requirements, and weights of equipment.

SD-07 Schedules

Material, Equipment, and Fixture Lists shall be submitted for the following showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Exit Lighting Units
Accessories

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Emergency exit lighting fixtures shall conform to UL 924, NFPA 101, and as specified.

Exit lighting fixtures shall be furnished completely assembled with mounting devices and ready for installation at the locations indicated. Ceiling-mounted fixtures shall be designed to be supported independent of the ceiling. Fixtures shall be Isolite, Model 2040, or approved equal.

2.2 SELF LUMINOUS EXIT SIGNS

All units shall be internally illuminated non-electric (light source is independent of electrical power and is generated by the action of tritium gas on a phosphorescent material).

All self luminous signs shall be in accordance with UL 924, OSHA 1910, Section 37, Part (G), Subparts (6) and (7), and NFPA 101, Section 5-10.3.3. All signs shall be licensed by the United States Nuclear Regulatory Commission. Integrity and performance shall be guaranteed for 20 years of normal use. Fixture manufacturer shall maintain an active program to collect, recycle or dispose of spent fixtures.

2.2.1 Enclosure

The assembled tamperproof enclosure shall be of aluminum.

Each sign shall bear a permanently attached nameplate bearing the Manufacturer's Name and Address and Date of Manufacture (in addition to information required by listed authorities.

2.2.2 Face

Each face of the sign shall be a non-colored translucent panel covered by a green faceplate bearing the word "EXIT" in 150 by 20 millimeter letters and including a universal directional arrow which indicates the direction of the exit (left, right or both ways).

2.2.3 Illumination

Illumination of the sign shall be by means of sealed glass tubes, internally phosphor coated and filled with tritium gas. Tubes shall be

securely bonded to the enclosure and cushioned against mechanical shock. Approved self-luminuous signs that provide evenly illuminated letters shall have a minimum luminance of 0.06 footlamberts (0.21cd/sqM) as measured by a color corrected photometer.

2.2.4 Mounting Accessories

Each sign shall be supplied with tamperproof hardware for wall mounting. end mounting, or pendant mounting for single face or double face units.

PART 3 EXECUTION

3.1 INSTALLATION

Fixtures shall be connected to the main panel bus through overcurrent protection. Emergency lighting panel shall be used where available.

3.2 FIELD TESTING

Exit lighting shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

-- End of Section --

SECTION 16972

VARIABLE FREQUENCY DRIVE UNIT

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C62.32	(1987) Standard Test Specifications for Low-Voltage Air Gap Surge-Protective Devices (Excluding Valve and Expulsion Devices

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Equipment and Performance Data shall be submitted for Variable Frequency Drive Unit indicating use life, system functional flows, safety features, and other features such as electrical system protective device ratings.

SD-04 Drawings

Connection Diagrams shall be submitted indicating the relations and connections of the following items. The drawings shall indicate the general physical layout of all controls, and internal tubing and wiring details.

Motors
Control Panels

SD-07 Schedules

Material, Equipment and Fixture Lists shall be submitted for Variable Frequency Drive Unit including manufacturer's style or catalog numbers, specification and drawling reference numbers, warranty information, and fabrication site information.

SD-08 Statements

Listing of Product Installation shall be submitted for Variable

Frequency Drive Unit showing at least 5 installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. The list shall include purchaser, address of installation, service organization, and ate of installation.

SD-19 Operation and Maintenance Manuals

The Contractor shall submit 6 copies of Operations and Maintenance Manuals 30 days prior to testing the Variable Frequency Drive Unit. data shall be updated and resubmitted for the final approval no later than 30 days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. pages for vendor data and manuals shall have 3/8-inch holes and be bound in 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose-leaf binder. The binder shall lie flat with printed sheets that are easy to read. Caution and warning indications shall be clearly labeled.

The Contractor shall provide classroom and field instructions in operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor, using the manufacturer's factory trained personnel or qualified representative. The Contracting Officer shall be given seven days written notice of scheduled instructional services. Instructional materials belonging to the manufacturer or vendor; e.g., lists, static exhibits, visual aids, shall be made available to the Contracting Officer.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVE UNIT

The VFD Unit is to consist of: Variable Frequency drive, electronic transducer, and microprocessor style single loop programmable static pressure controller.

Variable frequency drive shall be variable torque, solid state, pulse width modulation, modular design for use with AC motors.

All VFD components shall be factory mounted and wired in a NEMA 250 gasketed lockable enclosure.

VFD is to be CSA, UL or ETL listed. Control circuitry shall be electrically isolated from power circuitry.

Power Input: 460V, 3 phase, 60 Hz., 10% voltage, 2% frequency).

Power Output: 460V, 3 phase, 10 to 60 Hz.

Acceleration and deceleration to be linear and independently adjustable from 2 to 120 seconds.

Output Current Limit: 125% of rated continuous and 150% of rated for one minute. Full load output shall not be less than the grater of that listed for the motor equivalent horsepower in NEC table 430-150, or actual motor nameplate data.

Output Voltage: Proportional to frequency with low speed boost.

Power loss ride-through: 3 cycles.

Minimum Efficiency: 95% at 100% speed, 90% at 60% speed.

The load side of each VFD whether in automatic mode or in a bypass mode is to include thermal overload devices.

VFD speed control circuit is to accept a 4-20 mA DC isolated ungrounded transmitter signal from the EMCS slave panel controller in the automatic mode and from a manual speed potentiometer in the manual mode. Provide adjustable set points on the control circuit for offset (minimum frequency input), job speed, acceleration, deceleration, and stability including volts, hertz ratio and boost voltage for minimum hertz operations.

The VFD is to include manual transfer to a backup full voltage, non-reversing starter, within the VFD enclosure.

Maximum restart with adjustable time delay after unit shutdown for either VFD of bypass line.

Auxiliary contact for remote indication of VFD fault condition.

Additional set of contacts on the VFD unit in both the bypass mode or regular mode for interlocks.

2.1.1 Electronic Protection Circuits

Power circuits shall be protected by electronic protection circuits which shall provide an orderly shutdown without blowing fuses and prevent component loss under the following abnormal condition:

Instantaneous overcurrent (150%) and overvoltage trip of output.

Power line overvoltage (+10%) and undervoltage (-10%) protection.

Phase sequence detection on insensitivity incoming power phase sequence.

Single and three phase short circuit protection.

Control circuit malfunction.

Over temperature protection.

Output current limit (125% of rated current).

Also provide the following protection features:

Input transient protection up to 600 volts as per ANSI C62.32.

DC bus and control circuit transformer fusing.

Ground control chassis.

Fault reset push button.

Diagnostic indicator Led's for external fault, loss of phase, line frequency out of tolerance, over/under voltage, timed overcurrent trip, DC bus charged, fault detection relay, and high DC bus voltage.

Provide a list of recommended spare parts with pricing.

2.1.2 VFD Operating/Monitoring Devices on Front Panel

VFD Operating and Monitoring Devices on Front Panel:

Circuit breaker with door interlocked handle and padlock provision.

Operating mode selector switch marked "bypass-off-inverter."

Local/Off/Auto Reference switch.

Power on light.

Inverter fault light.

Speed indicating meter (0-100%) calibrated in percent of motor speed.

Bypass on light.

Inverter enable light.

Overcurrent light.

Over frequency light.

Overvoltage light.

Over temperature light.

Phase loss light.

Run light.

2.1.3 Electronic Transducer

Transducers to be used on the systems are to have a pressure range of 0" to

2" WC.

Transducers to be suitable for an indoor industrial HVAC application environment.

Transducer output signals are to be linear 4 to 20 mA. The 4 mA is to correspond to the 0" WC pressure witht 20 mA corresponding to the 2" WC on the exhaust systems.

Units are to be compatible for use with the programmable controllers and shall be manufactured by Triad or owner approved equivalent.

2.1.4 Programmable Static Pressure Controller

Input signal to be 4 to 20 mA signal from the electronic transducer.

Output signal to be 4 to 20 mA DC signal to the VFD unit.

Units are to compatible for use with the VFD's and the transducers.

Controllers to be microprocessor based.

Controllers to have proportional-integral-derivative capability.

Controllers to display process and setpoint signals simultaneously.

Controllers are to be suitable for an indoor industrial HVAC application environment at [illegible] C to 4[illegible] C space temperature.

A NEMA 250 enclosure of sufficient size to allow for easy access and maintenance is to be furnished for each controller.

Controller is to retain process setpoint and control data in memory for a minimum of two week period during power off condition whether shutdown or power failure.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated, as specified, and in accordance with manufacturer's recommendations.

-- End of Section --