TSRC – 8

MSFC TECHNICAL SPECIFICATIONS FOR REPAIRS AND CONSTRUCTION

September 2008

These specifications shall apply to each minor construction contract administered by the MSFC Facilities Office except as modified by drawings for a particular job. Some materials and corresponding execution specified herein may not be included in every project. In case of a conflict between the requirements of these specifications and the drawings, the requirements of the drawings shall govern.

TSRC is a generic, for information only type document. The TSRC becomes a controlled engineering document when applied to a specific project or work order by a direct reference in an MSFC contract document.

In the process of updating the TSRC specifications from version TSRC-7 to TSRC-8 a number of changes and additions have been incorporated. The intent of this document is to smooth the transition to the new TSRC-8 by providing descriptions of major changes to regular users of the specifications. It is not intended to be a comprehensive list of all changes, and each user should take the time to become familiar with the new specs.

Note TSRC-8 has been revised to reflect the new Construction Specification Institute's 2004 Master Format which consists of a total of 49 divisions. At the end of TSRC-8, a cross-reference table from the previous 17 division format to the new 49 division format is provided.

Section 01 10 00 – General Requiremets (Formerly Section 01011 – General Conditions)

Changes to this section include:

- Deleted paragraphs 1.16, " Unexploded Ordnance Precautions", and 1.17, Chemical Warfare material Precaution." These paragraphs were moved to **Section 01 35 23 – Safety Requirements.**
- Deleted Personnel Training Requirements Matrix and moved it to **Section 01 35 23 – Safety Requirements.**

Division 01 35 23 – Safety Requirements (Formerly Section 01061 – General Safety Requirements)

Changes to this section include:

- Added paragraphs 1.29, " Unexploded Ordnance Precautions", and 1.30, Chemical Warfare Material Precaution." These paragraphs were relocated from **Section 01 10 00 – General Requirements.**
- Relocated Personnel Training Requirements Matrix from **Section 01 10 00 – General Requirements.**
- Revised paragraph 1.03.e to update Safety Plan requirements.

Section 01 35 43 – Environmental Procedures (Formerly Section 01350 Environmental Compliance):

Changes to this section include:

- Several minor changes to reflect contractor training requirements.
- Paragraph 3.05.B is revised to remove contractor from direct process of completing and providing to AS10 the Material and Waste Certification forms

since this activity has been historically accomplished by the CMI contractor on behalf of the construction contractor.

- Added a close-out submittal, "Asbestos Management Information System (AMIS) Update Form, " to identify areas of facility where asbestos containing materials have been removed.

Section 02 83 00 – Lead Remediation

- Revised and added requirements for submittal of Lead Compliance and Lead Waste Management Plans.
- Revised paragraphs 3. 17, "Clean-Up" and 3.18, "Disposal."

Section 09 30 13 – Ceramic Tiling

- Combined former sections on ceramic tile wall and floor finishes into a single section.

Section 10 14 00 – Signage

- Wording/Titles of various signs have changed. Please note the table in paragraph 2.03 where examples of respective signs are provided.

Section 13120 – Pre-Engineered Retrofit Roof System:

- Added Paragraph 2.11, "SHOP DRAWINGS."
  Submit shop drawings which accurately depict the final "as-built" conditions to the COTR for approval. These shop drawings shall be submitted in both electronic and paper (hard copy) formats, in accordance with the requirements listed in Section 1330, "Submittals".

Section 21 05 00 – Common Work Results for Fire Suppression:

- Revised and new section to capture work previously common to all mechanical systems (formerly Section 15050).

Section 22 05 00 – Common Work Results for Plumbing:

- Revised and new section to capture work previously common to all mechanical systems (formerly Section 15050).

Section 22 40 00 – Plumbing Fixtures and Equipment:

- This section was revised to add new water saving/economizer requirements and acceptable fixtures.

Section 23 05 00 – Common Work Results for HVAC:

- Revised and new section to capture work previously common to all mechanical systems (formerly Section 15050).

Section 23 05 33 – Electrical Heat Tracing of HVAC Piping:

- New section in this revision of TSRC.

Section 23 09 23 – Direct Digital Controls / Utility Control System

- Major revision to ensure hardware compatibility with current Microscan system.

Section 26 29 23 – Variable Frequency Motor Controllers:

- New section to this revision of TSRC.

MSFC TECHNICAL SPECIFICATIONS FOR REPAIRS
AND CONSTRUCTION (TSRC-8)

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SECTION 01 10 00

GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 EXTENT OF WORK

A. The work to be performed under each delivery order / FWR consists of furnishing all plant, materials, equipment, supplies, labor and transportation, including fuel, power, water (except materials, equipment, utility or service, if any, specified herein to be furnished by the Government), and performing all work in strict accordance with the Contract Documents, and including such detail drawings as may be furnished by the Contracting Officer from time to time during the prosecution of the work in explanation of contract requirements.

1.02 CONTRACT DOCUMENTS

A. In addition to the Agreement between the Government and the Contractor, the Contract Documents consist of the conditions of the contract (these General Conditions), drawings, specifications, Schedule of Submittals, addenda issued prior to the execution of the delivery order / FWR, and modifications issued after the execution of the delivery order / FWR.

1.03 EXECUTION, CORRELATION AND INTENT

A. Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become familiar with local conditions under which the Work is to be performed and correlated personal observations with requirements of the Contract Documents.

B. The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all.

C. Organization of the Specifications into divisions, sections and articles and arrangement of Drawings shall not control the Contractor in dividing the work among Subcontractors or in establishing the extent of work to be performed by any trade.

1.04 APPLICABLE SPECIFICATIONS

A. These specifications shall apply to each delivery order / FWR administered by the MSFC Facilities Office except as modified by the drawings for a particular delivery order / FWR. Some materials and corresponding execution specified herein may not be included in every delivery order / FWR. In case of a conflict between the requirements of these specifications and the drawings, the requirements of the drawings shall govern.

B. The provisions of specification sections in Division 1 (those beginning with the number 01 XX XX) shall apply to and form a part of each section of the specifications.

1.05 ORDER OF PRECEDENCE

A. As a minimum standard, all work shall comply with codes and ordinances in effect at the site of the work on the date of the contract. The Contractor shall comply with requirements of the contract documents which are in excess of these codes and ordinances.

B. Products shall be installed in accordance with manufacturer's recommendations, as a minimum standard. The Contractor shall comply with requirements of the contract documents which are in excess of the manufacturer's recommendations.

1.06 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Maintain in good order at the jobsite, one copy of all applicable drawings, specifications, other contract documents and approved shop drawings. Provide these documents for review by the Government Inspector, A/E, COTR, and other Government authorities.

B. Maintain at the jobsite a notebook in neatly indexed form containing approved submittal data. Data shall be available for use during the construction period.

C. As work progresses, maintain a complete set of blue-line or black-line prints of the contract drawings and record work completed and changes from contract requirements. At the completion of work submit to the Government for approval one marked print showing an accurate record of as-built conditions.

D. At the completion of all FWR maintenance or construction projects (that did not have design drawings), the Contractor shall furnish to the Government for approval, redline drawings showing the as-built condition of all changes made to the configuration of the facilities at MSFC.

1.07 WORKSITE MAINTENANCE

A. Maintain the worksite in a safe and clean condition at all times.

B. Maintain weather-tightness of occupied structures during renovations and modifications.

C. Do not remove or penetrate any portion of the building that cannot be replaced with the specified modification by the end of the work day or protected by other acceptable measures in the event of rain or other inclement weather that might occur. The connection of the installed specified system to an existing system shall be made watertight at the end of each work day or at the onset of inclement weather that may occur during the construction period.

D. Before the commencement of work on the project, submit for review by the COTR, the contractor's plan for maintaining water-tightness throughout the entire period of performance. Include details for temporary connection of new work to existing. The Contractor will be held responsible for keeping moisture out of the building interior at all times during the period of the contract.

E. In the event that there is water penetration, take immediate action to provide all materials, equipment, and labor to capture the moisture, dispose of the moisture, and protect all contents of the building. Work will be allowed to resume once the Contractor has prepared an adequate plan of preventative measures to ensure watertight conditions throughout the remainder of the contract.

F. Make repairs to stop water penetration at once. The Contracting Officer reserves the right to stop work if he feels that the Contractor is not responsibly executing the work and is allowing any water penetration of the building.

1.08 REFERENCED AUTHORITIES

Where articles, materials and equipment are required to conform to standard specifications or tests of the Government or other authorities incorporated by reference, they shall conform to the respective editions, including amendments, in effect on the date of the Invitation for Bids.

1.09 PROTECTION OF MATERIAL AND WORK

The Contractor shall at all times protect and preserve all materials, supplies, and equipment of every description (including property which may be Government-furnished or owned) and all work performed. All reasonable requests of the Contracting Officer to enclose or especially protect such property shall be complied with. If, as determined by the Contracting Officer, material, equipment, supplies and work performed are not adequately protected by the Contractor such property may be protected by the Government and the cost thereof may be charged to the Contractor or deducted from any payments due him.

1.10 DISCREPANCIES AND INTERPRETATIONS

The Contractor shall check all drawings and specifications for construction interferences, detail mis-descriptions, dimensional errors, and other conflicts, and shall promptly notify the Contracting Officer of any discrepancies. The Contracting Officer will make a written interpretation.

1.11 WATER

All reasonably required amounts of water will be available to the Contractor by the Government from such existing water systems, outlets, and supplies, without cost to the Contractor for the water he consumes. The Contractor shall be responsible for approved disposal of waste water. The Contractor shall install and maintain at his own expense any necessary supply connections and facilities as may be approved by the Contracting Officer. All water shall be carefully conserved. Before final acceptance, temporary connections and piping installed by the Contractor shall be removed.

1.12 ELECTRICITY

All reasonably required amounts of electric power will be made available to the Contractor by the Government from Government-owned or operated electrical systems and supplied without cost to the Contractor. The Contractor shall install and maintain at his own expense any necessary supply connections and facilities as may be authorized by the Contracting Officer. All electricity shall be carefully conserved. Before final acceptance, temporary connections and facilities installed by the Contractor shall be removed.

1.13 INTERRUPTION OF UTILITIES

A. Schedule of Interruptions: Interruption to utility services, including but not necessarily limited to water, sanitary sewer, steam, electricity, communications, air, high-pressure systems, heating, and air conditioning systems, shall occur at such times as permitted by the Contracting Officer (COTR), so that interruption of such services will not adversely affect Center operations.

B. Generally, such outages to utility services shall be scheduled in advance and performed by the Contractor on Saturdays, Sundays, or other non-work days or periods, at no additional cost to the Government. The existing steam distribution system shall not be altered nor service to existing buildings be interrupted without prior written approval of the COTR. Such interruption to the steam distribution system shall be accomplished in the summer season, except as approved by the COTR. All interruptions shall be held to the minimum practicable duration necessary for construction modifications.

C. Each required interruption anticipated by the Contractor shall be indicated on the Project Schedule, submitted to the COTR for approval, to verify the workability of the schedule; lack of such indication or an outage date variance from the approved Project Schedule may result in unplanned construction delays, and expenses due to Contractor delays will be borne by the Contractor.

D. Notice of Interruptions: At least seven calendar days in advance of the actual need date, the Contractor shall submit for approval a written request to the Contracting Officer for each individual utility outage. (Exceptions: Interruption to high-pressure systems requires a request to the COTR be made at least 30 days prior to the outage beginning. Also, utility outages for mission essential facilities, i. e., Buildings 4207, 4436, 4629, and 4663 shall be identified and scheduled through the COTR at the pre-construction meeting.) The requested interruption start/stop date(s) shall be clearly established, and once approved, deviation from the outage schedule shall not occur except as approved by the COTR.

1.14 IDENTIFICATION AND ENTRY

The Contractor will be required to conform to identification and entry procedures as directed by the Contracting Officer.

1.15 TOILETS

Pit toilets will not be allowed.

1.16 COOPERATION WITH OTHERS

During the life of this contract it is anticipated that other contractors will be performing operation in the general area where work under this contract is being performed. The Contractor shall cooperate in all respects wherever necessary for the better prosecution of the work. As far as practicable, all persons working in the vicinity shall have equal rights to the use of all transportation facilities and grounds within the limitations specified in Standard Form 1442, Section I, Provision Clause No. 52.236-10. The Contractor shall so arrange his operations as to not interfere with work in progress. In case of dispute or disagreement regarding use of transportation and storage facilities and rights of access, the decision of the Contracting Officer will govern.

1.17 PERMITS

Prior to any excavation, demolition, or burning operations, the Contractor shall obtain a permit from the Contracting Officer authorizing and approving the Contractor’s methods of operation. Allow five working days for processing of each permit requested.

1.18 SPECIAL CONSIDERATIONS FOR SPECIAL HOURS OF WORK

During the period of performance for this contract, the Contractor may be prohibited from working in the area approximately two days per week during hazardous testing operations. The Contracting Officer will notify the Contractor 48 hours in advance of any testing scheduled which would prevent access to the project work site so the Contractor may schedule other work for that period. The Contractor will not receive additional compensation for time lost due to testing at a given facility.

1.19 CREDIT CARD CONSTRUCTION

When work has been ordered using Government Credit Card, the Contractor shall not submit the Credit Card Number to the bank until notified by the NASA Project Manager or the COTR.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION

SECTION 01 33 00

SUBMITTALS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

Submittal Procedures

Drawing Submittals

Data Submittals

Samples

Manufacturer's Instructions

Manufacturer's Certificates

Submittal Descriptions

1.02 SCHEDULE OF SUBMITTALS

A. Submittal descriptions (SD's) listed in this section give general requirements for each type of submittal. Further specific requirements may be specified in the pertinent technical specification section.

B. When applicable, a Schedule of Submittals will be furnished to each Contractor prior to the bid date. The Schedule of Submittals, provided as a compilation of required job submittals, is furnished to assist the Contractor and others in defining documentation requirements for quality assurance. However, additional submittals for a given job may be required by the contract drawings and/or specifications. Unless waived in writing by the COTR, all submittals required by the Contract Documents shall be supplied. The Schedule of Submittals is a supplement to the Project Manual and is a Contract Document.

C. The following shall be submitted on all jobs whether listed on the Schedule of Submittals or not:

1. Redline drawings in accordance with Section 01 45 00.

2. O & M manuals for mechanical and electrical equipment in accordance with the applicable technical sections of this Specification, to include Model #, Serial #, and date installed.

3. Items listed in Section 02 83 00, “Lead Remediation.”

4. Items listed in Section 22 15 13.01-3.03, “Cleaning for Compressed Air and Gas Piping Systems.”

5. EPA guideline items containing recyled materials in accordance with Section 01 35 43, “Environmental Procedures.”

6. Warranties.

D. Upon completion of all work involving the demolition and/or construction of walls, doors, windows, etc. as described on the architectural floor plan drawings, the contractor shall submit a preliminary red-line floor plan drawing reflecting dimensioned “as-built” conditions. These preliminary red-line drawings will be used to revise master floor plans and update emergency evacuation plans prior to project completion. These preliminary red-line floor plan drawings are in addition to a complete set of contract red-line drawings as required in 1.02.C above.

1.03 SUBMITTAL PROCEDURES

A. Transmit each submittal with forms approved by the Contracting Officer’s Technical Representative (COTR).

B. Sequentially number the transmittal forms. Resubmittals shall have original number with an alphabetical suffix.

C. Identify project, Contractor, lower tier contractors or supplier, and specification number as appropriate.

D. Apply contractor's stamp, signed or initialed, certifying that review, verification of products required, field dimensions, adjacent construction work, and coordination of information, is in accordance with the requirements of the work and contract documents. Identify specific variations from contract requirements in the transmittal letter. Failure to point out deviations may result in the Government requiring rejection and removal of work at no additional cost to the Government.

E. Schedule submittals to expedite the project. No work shall be begun until all submittals for that work (such as submittals for materials, data, schedules, instructions, procedures, drawings, Material Safety Data Sheets, etc.) are either APPROVED (APR) or APPROVED AS NOTED, RESUBMITTAL NOT REQUIRED (AAN).

F. Identify variations from contract documents and product or system limitations which may be detrimental to successful performance of completed work.

G. Provide space for architect/engineer review stamp.

H. Revise and resubmit submittals as required. Identify changes made since previous submittal.

I. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

J. The cost of any redesign caused by a substitution shall be borne by the Contractor.

1.04 CONTRACTING OFFICER'S REVIEW

A. The Contracting Officer will review submittals and provide pertinent notation within ten working days after date of receipt.

B. Notations will be as follows:

1. Submittals marked <u>approved (APR)</u> authorize the contractor to proceed with the work covered.

2. Submittals marked <u>approved as noted (AAN), resubmittal not required</u> authorize the Contractor to proceed with the work covered, provided no exception is taken to the correction noted. If the Contractor takes exception to the corrections noted, or is unable to proceed according to the notations, resubmittals shall be required with full explanation.

3. Submittals marked <u>approved except as noted (AEN), resubmittal required</u> require the contractor to re-submit with appropriate changes and receive approval before proceeding with the work covered.

4. Submittals marked <u>rejected (REJ)</u> indicate noncompliance with the contract requirements. The Contractor shall resubmit with appropriate changes and receive approval before proceeding with the work covered.

C. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract requirements, notice shall be given to the Contracting Officer. Resolution shall be received before proceeding with the work covered. Failure to give notice, or proceeding without a resolution, constitutes acceptance of the correction or notation with no change in the contract.

1.05 DRAWING SUBMITTALS

A. Submit in the form of one reproducible transparency and four opaque reproductions. Transparency with review comments will be returned to the Contractor. EXCEPTION: SEE ITEM C.

B. After receipt, reproduce and distribute in accordance with Submittal Procedures above.

C. Where noted in technical spec sections, submit drawings in electronic file format on CD-ROM. .

1.06 DATA SUBMITTALS

A. Submit seven copies of all submittals.

B. Mark to identify products, models, options, and other data. Methods of marking shall be reproducible by coping machine (no hi-liter). Supplement manufacturer's standard data to provide information unique to this project.

C. Four copies will be returned to the Contractor with review comments.

D. After receipt, distribute in accordance with Submittal Procedures above.

1.07 SAMPLES

A. Submit samples to illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

B. Submit samples of colors and finishes from full range of manufacturer's standard colors, textures, and patterns for selection. Submit samples of all products and materials for color selection at the same time to facilitate selection of compatible colors. Colors will not be selected until all samples have been received.

C. Include identification of each sample with full project information.

D. Submit the number of samples specified in the individual specification sections, one of which will be retained. Reviewed samples which may be used in the work are identified in individual specification sections.

1.08 PROGRESS SCHEDULES

A. PROJECT CONSTRUCTION SCHEDULE

A project construction schedule is generally required for only those delivery orders / FWRs for which the Contractor seeks progress payments. However, the Contracting Officer reserves the right to require a construction progress schedule for any delivery order / FWR.

Unless otherwised specified on the construction drawings, a construction schedule bar chart shall be submitted in sufficient detail to facilitate the Contractor's control of the job and to allow the Contracting Officer to readily follow progress for all major portions of the work. As a minimum, the bar chart will graphically depict a running total of the percent completion based on completed activity costs versus total contract cost, and a system for indicating scheduled versus actual activity dates.

The Contractor shall submit the initial progress schedule within 21 days of notice to proceed. The schedule shall be updated and resubmitted monthly beginning 7 days after return of the approved initial schedule. Updating shall entail complete revision of the graphic and data displays incorporating changes in scheduled dates and performance periods. Redlined updates will only be acceptable for use as weekly status reviews.

The Contractor shall provide a single point contact from his on-site organization as his Schedule Specialist. The Schedule Specialist shall have the responsibility of updating and coordinating the schedule with actual job conditions. The Schedule Specialist shall participate in weekly status meetings and present current information on the status of purchase orders, shop drawings, off-site fabrication, material deliveries, Subcontractor activities, anticipated needs for Government furnished equipment, and any problem which may impact the contract performance period.

B. PROJECT NETWORK ANALYSIS

When a detailed project network analysis is required by the contract drawings, it shall include:

a. The graphic display shall be a standard network or arrow diagram capable of illustrating the required data. Drafting shall be computer generated on standard 24 by 36 inch (nominal size) drafting sheets or on small (11 by 17 inch minimum) sheets with separate overview and detail breakouts. Any graphic display

system used shall be readily legible with a clear, consistent method for continuations and detail referencing. The critical path shall be clearly delineated on the display. When milestone dates are included in the Contract they shall be clearly indicated on the display.

b. Data shall be presented as a separate printout on paper or, where feasible, may be printed on the same sheet as the graphic display. Data shall be organized in a logical coherent display capable of periodic updating.

c. Data shall include narrative activity descriptions with a numerical ordering system cross referenced to the graphic display. Additionally, costs (broken down into separate materials and labor costs), duration, early start date, early finish date, late start date, late finish date, and float shall be detailed for each activity. A running total of the percent completion based on completed activity costs versus total contract cost shall be indicated. A system for indicating scheduled versus actual activity dates and duration shall be provided.

d. The schedule shall be of sufficient detail to facilitate the Contractor's control of the job and to allow the Contracting Officer to readily follow progress for portions of the work.

1.09 STATUS REPORT ON MATERIALS ORDER

On delivery orders/FWRs requiring a network analysis schedule, within 10 working days after receipt of the delivery order/FWR 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 at weekly project meetings, or as directed by the Contracting Officer as the status on material orders changes.

The report shall list, in chronological order by need date, materials orders necessary for completion of Delivery Order/FWRs. The following information will be required for each material order listed.

a. Delivery order/FWR numbers.

b. Material name, supplier, and invoice number.

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

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

e. Current delivery date agreed on by supplier.

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

g. 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.

1.10 MANUFACTURER'S CERTIFICATES

A. When noted on the Schedule of Submittals, submit manufacturer's certificates in quantities specified for product data submittals.

B. Indicate that material or product conforms to, or exceeds, specified requirements. Submit supporting reference data, affidavits, and certificates as appropriate.

C. Certificates may be recent or previous test results on material or product, but must be acceptable to the Contracting Officer.

1.11 OPERATION AND MAINTENANCE MANUALS

Submit six copies of the manufacturer's O & M manuals. In addition to hard copies of each manual, provide CD ROM of operation and maintenance data using .*PDF format from Adobe Acrobat Author. CD ROM shall contain Acrobat Reader. Operations and maintenance data to be indexed by the use of tagged bookmarks. (Note that “AcroBld” program, available from NASA, will provide an automatic indexing capability for Adobe files prior to version 7 format).

1.12 SUBMITTAL DESCRIPTIONS (SD's)

A. Submittals 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.

B. The following are explanations of the submittal descriptions which may be required by the Schedule of Submittals on each contract or on each delivery order for IDIQ contracts.

SD-01 Preconstruction Submittals

Submittals which are required prior to a notice to proceed on a new contract such as Contractor’s Safety, Health and Environmental (SHE) Plan and QA/QC plan. If noted on the drawings, a project specific QA/QC plan shall be submitted

Submittals required prior to the start of the next major phase of the construction on a mulit-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.

Submittals describing proposed procedures to be used in upcoming construction phases.

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

A. 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.

B. Equipment Nameplate Data Sheet: See applicable sections in Divisions 22 and 23.

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-05Design 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 finding of his product during field inspections, attesting that the products are installed in accordance with the manufacturer’s installation instructions, shop drawings, or the 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.

Written reports documenting results of tests performed by manufacturer, Contractor, or independent agency.

Radiographic Films used to evaluate the quality of welds.

SD-07Certificates

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.

SD-08Manufacturer’s Instructions

Preprinted material describing installation of a product, system, or material, including special notices and material safety data sheets, if any concerning impedances, hazards, and safety precautions.

SD-09Reports

Reports of inspections and laboratory tests, including analysis and Interpretation of test results. Each report shall be properly identified. Tests methods used and compliance with recognized test standards shall bedescribed.

SD-10Operation and Maintence Data

Information bound in manual format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, printed instructions, and safety precautions.

Information included in O & M manuals shall include general operating procedures, preventative maintenance and inspection recommendations, special tools and test equipment required, troubleshooting and repair instructions, and spare parts listings.

SD-11 Closeout Submittals

Special requirements necessary to properly close out a construction contract. For example, red-lined drawings, warranties, manufacturer's help and product lines necessary to maintain and install equipment. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

All red-lined drawings shall be submitted on the same size sheet. Red-lined drawings shall consist of one copy of each drawing at a minimum sheet size of 11" x 17", unless another size sheet is required by the contract drawings. Red-lined drawings shall be clearly legible. Should the submitted red-line drawings be rejected due to illegibility, the COTR reserves the right to require resubmittal of a full size red-line drawing set. Red-lined drawings shall be clearly marked to indicated all deletions and additions and to reference all attachments. Attachments shall include RFI's, DCR's, revised details, revised schedules, field sketches and other items reflecting a change to the content of the drawings. Attachments shall be attached only to each relevant drawing; provide multiple copies of attachments if relevant to multiple drawings. Do not attach items without content relevant to drawing revisions; i.e. letters of transmittals for RFI's, DCR's, etc. Submitted red-lined drawings shall include all relevant information required for revision of original design drawings to accurately reflect final as-built conditions without additional field research.

When required by respective technical section of these specifications, and at completion of installation, the Contractor shall submit shop drawings to the COTR which accurately depict the final "as-built" conditions. These drawings will be incorporated into the record facility drawing files. The "as-built" shop drawings shall be submitted in both electronic and paper (hard copy) formats and shall comply with the format requirements described below.

1. Electronic files shall be submitted in PDF file format. Drawings prepared using Computer Aided Design (CAD) software are acceptable substitutes and shall be delivered in dxf, dwg or dgn format only. All Computer Aided Design (CAD) files shall be self-contained and stand-alone. All cross-referenced or reference files shall be electronically merged into the contract drawing such that each drawing file shall be a completely stand-alone document. All levels and/or layers shall be turned on.

All electronic files of drawings shall be delivered on a CD-ROM. All media shall be formatted so that it is compatible with Microsoft Windows 98 (or above) operating system

SD-12Welding Procedures Specifications (WPS)

Detailed specification of a welding procedure including joint design, base metals, filler metals, shielding, positions, electrical characteristics, welding techniques, preheat, and postweld heat treatment. Submit specification for each procedure on a form similar to AWS D1.1, Form E-1 (front).

SD-13Welding Procedures Qualification Record (PQR)

Results of independent laboratory testing of specimens welded per approved procedures. Results shall include tensile test, guided bend tests, visual inspection, radiographic-ultrasonic examinations, and fillet weld tests (if applicable). Information shall be tabulated on a form similar to AWS D1.1, Form E-1 (back), and shall include the welder's name and stamp number, the name of the testing agency, and the signature of the evaluator.

SD-14Welder's Qualification Reports

Submit evidence, satisfactory to the Contracting Officer, that each welder employed in the work has been certified for the types and positions of welds used in the work. Welders shall carry on their person a certification card and present it to the Contracting Officer or Government Inspector if so requested. Unless otherwise noted, evidence shall consist of a Welder and Welding Operator Qualification Test Record Similar to AWS D1.1, Form E-4. The form shall identify the welder, welding procedure used, welding process, position, base and filler metals, plus test results described in SD- 13.

END OF SECTION

SECTION 01 35 23

GENERAL SAFETY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

The publications listed below form a part of this contract as required by law or as referenced:

A. CODE OF FEDERAL REGULATIONS (CFR)

29 CFR Part 1910	Occupational Safety and Health Standards
29 CFR Part 1925	Safety and Health Standards for Federal Service Contracts
29 CFR Part 1926	Safety and Health Regulations for Construction
40 CFR Parts 1- 1068	Protection of Environment

B. NASA/MSFC PUBLICATIONS

NPR 8715.1	NASA Safety and Health Handbook
NPR 8715.3	NASA General Safety Program Requirements
NASA-STD-8719.11	Safety Standard for Fire Protection
MPR 1040.3	MSFC Emergency Plan
MPD 1800.1	MSFC Smoking Policy
MPR 1800.1	Bloodborne Pathogens
MPR 1800.2	MSFC Ergonomics Program

MPR 1810.1	MSFC Occupational Medicine
MPR 1840.1	MSFC Confined Space Entry Program
MPD 1840.1	MSFC Environmental Health Program
MPD 1840.2	MSFC Hearing Conservation Program
MPD 1840.3	MSFC Respiratory Protection Program
MPR 1840.2	MSFC Hazard Communication Program
MPR 1840.3	MSFC Hazardous Chemicals in Laboratories Protection Program
MPR 1840.4	MSFC Asbestos Program
MPR 1860.1	MSFC Radiation Safety Procedural Requirements
MPD 1860.1	Laser Safety
MPD 1860.2	Radiation Safety Program
MPD 8500.1	MSFC Environmental Management Policy
MPR 8500.1	MSFC Environmental Management Program
MPR 8500.2	MSFC Environmental Management System Manual
MPR 8823.2	Pressure System Safety and Certification
MWI 3410.1	Personnel Certification Program
MWI 8540.2	Affirmative Procurement Program for Environmentally Preferable Products
MWI 8550.1	Waste Management
MWI 8550.2	Storm Water Management
MWI 8550.3	Wastewater Compliance
MWI 8550.4	Air Emissions Compliance

MWI 8550.5	Chemical Management
MWI 8621.1	Mishap and Close Call Reporting and Investigation
MPR 8715.1	Marshall Safety, Health, and Environmental (SHE) Program
MWI 8715.1	Electrical Safety
MWI 8715.2	Lockout/Tagout Program
MWI 8715.3	Hazard Identification and Warning System
MWI 8715.4	Personal Protective Equipment (PPE) and Systems
MWI 8715.9	Occupational Safety Requirements for MSFC Contractors
MWI 8715.10	Explosives, Propellant, and Pyrotechnics Program
MWI 8715.11	Fire Safety Program
MWI 8715.12	Safety, Health & Environmental Finding Tracking System (SHEtrak)
MWI 8715.13	Safety Concerns Reporting System (SCRS)
MWI 8715.15	Operational Safety Assessment Program
MWI 8715.16	Supervisor Safety, Health and Environmental (SHE) Visits

C. Fire Protection

National Fire Protection Association (NFPA) codes

NFPA 241	Construction, Alteration, and Demolition Operations

1.03 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 "Submittals," in sufficient detail to shown full compliance with the contract documents.

A. Safety, Health and Environmental (SHE) Plan

Contractor shall submit a SHE Plan or a signed MSFC SHE Work Agreement for Construction to the Contracting Officer (CO) for approval prior to start of work. The SHE Plan shall describe the contractor's methods of planning, implementing, and controlling industrial safety, occupational health, and environmental requirements to assure compliance with the MSFC SHE program over the duration of the contract.

The SHE Plan, when required, shall include, as a minimum, the following: (Note: A contractor signed SHE Work Agreement for Construction provided by FMO or ISB can be used in lieu of the contractor's SHE plan when requested by the CO If the contractor performs work under multiple MSFC contracts, the CO can request the contractor to submit a SHE Plan specific to a job in addition to a signed SHE Work Agreement for Construction.)

a. SHE program objectives and describes the methods to attain these SHE objectives as described in section e.

b. Responsibility of key personnel for the Contractor.

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

d. List of applicable documents.

e. Describe the methods for compliance with 29 CFR 1910, "Occupational Safety and Health Standards", 29 CFR 1926, "Safety and Health Regulations for Construction" and the MPR 8715.1, "MSFC Safety, Health, and Environmental (SHE) Program". The MSFC SHE Program has five core program requirements, (CPRs) each of which shall be addressed in your company's SHE Plan.

1. Management leadership and employee involvement:

- A description of the contractor's policy and managements commitment to (1) provide a safe and healthful workplace for personnel (i.e., employees, customers, and public), (2) protect the property and the environment, and (3) assure

compliance with EPA, OSHA, NASA, MSFC MPR 8715.1 and all other MSFC SHE document requirements listed in paragraph 1.02B of this section that are applicable to this contracted effort.

- A description of the techniques implemented by the contractor to assure management and employees are (1) held accountable and fully understand their roles and responsibilities to perform their jobs/tasks in a safe and healthful manner while protecting the environment and (2) how these roles and responsibilities are flowed-down to all subcontractors, when applicable.

- A description of the actions taken or the disciplinary program implemented by the contractor when management or employees are discovered not performing their jobs/tasks in a safe and healthful manner or protecting the environment and how these actions are flowed-down to subcontractors, when applicable.

- A description of the contractor's safety, health, environmental awareness programs that includes documented weekly safety meetings and safety awareness training for employees.

- A description of how self evaluations of the contractor's safety, health and environmental program are performed and documented, and includes the frequency of these self evaluations.

- Provide the identification, by title, of the individual assigned by the contractor to be responsible for implementing the contractor's SHE program elements and will serve as the day-to-day SHE Point of Contact (POC) for this contracted effort.

- A description of how the SHE plan is maintained current with contract, NASA and MSFC requirements, and updated as necessary.

2. System and worksite analysis:

- A description of how the contractor assures potentially hazardous conditions are identified in the work area and operations (e.g., Hazardous Operations Checklist (HOC), hazard analysis, safety assessment, risk assessment and

employee identified concerns).

- A description of the interrelationship between the applicable MSFC documented programs listed in paragraph 1.02B of this section and the OSHA programs that require documented program applicable to this contracted effort (e.g., Respiratory Protection, Hazard Communication, Confined Space, and Lockout/Tagout).

- A description of how the contractor performs and documents weekly worksite safety inspections.

3. Hazard prevention and control:

- A description of how the contractor assures potentially hazardous conditions are controlled in the work area or in an operation. This can include the generation of plans, procedures, and other working documents that clearly identify the hazardous conditions and the necessary cautions taken to mitigate the hazards in accordance with MWI 8715.15. (**NOTE**: MSFC Industrial Safety Branch (ISB) concurrence is required for all onsite hazardous procedures and MSFC requires these procedures and plans to be reviewed annually.)

- A description of how the contractor assures (1) the procurement, storage, issuance, and use of hazardous chemical and materials is in accordance with MPR 8500.1 and (2) the recycling and disposal of any hazardous waste generated under this contracted effort is in accordance with MWI 8550.1 (**NOTE**: This can be described in paragraph 5. environmental compliance if CPR 5. is applicable.)

- A description of the contractor's emergency management program and provide a list of contractor emergency points of contact located onsite in accordance with MPR 1040.3. (**NOTE**: Onsite contractors may use MPR 1040.3 as their emergency management program.)

- A description of how the contractor assures all mishaps and close calls are investigated to the extent necessary to determine root cause and the reporting requirements are in accordance with MWI 8621.1. (Reference DRD STD/SA-MSR, *Mishap and Safety Statistics Report*).

- A description of how the contractor provides safety, health,

and environmental services applicable to this contracted effort (e.g., hazardous waste disposal, industrial hygiene monitoring, emergency medical support, hearing conservation program, respiratory protection, and hazard communication). (**NOTE:** Provide a list of all services that are to be provided by MSFC for onsite work.)

- A description of how contractor employees are trained to and given the authority to suspend work where safety, health or environmental conditions warrant such action in accordance with MPR 8715.1.

4. Safety, health and environmental training:

- A description of how each contractor employee is (1) trained to recognize hazards, (2) avoid accidents, (3) know the hazards specific to their job, and (4) fully understands the contractor's disciplinary program in accordance with 29 CFR 1926.1, MPR 3410.1, and MPR 8715.1.

- A description of how contractor employee training needs are determined that are specific to the job the employee is expected to perform in accordance with applicable parts of 29 CFR 1910, 29 CFR 1926, and MPR 3410.1.

- A description of how the contractor provides and documents training for employees that are designated as (1) competent, or (2) qualified, or (3) authorized, or (4) certified to perform operations and/or inspections that require job specific training and/or knowledge and experience in accordance with applicable parts of 29 CFR 1910, 29 CFR 1926, and MPR 3410.1. **[NOTE**: This applies to job categories being performed onsite that do not require a MSFC Safety Certification per MWI 3410.1.]

- Provide a list of operations or job categories performed by the contractor that require a MSFC Safety Certification under this contracted effort in accordance with MWI 3410.1, "Personnel Certification Program." (**NOTE**: This is only applicable if the contractor will operate MSFC owned equipment or perform MSFC processes that require MSFC Safety Certification. If a MSFC Safety Certification is required, it shall be tracked in the MSFC Certification Database (CERTRAK).

- A description of how the contractor will provide evidence of

any required employee training (i.e. PPE, personal fall arrest systems, confined space entries, operate cranes/material handling equipment, welding and cutting) in accordance with the applicable parts of 29 CFR 1910, 29 CFR 1926, and MPR 3410.1 when requested by the Government.

5. Environmental compliance – A description of how the contractor assures compliance with environmental laws and regulations CFR Title 40 Parts 1-1068, Alabama Department of Environmental Management (ADEM), and MPR 8500.1 under this contracted effort by:

- Reporting hazardous and toxic substance use in accordance with MWI 8550.5.
- Implementing and reporting green procurements in accordance with MWI 8540.2.
- Reducing, reusing, and recycling of hazardous and toxic substances prior to disposal in accordance with MWI 8550.1.
- Minimizing storm-water pollution in accordance with MWI 8550.2.
- Ensuring equipment and processes permitted by applicable laws in accordance with MWI 8550.4.
- Disposing of solid and liquid materials as permitted by applicable laws in accordance with MWI 8550.1.

f. Describe the procedures for securing the accident site so that the area remains secure until arrival of security officer and/or a safety investigator. The accident site shall remain secured until released by the CO.

g. Describe the process to ensure Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations are protected against damage.

h. Control of Hazardous Energy, Lockout/Tagout System (29 CFR 1910.147, 29 CFR 1926.417, and MWI 8715.2). At MSFC **ONLY** locks with a red case and tags with red diagonal strips containing the word “lockout” are allowed to be used for lockout/tagout during construction, maintenance and servicing activities. All construction employees authorized to perform Lockout/Tagout activities at MSFC are required to attend and complete the MSFC

Lockout/Taout Awareness Training. Contact FMO or the MSFC ISB for more information. NOTE: Work on energized equipment shall only be allowed under special situations and shall be performed in accordance with MWI 8715.1.

i. Hazard Communication (29 CFR 1910.1200 and MPR 1840.2). During the Pre-Construction Conference, to be arranged by the FMO, ISB and/or the Environmental Engineering & Occupational Health (EEOH) Office may discuss common safety and health requirements at MSFC and distribute handouts addressing these requirements.

j. Fall Protection. If under this contracted effort the work will be performed on elevated surfaces, the contractor shall describe in detail the methods to ensure a proper fall protection system (guard rails, personal fall arrest system, or safety net) is provided in accordance with 29 CFR 1926.501 and 29 CFR1926.502. If a conventional fall protection system cannot be provided, a Site Specific Fall Protection Plan shall be provided in accordance with 29 CFR 1926.503(k) and MWI 8715.4.

B. Reports. In addition to documentation and reports required elsewhere in this section, the following reports shall also be submitted:

1. Monthly Report: The Contractor shall complete each month MSFC Form 4371, MSFC Contractor Accident and Safety Statistics, and submit to the CO by the 15th day of the month following the report month. The form shall be complete and accurate in every detail.

2. General: a) Safety meetings and training shall be documented and retained at the construction site. Safety meeting sign-in sheets and a general description of the items covered shall be submitted to the CO. b) All job hazard analyses (JHA's) and Hazardous Operations Checklists (HOC's) shall be in writing and communicated to all effected workers. c) All safety, health, and environmental related documents (plans, forms, reports, supervisor safety visits, inspections, correspondence, JHA's MSDS, logs, certifications, etc.) shall be retained in an orderly fashion at the construction site and readily available for review.

3. MSFC SHE 101 Construction Awareness training will be provided to the contractor by the ISB during the Pre-construction Conference. The contractor shall provide in this training within

the time limits specified to all contractor employees that will be working onsite in support of this contracted effort. It is recommended that this training be provided during a weekly safety meeting. A signed attendance sheet of employees attending this training shall be provided to the COTR as a record of this training being conducted.

1.04 GENERAL SAFETY PROVISIONS

A. 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.

B. During the performance of work under this Contract, the Contractor is responsible for control and safety of persons working on and visiting the project site. Contractor is responsible for ensuring his and his subcontractors' compliance with the safety requirements. Contractor shall advise the CO of any special safety restriction he has established so that Government personnel can be notified of these restrictions.

C. For any operation or task identified in 29 CFR 1910 or 29 CFR 1926 that references a "competent" person, the contractor shall identify that person(s) by name and he/she shall be on the project site during such operation.

1.05 LOCKOUT/TAGOUT FOR HAZARDOUS ENERGY

A. Contractor shall comply with the MSFC lockout/tagout program (MWI 8715.2), when working on MSFC, to control hazardous energy. Only employees that have been trained in the proper use of Lockout/tagout devices shall be authorized to place lockout/tagout devices. The employees shall attend the MSFC Lockout/Tagout Awareness Training.

B. Working on energized equipment at MSFC is **prohibited** and allowed only in special situations defined in MWI 8715.1. The work shall be performed by employees trained in accordance with the requirements in 29 CFR 1910.331 – 335 (Subpart S). In these special situations the contractor shall provide documentation of this training when requested by the ISB

1.06 ACCIDENT TREATMENT AND RECORDS

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

B. Contractor employees may utilize government dispensary facilities located in building 4249 for injury and emergency medical treatment. Contact occupational medicine services (telephone 256-544-2390).

C. Contractor shall report all mishaps in accordance with the procedures described in MWI 8621.1, “Mishap and Close call Reporting and Investigation Program.”

1.07 FIRE PREVENTION AND PROTECTION

A. Open-flame heating devices will not be permitted except by approval in writing from the ISB. 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.

B. Burn Permits are issued by the ISB and details for requesting burn permits will be provided by the ISB representative during the Pre-Construction Conference.

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

1.08 USE OF EXPLOSIVES

Explosives shall not be permitted on Government Property.

1.09 ELECTRICAL

Contractor shall appoint a competent employee familiar with the safety requirements in 29 CFR 1926. 400 – 449 (Subpart K) to be responsible for the electrical safety of the contracted effort and to restrict entry to dangerous locations to only those authorized by him and the FMO.

1.10 CONFINED SPACE ENTRY

A. Safety clearance from the EEOH and ISB is required before contractor personnel are allowed to enter a confined space at MSFC. Confined Space Entry shall be performed in accordance with MPR 1840.1 and 29 CFR 1910.146. Contractor shall contact the Government Inspector for support services at least 24 hours in advance.

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

C. 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 in accordance with 29 CFR 1910.146(g) &(i). 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.

D. 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 EEOH is required prior to entering confined space. Surveillance and monitoring shall be required in these types of work spaces by both Contractor and EEOH Office personnel.

1.11 RADIATION SAFETY REQUIREMENTS

A. The Contractor shall comply with 29 CFR1926.53, MPR 1860.1 and MPD 1860.2 for use of all radioactive material. The Contractor shall notify the MSFC Radiation Safety Officer (RSO) at least 48 hours in advance of any planned radiography. However, if planned during a weekend, notice shall be provided by Thursday. The Contractor shall report to the RSO once on-site and prior to starting work.

B. Loss of radioactive material shall be reported immediately to the CO and RSO.

C. Actual exposure of the radiographic film or unshielding the source shall not be initiated until after 5 p.m. on weekdays, unless prior

approval is obtained from the COTR and RSO to accomplish such activities prior to 5:00 p.m.

D. In instances where radiography is scheduled near or adjacent to buildings or areas having limited access or one-way doors, no assumptions shall be made as to building occupancy. Where necessary the CO will direct the Contractor to conduct an actual building entry, search, and alert. Where removal of personnel from such a building cannot be accomplished and it is otherwise safe to proceed with the radiography, a fully instructed employee shall be positioned inside such building or area to prevent exiting while external radiographic operations are in process.

E. Contractor shall perform a hazard analysis (HA) when lasers are used or are in the work area. The HA shall be approved by the CO and communicated to all personnel and all necessary protective measures taken.

1.12 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 CO.

1.13 PROTECTION OF UNDERGROUND UTILITIES

A. Prior to performing any excavation work or any surface penetrations 6 inches (150 millimeters) or deeper (such as driving stakes more than 6 inches (150 millimeters) in the ground) on any ground surface, the Contractor shall obtain from the FMO a digging permit to include the current subsurface utility drawing of the particular area to be worked on. Requests for dig permits shall be made a minimum of two working days prior to conducting any planned digging or excavation activities. 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 Government Inspector on how much closer to cable or pipe the excavations can be permitted.

B. Contractor shall notify the Government Inspector, two working days prior to the start of excavation work or surface penetration, to enable the Government Inspector 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 Government Inspector of his intention to initiate work prior to actual start of activity.

C. After obtaining clearance from the Government Inspector, 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 10 feet (3 meters) of the staked-out cable or pipe line until the Contractor has exposed the cable or pipe by hand excavation to fix its location.

1.14 ROOFING AND COATING

At the beginning of each work day the Contractor shall check with the Government Inspector before proceeding to work on the roof to ensure safe work conditions. Roofing and coating work shall adhere to NFPA-241.

1.15 FALL PROTECTION

A. Use of the monitoring system as the sole fall protection method shall not be allowed at MSFC. All roof related work activities shall be specifically addressed by a written fall protection plan and approved by the CO, the FMO's Program Manager, and the ISB. When an employee is engaged in leading edge work during construction conventional fall protection devices shall be used unless, the contractor can demonstrate that it is infeasible or it creates a greater hazard to used conventional fall protection equipment in accordance with 29 CFR 1926.502(k). NOTE: The Fall Protection Plan shall be site specific.

B. The Contractor shall ensure employees requiring fall protection are trained in accordance with 29 CFR 1926.503 and provide documentation of this training when requested by the ISB.

C. The Contractor shall ensure compliance with the MSFC Fall Protection Plan defined in MWI 8715.4, "Personal Protective Equipment (PPE) and Systems."

1.16 TEMPORARY HANDRAILS.

Temporary hand rails shall be provided on all stairwells until permanent hand rails are installed. All floor and wall openings from which there is a

drop of more than 4' shall be guarded by rail. Where there is exposure below of falling materials, a removable toe board or equivalent shall also be provided. In places where people are required to access an area close to or underneath walkways, handrails, and toe boards; approved netting shall be used.

1.17 PORTABLE TOOLS

A. All portable electrically-powered tools used on this work shall be grounded by means of a 3-wire polarity type grounding system via ground fault interrupter unless the tool is UL-listed as double-insulated. Operators of Power-operated tools shall be familiar with their safe operation in accordance with 29 CFR 1910.241 -244 (Subpart P) and 29 CFR 1926.300 – 307 (Subpart I).

B. Operators of explosive activated tools shall have an approved permit from the manufacturer and from the Contracting Officer's Technical Representative (COTR). Operators shall be trained in accordance with 29 CFR 1926.302(e) and provide documentation of this training when requested by the ISB.

1.18 REVERSE SIGNAL ALARM

A. Self-propelled construction equipment (except light service vehicles), crawler-type equipment, such as cranes, power shovels and draglines, whether moving alone or in combination shall be equipped with a reverse signal alarm in accordance with 29 CFR 1926.601. The alarm shall be mounted on the rear of the equipment and shall withstand severe wear and tear, adverse weather, and unfavorable environmental working conditions and shall be certified by the manufacturer as fully meeting the following performance standards.

B. The alarm shall produce a relatively pure tone which shall peak within the United Standard Association standard octave passband of 600 to 2,400 cycles per second and shall produce a 0.2 to 0.5 second audible warning within the initial 3 feet of backward movement of the vehicle on which it is mounted and at regular intervals, not to exceed 3 seconds, throughout the backward movement. The alarm shall automatically cut out when the backward movement ceases. The sound intensity of the alarm shall range from and not exceed 100 dB at a horizontal distance of 5 feet from the alarm.

C. Actuation of the alarm shall be automatic by direct connection to any part of the equipment that moves or acts in a manner

distinctive only to the rearward movement of the vehicle with no manual controls of any kind between the source of actuation and the alarm. Where application of this requirement to specific types of equipment has impractical application, other means of actuation may be used upon written approval of the CO.

1.19 RADIOS

To insure safety to Government personnel on nearby test stands and to prevent dangerous radio interference from damaging space vehicle test programs underway near the site, the Contractor shall not use any radio communication on or near the site without coordinating with the CO. All radio frequencies used shall be approved by the CO prior to use.

1.20 WELDING, FLAME CUTTING, AND MELTING

A. Contractor shall clear welding and cutting operations with the ISB before operations begin.

B. Contractor shall ensure welding and cutting operators are familiar with the safe operation of welding and cutting equipment requirements in 29 CFR 1926.350 -354 (Subpart J).

C. 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, or as required by the Hot Work Permit (MSFC Form 1155), after discontinuing these operations to make a thorough inspection of the area for possible sources of latent combustion. He shall be equipped with two full 15-pound (6.8 kilogram) carbon dioxide fire extinguishers. Details for reporting fires will be provided by the ISB representative during the Pre-Construction Conference.

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

E. Roofing/Tar Melting/Handling Devices shall comply to the requirements of NFPA 241. Tar melting kettles and handling devices shall be used in a safe manner to eliminate any chance of an employee being burned or starting a fire. Melting kettles shall be placed on a level, firm foundation and protected against traffic,

accidental tipping or similar hazard. An approved type of fire extinguishers shall be available at all locations where melting kettles or heating devices are in use. Melting kettles or heating devices, when in use, shall be provided with a lid and thermometer.

1.21 HIGH NOISE LEVEL PROTECTION

Contractor shall ensure employees required to wear Personal Protective Equipment (PPE) been trained in PPE usage in accordance with 29 CFR 1910.132(f) and MWI 8715.4.

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 scheduled for weekends or after duty working hours as directed at the pre construction conference. Use of any such equipment shall be approved in writing by the CO prior to commencement of work.

When the sound pressure level in any working area exceeds 85 dBA, personnel shall be required to wear hearing protective devices in accordance with 29 CFR 1926.101.

When the sound pressure level in any work area exceeds 120 dBA, hearing protection equivalent to the combination of ear plugs and ear muffs shall be required.

1.22 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.

d. Vacate temporary construction trailers.

1.23 SCAFFOLDS

A. Scaffolds. The Contractor shall comply with the requirements of 29 CFR 1926 Subpart L and 29 CFR 1910.66 for use of scaffolds. The Contractor shall ensure employees erecting and working on scaffolds are trained in accordance with 29 CFR 1926.454 and provide documentation of this training when requested by the ISB. The following shall apply to use of swinging scaffolds.

1. Scaffold machines used for hoisting personnel shall be approved by the Underwriters' Laboratories. Scaffolds shall not be loaded beyond manufacturer's rated capacity.

2. Scaffold machines with cast-iron parts or components shall not be used.

3. A positive action pawl or brake shall be provided to prevent free fall of scaffold.

4. Scaffold machines with latching arrangements for locking out pawls or brakes shall not be used. Operation of the scaffold machine shall be performed only from the working level of the scaffold.

B. All scaffolds, platforms, and runways shall be constructed in accordance with OSHA requirements and be inspected by qualified personnel. All scaffold boards shall be 2" x 10." Barricades or covers shall be provided for all roof or openings which present a hazard. An adequate number of ladders will be furnished at all times. Job constructed ladders shall be of select material. All fixed ladders above 20 feet in height will be staggered or caged. All ladders placed on concrete floors or slippery surfaces shall be equipped with an approved type no-skid shoe or adequately made to prevent slipping. Hand rails with intermediate rails and toe boards shall be provided on all scaffolds 6' or greater in height.

C. All personnel working from swing scaffolds shall wear safety belts attached to an independently suspended safety line. Independent line shall not be attached to any scaffold component or supporting beam.

1.24 TRENCHING/EXCAVATIONS

A. Prior to beginning any excavations, an excavation permit shall be obtained from the FMO. Trenching machines and augers shall not be used unless approved in advance by the COTR and it shall be so annotated on the issued excavation permit. Before starting any earth work, the location of underground utilities shall be carefully verified. Utilities to be left in place shall be protected from damage. Trench excavations over 5' in depth shall be shored, braced or sloped to the angle of repose of the material. Excavated or other materials shall be shored and retained at least 2' from the edge of the excavation to prevent it from falling or sliding back into the excavated area and to prevent excessive pressure upon the side of the excavation.

B. Excavations, trenching and shoring requirements for the protection of employees in OSHA Regulation, CFR 29 part 1926.650 shall be employed and enforced. Side and slopes of excavations shall be maintained in a safe condition by scaling, benching or barricading. Where employees are required to be in trenches, a ladder extending from the floor of trench/excavation to at least 3' above top of excavation, located as to provide means of exit without more than 25' of lateral travel. Excavations will be barricaded and posted with warning signs for the safety of personnel. Warning lights will be provided during hours of darkness.

C. The Contractor shall ensure employees working in or around excavation projects are trained and familiar with the safety requirements in 29 CFR 1926. 650 – 652 (Subpart P).

1.25 ROPES/SLINGS/CHAINS

A. No loads shall pass over workmen and other personnel at any time. Slings, their fittings and fastenings, when in use, shall be inspected daily by a qualified craft person for evidence of overloading, excessive wear or damage. Defective slings shall be removed from service. Proper storage shall be provided for qualified slings when not in use. Wire rope shall be inspected by a competent person at the time of installation and at scheduled intervals thereafter. Drums, sheaves, or pulleys having eccentric bores or cracked hubs, spokes, or flanges shall be removed from service. To eliminate rope damage: drums, sheaves, and pulleys shall be smooth and free of surface defects.

B. Connections, fittings, fasteners, parts, etc., used in connection with ropes shall be of good quality and of proper size and strength, and shall be installed in accordance with recommendations of the manufacturer. Chains used for lifting loads shall be inspected before each use. After the initial inspection, the chains shall be inspected each week. Chains shall be removed from service when showing evidence of cracks, nicks, or other damage. All hooks, used to support human loads (on approved lifting devices) or any loads, shall be closed or equipped with a safety latch.

C. Hooks, shackles, rings, pad eyes, and other fittings that show excessive wear or that have been bent, twisted or otherwise damaged shall be removed from service. Frozen fiber rope shall not be used. Fiber rope that has been subjected to acids or excessive heat shall not be used. Fiber rope shall be protected from abrasion by padding where it is fastened. The same protection applies for fiber rope drawn over square corners, sharp or rough surfaces.

D. The Contractor shall ensure employees performing rigging and hoisting operations are trained and familiar with the safety requirements in 1926.753 and 761.

1.26 OPERATIONS ADJACENT TO POWER LINES

Equipment or any part thereof shall not have the capability of coming within the following minimum clearances from energized power lines. Positioning and blocking of equipment to assure that no part thereof, including cables, can come within the following minimum clearances will be considered an acceptable alternate.

Power Lines Nominal System KV	Minimum Required Clearance (Feet)
5	3
15	8
44	10
69	12
115-161	15

A notice of the minimum required clearance shall be posted at the operator’s position.

The Contractor shall ensure employees performing operations adjacent to power lines are trained and familiar with the safety requirements in 29 CFR 1926. 950 – 960 (Subpart V).

1.27 CONSTRUCTION EQUIPMENT

A. All construction equipment and machinery, including required guards, brakes, cable, etc., shall be inspected by qualified personnel before use for safe and serviceable mechanical condition. All inspections shall be done daily before each shift and will be properly maintained by qualified personnel. A warning device or service of a Signal-man shall be provided where there is danger to personnel from moving equipment, swinging loads, buckets, booms, etc. All equipment capable of hauling 5 tons of material is considered to be heavy duty and shall be equipped with an emergency brake system. The State Commercial Drivers License, (CDL) requirement and regulation applies on Redstone Arsenal.

B. Before any machinery or mechanized equipment is placed in use, it shall be inspected and tested by a competent mechanic and certified to be in safe operating condition. Records of tests and inspections will be maintained at the site and will be available upon request. All machinery or equipment found to be unsafe shall be tagged out and its use prohibited until unsafe conditions have been corrected. Machinery or equipment requiring an operator shall not be permitted to run unattended. Equipment shall be locked or secured to prevent operation by unauthorized personnel. All guards and devices shall be replaced immediately after completion of repairs and adjustments.

C. The Contractor shall ensure employees working with construction equipment are trained in its safe operation and are familiar with the safety requirements in 29 CFR 1926. 600 – 606 (Subpart O).

1.28 ELECTRICITY AND LIGHTNG

All temporary wiring shall be in accordance with the National Electric Codes, OSHA standards, and installed by competent personnel. Adequate, safe lighting shall be provided in advance for any work requiring artificial light. Grounding of all electrical portable equipment and hand tools shall be accomplished by installing three-wire plug systems. All 120 volt, single-phase, 15 and 20 ampere receptacle outlets on construction sites which are not part of the permanent wiring of the building or structure and which are in use by employees shall have approved ground fault circuit interrupters (GFCI) for personnel protection.

1.29 UNEXPLODED ORDNANCE

A. The possibility exists that materials of unexploded ordnance (UXO) could be encountered on NASA/MSFC property. In most areas, the potential for these occurrences is small. However, if materials resembling and suspected to be UXO are discovered in a work area, immediately stop all work, cordon off or barricade suspect area, withdraw from the area, contact the Fire Department at 911, the CO, and the FMO COTR and inform them of the findings. Then, post temporary barriers to prevent personnel entry into the area and remain near the site at a safe distance from the suspected UXO until the CO or COTR takes charge of this activity. The CO or COTR will then arrange for investigation and safe disposal of suspect material. Upon clearance from the CO or COTR, work may then be resumed in the area.

B. Some areas are known to have formerly been utilized for ordnance related manufacturing, delivery, storage, and/or disposal activities. These areas are identified on the “Army and NASA Site Access Control Boundaries” map. When work is to be accomplished in the areas designated on the map as “Facilities Precautionary UXO Area” or as “UXO/CWM Probability ‘Occasional’, ‘Remote’, or ‘Seldom’”, prior to beginning construction, contractor shall procure the services of a UXO services provider (qualified for the project-specific requirements as shown on the drawings) for initial investigation and characterization, and then a remediation recommendation, required when suspect material is detected. Upon receipt of a report that states potential UXO was detected during investigation, the CO or COTR will then arrange for disposition of suspect material. UXO services provider shall employ personnel with skills that meet applicable minimum qualification requirements contained in the U.S. Army Corps of Engineers document, “Attachment to Chapter 20, EP 1110-1-18, Ordnance and Explosives Response, UXO Personnel Training and Experience Hierarchy”, attached to the end of this Section. UXO services provider shall submit for approval documentation that includes the number and names of employees to be utilized for the effort and their corresponding levels of training and experience, including copies of certifications and/or other qualifying paperwork to the COTR. Additionally, where required by drawings or the schedule of submittals, the UXO services provider shall have a project specific work plan and a safety plan approved by NASA MSFC prior to initiating job activities. Alternately, when working under a prime contractor, UXO investigation work and safety plan requirements may be included in the prime contractor’s work and safety plans. Questions concerning UXO operations and work plans

may be addressed to the CO or the COTR. Prior to commencing UXO investigation that requires disturbing the soil, obtain a digging permit from the CO or the COTR.

C. The Contractor shall be responsible for alerting personnel under his authority, including subcontractor personnel, when the site of work is located on a site known to have had former ordnance activity.

D. The “Army and NASA Site Access Control Boundaries” map, showing the areas at MSFC which have the potential to contain UXO, is available for reference. Contact the CO or COTR to obtain this information.

1.30 CHEMICAL WARFARE MATERIAL

A. The possibility exists that chemical warfare material (CWM) could be encountered on NASA/MSFC property. In most areas, the potential for these occurrences is small. However, if such materials are suspected in a work area, immediately stop all work, cordon off or barricade suspect area, withdraw from the area, contact the Fire Department at 911, the CO, and the FMO COTR, and inform them of the findings. Then, remain near the site at a safe distance from the suspected CWM, and post temporary barriers to prevent personnel entry into the area until the CO or COTR takes charge of this activity. The CO or COTR will then arrange for investigation and safe disposal of suspect material. Upon clearance from the CO or COTR, work may then be resumed in the area.

B. Some areas are known to have formerly been utilized for chemical warfare related manufacturing, delivery, storage, and/or disposal activities. These areas are identified on the “Army and NASA Site Access Control Boundaries” map. When work is to be accomplished in the areas designated on the map as “UXO/CWM Probability ‘Occasional’, ‘Remote’, or ‘Seldom’”, prior to beginning construction, contractor shall procure the services of a CWM services provider (qualified for the project-specific requirements as shown on the drawings) for initial investigation and characterization, and then a remediation recommendation, required when suspect material is detected. Upon receipt of a report that states potential CWM was detected during investigation, the CO or COTR will then arrange for disposition of suspect material. CWM services provider shall meet applicable minimum qualification requirements for the work to be performed. CWM services provider shall submit for approval documentation that includes the number and names of employees to be utilized for the effort and their corresponding levels of training and

experience, including copies of certifications and/or other qualifying paperwork. Additionally, where required by drawings or the schedule of submittals, the CWM provider shall have a project specific work plan and a safety plan approved by NASA MSFC prior to initiating job activities. Alternately, when working under a prime contractor, CWM work and safety plan requirements may be included in the prime contractor's work and safety plans. Questions concerning CWM operations and work plans may be addressed to the CO or COTR. Prior to commencing CWM investigation that requires disturbing the soil, obtain a digging permit from the CO or COTR.

C. The Contractor shall be responsible for alerting personnel, including subcontractor personnel, when the site of work is located on a site known to have had former CWM activity.

D. The "Army and NASA Site Access Control Boundaries" map, showing the areas at MSFC which have the potential to contain CWM, is available for reference. Contact the CO or COTR to obtain this information.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

Attachment to Chapter 20, EP 1110-1-18, Ordnance and Explosives Response
UXO Personnel Training and Experience Hierarchy

Position Description	Training Required (Notes 1, 2, & 3)	Minimum Years of EOD/UXO Experience	Special Requirements
UXO Safety Officer	1, 2, or 3	10 years	Experience in all phases of UXO remediation and applicable safety standards
UXO Quality Control Specialist	1, 2, or 3	10 years	Experience in all phases of UXO remediation and the transportation, handling and storage of ordnance and explosives materials
Senior UXO Supervisor	1, 2, or 3	15 years	Significant experience in all aspects of UXO remediation. Five years experience in supervisory positions.
UXO Technician III	1, 2 or 3	10 years	Prior military EOD and/or commercial UXO experience
UXO Technician II	1, 2 ---------- or 3	N/A ---------- 5 years	Prior military EOD experience ---------- Experience in UXO remediation/range clearance operations. Plus specific project/ordnance training
UXO Technician I	1, 2 or 3	0	Successfully completed DOD certified course of instruction appropriate to this skill level
UXO Sweep Personnel	Equipment and site specific training	N/A	Equipment and site specific training. (Experience at this position is not required for UXO Technician I certification.)

Notes: 1. Graduate of the Army Bomb Disposal School at Aberdeen, MD.
2. Graduate of the Naval EOD School
3. Graduate of a Department of Defense certified UXO Training Program
4. This is the minimum experience requirement for designation. This is not an automatic designation, but reserved for those who have demonstrated the requisite knowledge, maturity, judgment and are recommended by the contractor for recognition at the specified skill level.

END OF SECTION

SECTION 01 35 43

ENVIRONMENTAL PROCEDURES

PART 1 GENERAL

1.01 REFERENCE

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

MWI 8540.2	Affirmative Procurement Program for Environmentally Preferable Products

STEEL STRUCTURES PAINTING COUNCIL (SSPC)

SSPC Technology Guide No. 6	(2004) Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations

1.02 SUBMITTALS

A. Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

B. In addition, submit the following items:

SD-08 Manufacturer's Instructions

Material Safety Data Sheets (MSDS). The Contractor shall submit to the Government a list of all hazardous materials brought on site as defined by Federal Standard 313. The Contractor may submit a Chemical Inventory Worksheet, MSFC Form 4099, in place of the above mentioned list.

SD-06 Inspection Reports

Monthly Submittals (by the 10th for the previous month): Stormwater Inspection Records, EPA guideline items

SD-01 Preconstruction Submittals

1. Submit Site Specific Construction Best Management Practices Plan (CBMPP) (Attachment A for sites less than 1 acre) or Site Specific CBMPP (Attachment A and B for sites greater than 1 acre) for AS10 approval prior to on-site work start. AS10 must approve the CBMPP prior to contractor starting work.

2. Permits and Notices: Submit within 10 days of receipt a copy of any and all permits and notices received or granted.

3. Waste Management Plan: Submit plan no later than the preconstruction conference. Plan must be approved prior to starting field work. Plan to be submitted only when there will be construction or demolition waste.

4. Qualification Data: For Qualified Construction Planner and Qualified Construction Inspector.

SD-11 Closeout Submittals

1. Submit Stormwater Inspection Records at the end of the project.

2. Record and report purchases of items containing recycled materials. Include amount spent on items containing recycled materials and amount spent on items that do not contain recycled materials. See EPA's list of designated products (http://www.epa.gov/cpg/products.htm).

3. Waste Reduction Report: Before request for Final Inspection, submit waste calculations and report. Include the following information:

   a. Material category.
   b. Generation point of waste.
   c. Total quantity of waste in tons.
   d. Quantity of waste salvaged, both estimated and actual in tons.
   e. Quantity of waste recycled, both estimated and actual in tons.

f. Total quantity of waste recovered (salvaged plus recycled) in tons.
g. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

4. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

5. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

6. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.03 DEFINITIONS

Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

Disposal: Off-site removal of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

LEED: Leadership in Energy and Environmental Design Rating System as established by U.S. Green Building Council.

Inspection: Examining satellite accumulation points to ensure compliance with the State of Alabama Regulations. Examining site conditions, records, and plans for compliance.

Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

Waste Stream: A generation of a spent/waste hazardous or recyclable material that requires either recovery or disposal in accordance with appropriate environmental, NASA, Federal, State and local laws and regulations.

1.04 EXPLOSIVE ORDNANCE AND CHEMICAL WARFARE MATERIAL PRECAUTIONS

See Part 1, Section 01 35 23, “GENERAL SAFETY REQUIREMENTS.”

PART 2 PRODUCTS

2.01 ACCUMULATION CONTAINERS

A. Accumulation containers will be provided by the Government. The containers shall be requested by the Contractor three days in advance of the initial need date.

B. The containers will be labeled by the Government.

C. Ensure that the accumulation containers are secured such that the containers shall not be exposed to vehicular traffic.

D. Turn-in the containers when ninety percent (90%) of the rated volume of each container is used for liquid waste. Containers of solid waste may be filled to hundred percent (100%).

E. At the time of turn-in, identify if a replacement container is required.

F. Ensure that hazardous and controlled waste is segregated and labeled by type in different accumulation containers.

PART 3 EXECUTION

3.01 HAZARDOUS WASTE GENERATOR NOTIFICATION AND TRAINING.

A. The Contractor shall designate a person as point of contact (POC) and as many as two alternate people for each hazardous and controlled waste accumulation site.

B. The POC's shall be responsible for maintaining the Contractor's accumulation site in compliance with all applicable Federal, state and local laws and regulations.

C. The Contractor shall attend the first available SHE 101C, "Safety, Health, and environmental (SHE) Program Construction Awareness" training after initiation of the contract. The training is conducted on site by the Government at no cost to the Contractor.

D. Government personnel will inspect the accumulation site(s) to ensure compliance.

3.02 HAZARDOUS MATERIAL NOTIFICATION AND TRAINING

A. The Contractor shall submit to the Government a list of all hazardous materials brought on site as defined by Federal Standard 313. The Contractor shall maintain a copy of this list at the job site for inspection by the Government. Copies of the MSDS's shall be readily accessible to all Contractor employees at the job site either in hard copy or electronic format. Contractor shall provide copies to AS10 as requested..

B. The Contractor may submit a Chemical Inventory Worksheet, MSFC Form 4099, in place of the above mentioned list. The inventory shall be submitted to the Government prior to delivery of material on site. MSFC Form 4099 can be obtained from the Government. The Contractor shall maintain a copy of all Chemical Inventory Worksheets at the job site.

C. The Contractor shall attend the first available SHE 101C, "Safety, Health, and environmental (SHE) Program Construction Awareness" training after initiation of the contract. The training is conducted on site by the Government at no cost to the Contractor.

D. The Contractor shall ensure that all personnel working in the area are made aware of the chemical hazards associated with chemicals located at the jobsite.

3.03 HAZARDOUS AND CONTROLLED WASTE COLLECTION

A. The Contractor shall notify the Government of wastes being generated. The Government will determine the correct method of disposal.

B. The following types of hazardous and controlled waste are commonly associated with construction projects; however, it is not necessarily an all inclusive list. All wastes shall be collected and placed into accumulation containers for disposal.

1. All fluorescent light ballasts.

2. High Intensity Discharge (HID) lamps.

3. Free oil liquids and oil filters. Oil rags that are not saturated (no free liquids dripping) shall be disposed as solid waste.

4. Paint cans, paint, and paint thinners.

5. Sandblast material from tanks, equipment, and piping.

6. Materials used for cleaning and degreasing of equipment, tanks, and piping.

7. Paint chips from water blasting operation, scraping, sandblasting, grinding, etc. shall be collected on a daily basis. Materials to be recycled shall be free of loose lead paint chips prior to recycling.

8. Aerosol cans.

9. Process piping system cleaning operations fluids shall be collected and disposed as directed.

B. The Contractor shall adhere to Government guidelines for inspections, collection, and turn-in of waste materials.

C. Material containing asbestos (ACM) shall be bagged, labeled and handled in accordance with OSHA, EPA and MSFC regulations. The Contractor shall transport and dispose of ACM at the Redstone Arsenal Landfill (RSAL).

3.04 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

A. Quality Assurance

1. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

2. Waste Management Conference: Conduct conference at Project site. Review methods and procedures related to waste management including, but not limited to, the following:

   a. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
   b. Review requirements for documenting quantities of each type of waste and its disposition.
   c. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
   d. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
   e. Review waste management requirements for each trade.

B. Waste Management Plan

1. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

2. Waste Identification: Indicate anticipated types and quantities of land-clearing and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

3. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures. Waste must be recycled or reused whenever economically feasible.

   a. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.

b. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
c. Recycled Materials: Include list of local receivers and processors, and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
d. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
e. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.

4. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:

a. Total quantity of waste.
b. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
c. Total cost of disposal (with no waste management).
d. Revenue from salvaged materials.
e. Revenue from recycled materials.
f. Savings in hauling and tipping fees by donating materials.
g. Savings in hauling and tipping fees that are avoided.
h. Handling and transportation costs. Include cost of collection containers for each type of waste.
i. Net additional cost or net savings from waste management plan.

C. Plan Implementation

1. General: Implement waste management plan as approved by the Government. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

2. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work

plan. Coordinator shall be present at Project site full time for duration of Project.

3. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.

4. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

D. Salvaging Demolition Waste. Salvaged items for donation are permitted.

E. Recycling General Construction Waste

1. General: Recycle paper and beverage containers used by on-site workers. Contractor shall recycle construction and demolition waste when economically feasible.

2. Recycling Receivers and Processors: List below is provided for information only; available recycling receivers and processors include, but are not limited to, the following:

   a. Solid Waste Disposal Authority, Huntsville, Alabama; 256-830-BINS.

   b. The Defense Reutilization and Marketing Office (DRMO); 256-842-2532. Additional information may be obtained from the DRMO web site at: http://www.drms.dla.mil

   NOTE: The policies, procedures and restrictions of the landfill and recycling organizations above are not governed by NASA and are subject to change. All contractors should contact these agencies directly to familiarize themselves with the policies, procedures and restrictions prior to bidding and prepare their bids accordingly.

3. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

4. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.

a. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

b. Inspect containers and bins for contamination and remove contaminated materials if found.

c. Stockpile processed materials in containers on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

d. Stockpile materials in designated areas. Do not store within drip line of remaining trees.

e. Store components off the ground and protect from the weather.

f. Remove recyclable waste off the Government's property and transport to recycling receiver or processor.

F. Recycling Demolition Waste

1. Metals: Separate metals by type.

a. Structural Steel and Siding: Stack members according to size, type of member, and length.

b. Remove bolts, nuts, washers, and other rough hardware.

2. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

3. Conduit: Reduce conduit to straight lengths and store by type and size.

4. Concrete and Masonry: Segregate block and concrete.

G. Recycling Construction Waste

1. Packaging:

a. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.

b. Polystyrene Packaging: Separate and bag materials.

c. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.

d. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

2. Site Clearing Wastes: Chip brush, branches, and trees on-site.

3. Wood Materials:

a. Clean Cut-offs of Lumber: Grind or chip into small pieces.

b. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

H. DISPOSAL OF WASTE

1. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to the Government.

a. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.

b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

2. Burning: Do not burn waste materials.

3. Disposal: Transport waste materials and dispose at the Redstone Arsenal Landfill, if permissible, or dispose off the Government's property and legally dispose of them.

3.05 REDSTONE ARSENAL LANDFILL (RSAL) (Phone # 256-876-4199)

A. The following restrictions concerning use of the Government’s Redstone Arsenal Landfill (RSAL) are provided for general use as a example of some of the policies and restrictions that historically have been associated with the RSAL. They are not to be considered complete or necessarily correct. The policies, procedures and restrictions of the landfill and recycling

organizations above are not governed by NASA and are subject to change. All contractors should contact these agencies directly to familiarize themselves with the policies, procedures and restrictions prior to bidding and prepare their bids accordingly.

1. No garbage shall be mixed in with the construction rubble for disposal at the Redstone Arsenal Landfill (RSAL).

2. No liquids of any kind shall be disposed of at the RSA

3. No ammunition or explosive type material (including training devices) shall be disposed of at the RSAL.

4. No batteries shall be disposed of at the RSAL.

5. No hazardous wastes shall be disposed of at the RSAL, except asbestos as noted herein.

6. Large pieces of heavy metal, copper, metal shavings, etc. shall not be disposed of at the RSAL.

7. Asbestos shall be segregated and disposed of in a designated area of the RSAL.

8. Cans of 1 gallon or larger that contain paint, solvent, or any other liquid shall not be disposed of in the RSAL.

9. Empty drums in good condition from 5-gallon containers and up shall not be disposed of in the RSAL.

10. Empty drums in poor condition shall be flattened prior to delivery for disposal to the RSAL.

11. The RSAL will only accept a limited amount of non-pressure treated lumber construction waste. (Note: RSAL will accept unlimited quantities of non-pressure treated lumber that is result of demolition activities). Contractor shall maximize recycling of non-pressure treated lumber per paragraph 3.04.G.3.

12. There will be no loitering or scrounging at the RSAL.

B. For all demolition and construction waste to be disposed of at the RSAL, the Contractor shall submit documentation ensuring compliance with DES Permit No. 45-3 issued for the RSAL. The

MSFC Environmental Engineering and Occupational Health Office (AS10) will provide the Certification Number to be used for the project. The Contractor shall complete a Form 2435-R, "Delivery Ticket" for each load using the specific project's Certification Number.

C. The Government will refuse any material or not allow dumping of any material at the site if it does not meet the above requirements. If this occurs, the Contractor is responsible to dispose of the waste material offsite at approved landfills at his own expense.

3.06 EMPTY CONTAINER MANAGEMENT

A. Empty hazardous material containers shall be turned into the Government. The Contractor shall ensure the containers are empty using practices commonly employed to remove materials from that type of container such as pouring, pumping, and aspirating.

B. Clean and purge/triple rinse all empty containers as required by the Government.

C. Ensure bungs and/or tops are secured prior to storage/turn-in.

D. Empty containers shall not be stacked more than two high for any size container on pallets.

E. Containers that are damaged and will not seal shall be taped over the damaged area or turned upside down to prevent rainwater collection.

F. Empty containers shall be turned in frequently, as determined by the Government.

3.07 DISPOSAL OF REGULATED ASBESTOS CONTAINING MATERIAL (RCAM)

Disposal of RCAM shall be at the Redstone Army Landfill in accordance with the following regulations:

Submit a Notice of Demolition and/or Asbestos Removal Form to the Alabama Department of Environmental Management (ADEM) and a copy to AS10. Provide a copy of this form to the Asbestos Control Officer, (256) 955-8502, Directorate of Environmental Management and Planning (DEMP) at Redstone Arsenal, ten (10) days before proceeding with the project. This includes both reportable and non-reportable quantities.

Submit a Waste Shipment Record with each load, reportable and non-reportable, delivered to the RSAL. No RCAM will be accepted at the RSAL without the proper Waste Shipment Record (Materials Manifest) and a copy of the Notice of Demolition and/or Asbestos Removal Form that was initially submitted to DEMP. This requirement also applies to RCAM removed under Small Scale, Short Duration rules. The Contractor shall also submit a copy of the Waste Shipment Record to the COTR.

All RCAM will be clearly marked “FRIABLE ASBESTOS” on the Waste Shipment Record.

No non-friable ACM will be accepted at the RSAL without the proper Waste Shipment Record (Materials Manifest) and a copy of the Notice of Demolition and/or Asbestos Removal Form that was initially submitted to DEMP. All non-friable ACM will be marked “NON-FRIABLE ASBESTOS” on the Waste Shipment Record.

The contractor shall provide to the COTR a copy of the Waste Shipment Record, signed the by the RSAL operator, indicating that all RACM was appropriately disposed in accordance with above procedures.

Packaging, labeling, delivery and unloading shall be in accordance with OSHA and RSAL regulations.

3.08 CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN (CBMPP)

A. Construction Best Management Practices Plan (CBMPP) (**Site disturbing less than 1 acre**): The Contractor shall prepare, submit, and have approved a CBMPP in the format provided in Attachment A prior to work commencing on site. The Contractor will implement the CBMPP throughout the duration of the construction.

B. Construction Best Management Practices Plan (**Site disturbing greater than 1 acre**): The Contractor shall prepare, submit, and have approved a CBMPP on ADEM Form 498 (http://www.adem.state.al (ADEM Forms)) and include the information from Attachment A and B prior to work commencing on site. The Contractor will implement the CBMPP throughout the duration of the construction. This site specific CBMPPs must be prepared in accordance with ADEM Administrative Code 335-6-12-.21 by a Qualified Credential Professional (QCP).

C. Stormwater Inspection Record: The Contractor shall perform daily inspections of hazardous waste containers, hazardous materials containers, empty containers, vehicles and equipment, and erosion and sediment controls. The daily inspection will be documented in a

similar format as shown on Stormwater Inspection Record (available from the Government), or other format acceptable to the Contracting Officer. The inspection documentation will be maintained and available at the site for periodic verification of compliance by the Government and will be submitted to the Government upon completion of construction.

D. Inspections: When no work is being conducted (e.g., weekends, holidays, etc.), no inspection is necessary. The Contractor shall ensure that the site is in compliance with the CBMPP. If the project construction site is greater than 1 acre, inspections shall be performed by a contractor representative that meets the requirements outlined in Alabama Department of Environmental Management (ADEM) Administrative Code 335-6-12.02(p) and (q), which states that inspections must be conducted by a Qualified Credentialed Inspector (QCI) or Qualified Credential Professional (QCP), or a person under the direct supervision of a QCP (QCP designee).

E. Daily Stormwater Prevention Inspection. The Contractor shall inspect daily, unless otherwise noted, hazardous waste containers, hazardous material containers, empty containers, vehicles and equipment, and erosion and sediment controls for:

1. Containers protected from traffic.
2. Containers labeled.
3. Storage area neat and orderly.
4. No spillage from material handling.
5. Containers sealed, during inactivity.
6. No damaged pallets.
7. No damaged containers.
8. Spill kits available.
9. Containment system in good condition.
10. Containment valves closed.
11. Containment system water managed appropriately.
12. Fluid leaks from vehicles and equipment.

F. Monthly Stormwater Inspection Record

1. The Contractor shall perform monthly inspection of erosion and sediment controls for the construction site. The inspection shall be documented in a format acceptable to the Contracting Officer. The inspection documentation shall be maintained and available at the site for periodic verification of compliance by the Government and shall be submitted to the Government upon completion of construction.

2. The Contractor shall inspect erosion and sediment controls for:

   a. No signs of excessive erosion
   b. Erosion controls are effective and in good condition
   c. No sediment buildup in stormwater structures (inlets, ditches).

G. Deficiencies and Inspections: All deficiencies noted during the contractor's Stormwater Inspection must be corrected promptly to be in compliance with the Center's General Stormwater Permit.

H. The prime construction Contractor shall apply for the permit and advertise for a period of seven days, his permit application in the legal section of the local newspaper 15 days prior to starting any work at the selected site.

3.09 SPILLS OF HAZARDOUS MATERIALS

A. The Contractor shall activate the MSFC Emergency Plan by dialing 911 with "on-site" phone or by dialing 544-4357 (MSFC Security Office) with "off-site" phone for hazardous materials spills that cannot be cleaned up with Contractor spill kits. The Contractor is responsible for costs incurred in cleaning up spills.

B. The Government will determine the correct disposal method for spilled materials.

C. The Contractor shall maintain spill kits for the type of hazardous materials used at the construction site.

3.10 HANDLING, DUST CONTROL, AND DISPOSITION OF LEAD COATINGS

A. The following requirements, except as noted in Paragraph entitled "Requirements for Removing Lead Coatings- Small Scale / Short Duration," shown below, apply to all work performed in connection with the removal of lead-based coatings or materials coated with the lead-based materials:

   1. Worker protection and work practices shall conform with OSHA Safety and Health Standards, 29 CFR 1926.62.

   2. Methods utilized to remove lead-based coatings shall minimize the amount of dust generated, and shall be in

accordance with the Contractor's approved lead coatings safety plan. Engineering controls shall be employed to insure that airborne lead exposures do not exceed 50 micrograms / cubic meter. Contaminated air shall be filtered before it is discharged into the environment away from the source of intake air, in accordance with 29 CFR 1926.353.

3. All workers in the controlled lead abatement area shall wear NIOSH approved respirators with high efficiency filters and protective clothing as required by 29 CFR 1926.62. Use of respirators shall comply with 29 CFR 1910.134.

4. All lead particulate and waste shall be collected and sealed in non-permeable accumulation containers in accordance with article 2.01 of this Section.

5. The Contractor shall submit a written detailed plan, for approval, which describes the methods and equipment to be used to achieve the lead removal in conformance with the requirements listed above. This submittal shall, as a minimum, include the following:

Removal, containment and / or ventilation plans and drawings

Plan for protection of ambient air, soil and water

Worker protection programs

Plan for handling and disposal of debris

3.11 REQUIREMENTS FOR REMOVING LEAD COATINGS- SMALL SCALE / SHORT DURATION

A. The following minimum requirements shall be followed when removing material by grinding, cutting, or welding, which is attached to the steel structure.

1. Comply with 29 CFR 1926.62.

2. Local exhaust shall be used to ventilate the area during welding, cutting, or burning of lead coatings.

3. Personnel required to conduct welding, cutting, or burning of lead coatings, as a minimum, shall be outfitted with a

powered air purifying respirator (PAPR) equipped with high efficiency filter. Under certain conditions, i.e. poor ventilation, supplied air respiratory protection may be required.

4. Personnel required to conduct welding, cutting, or burning of lead coatings shall wear protective clothing. Contractors shall arrange for the laundering of protective clothing; or, if disposable protective clothing is used, the Contractor shall maintain an adequate supply at the worksite and arrange for its safe disposal according to applicable Federal (40 CFR 260) and State regulations.

5. Following welding, cutting, or burning of lead coatings, employees must exercise good personal hygiene (i.e., washing hands and face) since lead can become an ingestion hazard.

3.12 PRODUCTS CONTAINING RECYCLED MATERIALS

A. The Resource Conservation and Recovery Act (RCRA) requires that use of recovered/ recycled (recycled)materials in the products to the greatest extent practicable. Additionally, Executive Order 13423 requires (1) the reduced use of chemicals and toxic materials and purchase of lower risk chemicals and toxic materials as well as (2) the expanded purchasing of environmentally sound goods and services, including bio-based products.

B. The Contractor shall determine from the technical specifications what products require recycled content and purchase accordingly.

C. Non-Compliance Report: Whenever a product is required to contain recycled material by the technical specification but cannot be produced as specified, the Contractor shall notify the COTR, by submitting a product substitution request per the Section 01 60 00 entitled “ Product Requirements” with a Contractor-signed letter explaining in detail what suppliers and manufactures were contacted and why the product cannot be produced as specified. An internal waiver, coordinated with the COTR, is required prior to procuring the non-compliant product.

D. Product Reporting: The contractor shall submit a report listing purchases of items containing recycled materials. The contractor shall include the amount spent on items containing recycled materials and amount spent on items that do not contain recycled materials. The accounting shall include the amount spent on all products that meet the EPA (http://www.epa.gov/epaoswer/non-hw/procure/products.htm)

guidelines whether specified or not. The Report shall be submitted prior to final inspection of contracted work. Dollar amounts shall include actual product cost incurred, as in purchase price.

Products to be reported include:

1. Building insulation products.
2. Carpet (polyester)
3. Carpet cushion.
4. Cement and concrete containing:
   a. Coal fly ash
   b. Ground granulated blast furnace slag
   c. Cenospheres
   d. Silica flume
5. Consolidated and reprocessed latex paint
6. Floor tiles
7. Flowable fill
8. Laminated paperboard
9. Modular threshold ramps
10. Non-pressure pipe
11. Patio blocks
12. Roofing materials
13. Shower and restroom dividers/partitions
14. Structural fiberboard
15. Hydraulic mulch
16. Lawn and garden edging
17. Plastic lumber landscaping timbers and posts
18. Plastic trash bags
19. Park benches and picnic tables
20. Plastic fencing
21. Bike racks
22. Blasting grit
23. Pallets
24. Signage

3.13 ASBESTOS AND NEW CONSTRUCTION. The construction contractor shall provide an asbestos free statement for new construction or documentation of where asbestos is located in the new building.

ATTACHMENT A

CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN (CBMPP)

(For sites disturbing less than 1 acre)

Contract Information

Contractor: _____

Address: _____

Phone: _____

Construction Site Contact Name: _____

Construction Contract Number: NAS8-_____

General Information: Describe the planned construction project. Include a description of amount of disturbed land, expected duration, and location. Provide a site map or use the site map included on the design drawings detailing the construction site including general drainage areas and gradients, nearby landmarks (buildings, paved areas, etc.), erosion control measures, topography.

_____

_____

_____

_____

Construction Materials: Provide a general list of the types of chemicals, substances that will be used at the construction site.

_____

_____

_____

Erosion and Sediment Controls: Describe any erosion and sediment controls necessary. These controls shall be implemented during the construction period to prevent or control the loss of soil from the construction site. The methods could incorporate structural practices and/or vegetative stabilization. Examples are mulching, checkdams, temporary downdrain structures, sediment barriers, etc.

_____

_____

_____

_____

ATTACHMENT B

SITE SPECIFIC CONSTRUCTION BEST MANAGEMENT PRACTICES PLAN

(For sites disturbing more than 1 acre)

General construction activities have the potential to affect storm water at MSFC. If a construction project has the potential to disturb >1 acre of land (including the creation of access roads, equipment parking areas, and laydown yards) the contractor must prepare a site specific CBMPP. The CMBPP must include Attachment A above and the following as a minimum:

- A detailed description of the site, including topography and surface and sub-surface soil types, and the nature of construction, including design plans.
- A description of the intended sequence of construction activities that will involve soil disturbance, including grubbing, excavation, grading, etc.
- Planned project phasing to minimize the surface area that is exposed at any one time.
- Estimates of the total area of the construction site and portion of that total that will be disturbed.
- Estimates, including calculations, of the runoff coefficients of the site before and after construction.
- Identification of receiving waters for storm water discharges on a USGS 7.5-minute topographic map
- Detailed descriptions of temporary and permanent site stabilization practices that will be employed, including schedule and site plan.
- Detailed descriptions of structural controls that will be employed at the site.
- Maps showing topography and drainage patterns (pre-and post-construction), existing and proposed structures, roads, utilities, ROWs, water bodies, property boundaries and ownership, boundaries of construction and soil disturbance, locations where structural controls will be implemented, locations where flow channels and/or sedimentation basins will be constructed, areas where permanent stabilization and revegetation will be implemented after construction, etc.
- Schedules for inspections to ensure that the site-specific BMPs are implemented and maintained.

END OF SECTION

SECTION 01 42 00

REFERENCES

PART 1 GENERAL

1.01 SUMMARY

A. This section covers definitions and reference standards which relate to MSFC projects.

1.02 DEFINITIONS

A. Indicated: The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. Location is not limited.

B. Directed: Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed, requested, etc. by the Contracting Officer or an authorized representative such as the A/E.

C. Approved: The term approved, when used in conjunction with the A/E's action on the Contractor's submittals, applications, and requests, means approved by the A/E.

D. Equal: The term "equal" when used in the specifications means equal as determined by the A/E or by the Contracting Officer.

E. Regulations: The term regulations includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the work.

F. Furnish: The term furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. Install: The term install describes operations at the Project Site including the actual unloading, unpacking, assembly, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. Provide: The term provide means to furnish and install, complete and ready for the intended use.

I. Installer: An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term experienced, when used with the term Installer, means having a minimum of 3 previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.

J. Trades: Using terms such as carpentry does not imply that certain construction activities must be premiered by accredited or unionized individuals of a corresponding generic name, such as carpenter. It also does not imply that requirements specified apply exclusively to trades persons of the corresponding generic name.

K. Assigning Specialists: Specialists are recognized experts in operations where required by the specifications. Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in those operations. The specialists shall be engaged for those activities, and their assignments are requirements over which the Contractor has no option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.

L. Project Site: Is the space available to the Contractor for performing construction activities, either exclusively or in conjunction, with others performing other work as part of the Project. The extent of the Project Site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

M. Testing Agencies: A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

N. A/E: This is the entity responsible for the design of the project, usually a government employee or government contractor. The

A/E may have duties relating to the interpretation of the Contract Documents or other duties as designated by the Government.

O. Government Inspector: The Government Agency or contractor responsible for the day-to-day observation of the project.

P. Contracting Authority: Any of the designated Government authorities responsible for a portion of the administration of the project. This authority may be designated Contracting Officer or COTR.

Q. COTR: Contracting Officer's Technical Representative. This authority will be identified by the Government at the pre-construction conference.

R. Contractor: The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The term "Contractor" means the Contractor or the Contractor's authorized representative.

1.03 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specification Format: These specifications are organized into Divisions and Sections based on the Construction Specifications Institute's (CSI) 49-Division format and MASTERFORMAT numbering system.

B. Specification Content: This Specification uses certain conventions regarding the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

1. Abbreviated Language: Language used in Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpolated as the sense requires. Singular words shall be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.

2. In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an", but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

3. Imperative and streamlined language is used generally in the Specifications. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the Text, subjective language is used for clarity to describe responsibilities that shall be fulfilled indirectly by the Contractor, or by others when so noted.

4. The words “shall be” are implied wherever a colon (:) is used within a sentence or phrase.

1.04 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with the standards in effect as of the date of the Contract Documents unless otherwise designated in the Contract Documents.

C. Conflicting Requirements: Where compliance with 2 or more standards is specified, and where the standards may establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer requirements that are different but apparently equal, and uncertainties in requirements, to the Contracting Officer for a decision before proceeding.

1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of the requirements. Refer uncertainties to the Contracting Officer for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents. Where copies of standards

are needed to perform a required construction activity, the Contractor shall obtain copies directly from the publication source.

E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations, as referenced in Contract Documents, are defined to mean the associated names. Names, addresses, and URLs are subject to change, and are believed, but not assured, to be accurate and up-to-date as of the date of publication of the Contract Documents:

AA	The Aluminum Association, Inc. 900 19th Street, NW Washington, DC 20006 www.aluminum.org	(202) 862-5164
AASHTO	American Association of State Highway & Transportation Officials 440 North Capitol Street, NW, Suite 249 Washington, DC 20001 www.aashto.org	(800)-231-3475
ACI	American Concrete Institute P.O.Box 9094 Farmington Hills, MI 48333 www.aci-int.org	(248) 848-3700
AFPA	American Forest & Paper Association 1111 19th Street, NW, Suite 800 Washington, DC 20036 www.afandpa.org	(202) 463-2467
AGC	The Associated General Contractors of America 333 John Carlyle Street, Suite 200 Alexandria, VA 22314 www.agc.org	(703) 837-5317
AIA	The American Institute of Architects 1735 New York Ave., NW Washington, DC 20006 www2.aia.org	(800) 242-3837 (202) 626-7300

AISC	American Institute of Steel Construction, Inc One East Wacker Drive Suite 3100 Chicago, IL 60601-2001 www.aisc.org	(312) 670-2400
AISI	American Iron and Steel Institute 1101 17th Street, N.W. Suite 1300 Washington, DC 20036 www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction 7012 S. Revere Parkway, Suite 140 Englewood, CO 80112 www.aitc-glulam.org	(303) 792-9559
ALDOT	Alabama Department of Transportation P.O. Box 303050 Montgomery, AL 36130-3050 www.dot.al.state.us	(334) 242-6358
ANSI	American National Standards Institute 25 West 43rd St., 4th Floor New York, NY 10036 www.ansi.org	(212) 642-4900
APA	APA - The Engineered Wood Association P.O. Box 11700 Tacoma, WA 98411-0700 www.apawood.org	(253) 565-6600
APA	Architectural Precast Association 6710 Winkler Road, Suite 8 Fort Myers, FL 33919 www.archprecast.org	(239) 454-6989
API	American Petroleum Institute 1220 L Street, NW Washington, DC 20005-4070 www.api.org	(202) 682-8000
ASCE	American Society of Civil Engineers 1801 Alexander Bell Drive Reston, VA 20191-4400 www.asce.org	(800) 548-2723 (703) 295-6300

ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers 1791 Tullie Circle, NE Atlanta, GA 30329 www.ashrae.com	 (800)-527-4723 (404) 636-8400
ASME	American Society of Mechanical Engineers P.O. Box 2900 Fairfield, NJ 07007-2900 www.asme.org	 (973) 882-1170 (800) 843-2763
ASTM	American Society for Testing & Materials 100 Barr Harbor Drive. West Conshohocken, PA 19428-2959 www.astm.org	 (610) 832-9585
AWI	Architectural Woodwork Institute 1952 Isaac Newton Square West Reston, VA 20190 www.awinet.org	 (707) 733-0600
AWPA	American Wood Preserver's Association P.O. Box 361784 Birmingham, AL 35236-1784 www.awpa.com	 (205) 733-4077 (205) 733-4075
AWS	American Welding Society, Inc. 550 Lejeune Road N.W. Miami, FL 33126 www.aws.org	 (800) 443-9353 (305) 443-9353
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235 www.awwa.org	 (800)-926-7337 (303) 794-7711
BHMA	Builders Hardware Manufacturers Association 355 Lexington Avenue, 17th Floor New York, NY 10017 www.buildershardware.com	 (212) 297-2122
BIA	Brick Industry Association 11490 Commerce Park Drive Reston, VA 20191-1525 www.bia.org	 (703) 620-0010 X111

BOCA	Building Officials and Code Administrators International 4051 W. Flossmoor Road Country Club Hills, IL 60478 www.bocai.org	(708) 799-2300
CMAA	Crane Manufacturers Association of America 8720 Red Oak Boulevard, Suite 210 Charlotte, NC 28217 www.mhia.org/psc/PSC_Products_Cranes.cfm	(704) 676-1190
CRSI	Concrete Reinforcing Steel Institute 933 North Plum Grove Road Schaumburg, IL 60173 www.crsi.org	(847) 517-1200
CSDA	Concrete Sawing & Drilling Association 10901 D Roosevelt Blvd. N., Suite 100 St. Petersburg, FL 33716 www.csda.org	(727) 577-5004
CSI	Construction Specifications Institute 99 Canal Center Plaza, Suite 300 Alexandria, VA 22314 www.csinet.org	(800)-689-2900 (707) 684-0300
FM	Factory Mutual Global P.O. Box 7500 Johnston, RI 02919 www.fmglobal.com	(401) 275-3000
GA	Gypsum Association 810 First St., NE, Suite 510 Washington, DC 20002 www.gypsum.org	(202) 289-5440
IBC	International Building Code: available from SBCCI or BOCA as listed herein. www.intlcode.org	
IEEE	Institute of Electrical and Electronic Engineers 3 Park Avenue, 17th Floor New York, NY 10016-5997 www.ieee.org	(212) 419-7900

IESNA	Illuminating Engineering Society of North America 120 Wall Street, 17th Floor New York, NY 10005 www.iesna.org	 (212) 248-5000
LGSEA	Light Gage Steel Engineers Association 1201 15th Street, NW, Suite 320 Washington, DC 20005 www.lgsea.com	 (866)-465-4732 (202) 263-4488
LGSFA	Light Gage Steel Framing Alliance www.lgsframing.com	 (866) 316-5300
LGSI	Light Gage Structural Institute Loseke Technologies 5150 Paige Road The Colony, TX 75056 www.loseke.com/lgsi.html	 (973) 370-0967
MBMA	Metal Building Manufacturers Association 1300 Sumner Ave. Cleveland, OH 44115-2851 www.mbma.com	 (216) 241-7333
ML/SFA	Metal Lath/Steel Framing Association See SSMA	
NEC	National Electrical Code (from NFPA)	
NEMA	National Electrical Manufacturers Assoc. 1300 North 17th Street, Suite 1847 Rosslyn, VA 22209 www.nema.org	 (703) 841-3200
NFPA	National Fire Protection Assoc. One Batterymarch Park P.O. Box 9101 Quincy, MA 02269-9101 www.nfpa.org	 (800) 344-3555 (617) 770-3000
NRMCA	National Ready-Mixed Concrete Association 900 Spring Street Silver Spring, MD 20910 www.nrmca.org	 (301) 587-1400

NSF	National Sanitation Foundation 3475 Plymouth Rd. P.O. Box 130140 Ann Arbor, MI 48113-0140 www.nsf.org	 (800) 223-2301 (734) 769-8010
PCI	Precast/Prestressed Concrete Institute 209 West Jackson Boulevard Chicago, IL 60606-6938 www.pci.org	 (312) 786-0300
PDCA	Painting and Decorating Contractors of America 3913 Old Lee Highway, Second Floor Fairfax, VA 22030 www.pdca.com	 (703) 383-0800
RCSC	Research Council on Structural Connections Through AISC www.boltcouncil.org	
SBCCI	Southern Building Code Congress International 900 Montclair Road Birmingham, AL 35213-1206 www.sbcci.org	 (205) 591-1853
SDI	Steel Deck Institute P.O. Box 25 Fox River Grove, IL 60021 www.sdi.org	 (847) 458-4647
SJI	Steel Joist Institute 3127 10th Avenue N. Ext. Myrtle Beach, SC 29577-6760 www.steeljoist.org	 (843) 626-1995
SMACNA	Sheet Metal & Air Conditioning Contractors' National Association 4201 Lafayette Center Drive Chantilly, VA 20151-1209 www.smacna.org	 (703) 803-2980
SSMA	Steel Stud Manufacturers Association 8 South Michigan Avenue Chicago, IL 60603 www.ssma.com	 (312) 456-5590

SSPC	The Society for Protective Coatings 40 24th Street, 6th Floor Pittsburg, PA 15222-4656 www.sspc.org	(877) 281-7772
TCA	Tile Council of America, Inc. 100 Clemson Research Blvd. Anderson, SC 29625 www.tileusa.com	(864) 646-8453
TPI	Truss Plate Institute 583 D'Onofrio Drive, Suite 200 Madison, WI 53719 www.tpinst.org	(608) 833-5900
UL	Underwriters Laboratories 333 Pfingsten Rd. Northbrook, IL 60062-2096 www.ul.com	(847) 272-8800
WPC	Wood Products Council 3380 Sheridan Drive, PMB 327 Amherst, NY 14226-9914 www.woodinfo.com	(800)-520-6281

F. Federal Government Agencies: Names and titles of federal government standard or specification producing agencies are often abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard or Specification-producing agencies of the federal government. Names, addresses, and URLs are subject to change, and are believed, but are not assured, to be accurate and up-to-date as of the date of the publication of the Contract Documents:

CFR	Code of Federal Regulations (Available from the Government Printing Office) 732 N. Capitol St. NW Washington, DC 20401 (Material is usually first published in the "Federal Register") www.access.gpo.gov/nara/cfr/	(202) 512-0000
CPSC	US Consumer Product Safety Commission Washington, DC 20207-0001 www.cpsc.gov	(800) 638-2772

EPA	Environmental Protection Agency Ariel Rios Building 1200 Pennsylvania Avenue, NW Mail Code 3213A Washington, DC 20460 www.epa.gov	(202) 260-2090
HUD	Department of Housing and Urban Development Office of Lead-Based Paint Abatement and Poisoning Prevention Room B-133 451 7th St., SW, Washington DC 20410 www.hud.gov	(202) 755-1805
MS	Military Specifications Department of Defense Single Stock Point Bldg. 4/D 700 Robbins Avenue, Philadelphia, PA 19111-5094	(215) 697-2179
MSHA	Mine Safety and Health Administration (U.S. Department of Commerce) 1100 Wilson Blvd., 21st Floor Arlington, VA 22209-3939 www.msha.gov	(202) 693-9400
NIOSH	National Institute of Occupational Safety and Health Hubert H. Humphrey Building 200 Independence Ave, SW Washington, D.C. 20210 www.cdc.gov/niosh/homepage.html	(800) 356-4674
NIST	National Institute of Standards and Technology (U.S. Department of Commerce) 100 Bureau Dr. Stop 3460 Gaithersburg, MD 20899-3460 www.nist.gov	(301) 975-6478
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor) 200 Constitution Ave., NW Washington, DC 20210 www.osha.gov	(800)-312-6742 (202) 219-6091

USDA	US Department of Agriculture www.usda.gov

END OF SECTION

SECTION 01 45 00

QUALITY ASSURANCE / QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

This specification sets forth quality assurance/quality control requirements for the provision of materials, equipment, systems, inspections, tests, services, and construction of facilities and site improvements.

1.02 RELATION TO OTHER CONTRACT DOCUMENTS

The requirements of this specification shall be fully complied with in close concert with the detail requirements of the technical specifications and all other contract documents. Overlapping and interfacing contractual requirements shall not result in duplication of Contractor efforts. The quality program shall effectively complement and support functions required by the technical specifications and other contract documents.

1.03 SUBMITTALS

A. The following shall be submitted in accordance with Section 01 33 00 “Submittals,” in sufficient detail to shown full compliance with the specification:

SD-01 Preconstruction Submittals

1. Contractor’s Quality Assurance/Quality Control Plan as described in this Section. The Contractor’s primary QA/QC Plan shall be submitted per the terms and conditions of the Construction IDIQ or Center Operations Services Support (COSS) contract. If noted on the drawings, a project or delivery order specific QA/QC Plan shall be submitted.

B. Contractor’s Quality Assurance / Quality Control Plan

Describe how the quality requirements of the contract documents will be met, and address each of the following:

1. Delegation of Contractor’s authorized representative responsible for quality assurance / control of contract work.

2. The Contractor's procedure for accomplishing and reviewing construction methods and controls, fabrication controls, certifications, documentation of quality control operations, inspections, and test records including those required for suppliers and subcontractors. Describe methods to be effected during procurement of construction materials, suppliers, subcontractor, on-site and off-site fabrication and assembly of Contractor-furnished materials and equipment, work procedures, workmanship, and testing to ensure full compliance with drawings, specifications, codes, regulatory requirements, and other contract documents.

   The Contractor's program shall provide for a functional system to document that quality provisions of contract schedules, specifications, and drawings have been performed.

3. Training, certification(s), and re-certification(s) of personnel as required by the contract documents.

4. Certification of materials, processes, or equipment as required by the contract documents.

5. Qualification of procedures as required by the contract documents.

6. Nondestructive testing requirements as required by the contract documents.

7. Identification of independent certifying and testing laboratories to be used as required by the contract documents.

C. RECORDS

Records shall include all quality control data; factory test plans/results, manufacturer's certifications, receiving inspections, deficiency reports; non-conformance reports; training / certifications; and routine technical test plans / results, i.e., hydrostatics, electrical continuity, grounding, welding, line cleaning, etc. Quality records shall be available for examination by the designated Government representatives. The Contractor shall provide copies of tests plans / reports and data upon request of Government's designated representatives. Quality control records shall be maintained in a central on-site location. Maintenance of quality control records shall not relieve the Contractor from

submitting samples, test data, detail drawings, material certifications, or other information required by each section in the specification. All quality records shall be turned over to the Government's designated representatives as a file of record at contract completion.

1.04 QUALITY ASSURANCE

A. Qualifications

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 certifications prior to starting the work.

B. Management and Organization

Contractor shall ensure effective execution of quality assurance / quality control functions and provide competent personnel to provide supervision, inspection, and testing. Contractor shall be responsible for each of his suppliers and subcontractors. Contractor shall provide quality assurance oversight of suppliers and subcontractors and ensure that each provides effective quality control in the execution of their work.

The program shall encompass management and supervisory actions that affect quality of all work-in-progress and finished construction work.

The individual designated to direct the program shall report to the contractor's management and shall have the necessary authority to discharge his responsibilities.

C. Identification and Data Retrieval

The Contractor shall have an identification and data retrieval system. Records, drawings, submittals, and equipment shall be identified to reference the following:

1. Contract Number

2. Contract Specification Number

3. Contract Drawing Number

4. Submittal Document Number

5. Contract Change Number

6. Contractor's Drawing Number System

D. Procurement

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

1. The Contractor shall ensure that his purchase documents include:

   a. The basic quality requirements, standards, drawings, and specifications called out in the contract specifications.

   b. Inspection and Test Characteristics.

   c. Inspection and Test Records.

   d. Operation and Maintenance (O&M) manuals, Instructions, Certifications of Compliance, and such other data as may be required by the specification.

   e. Preservation, packaging, shipping directions.

2. When Government source inspection is required on a Contractor's purchase, the purchase document shall include the following statement:

   "All work on this order is subject to inspection and testing by the Government at any time and place. The Contracting Officer shall be notified immediately upon receipt of this order. The Contacting Officer shall be notified 48 hours in advance of the time articles or processes are ready for inspection or test."

3. Procurements that do not require Government source inspection shall include the following statement:

   "The Government reserves the right to inspect any or all of the materials included on this order at the Contractor's plant and material supplier's factory."

4. Required Government source inspections will be determined by the Contracting Officer. Government source inspections shall not replace Contractor inspections or relieve the Contractor of his responsibility for ensuring quality procurements and records verifying quality control activities.

E. Receiving Inspection System

1. Contractor shall maintain a receiving inspection system that ensures procured materials and equipment are inspected and tested when received and that they comply with the contract documents.

2. Shipping / receiving inspection records shall accompany each procurement delivery to the construction site. Maintain records of contractor's receiving inspections at the construction site.

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

F. Nonconforming Articles and Material Control

1. The Contractor shall control nonconformances discovered by the Contractor, subcontractors, suppliers or Government quality representatives to prevent their use and to correct deficient operations. Contractor shall prepare a construction deficiency report for each instance comprising:

   a. A unique and traceable number.
   b. Identification of the nonconforming article or material.
   c. A description of the nonconformance and the applicable requirement.
   d. Cause or reason for the nonconformance.
   e. Remedial actions taken or recommended.
   f. Disposition of the nonconforming article or material

2. The Contractor shall identify, mark, and segregate each nonconforming article for removal from the work area to prevent inadvertent use.

3. The Contractor shall monitor and correct deficient operations.

G. Fabrication, Process, and Work Control

1. The Contractor's procedures and controls shall be derived from stated requirements in contract specifications and drawings.

2. The Contractor shall establish all in-process inspections that are necessary to ensure compliance with quality requirements that are not readily detectable or measurable by inspection and testing of finished elements.

3. Special in-process inspections may include, but are not limited to, concrete placement, piping system cleaning, plating, anodizing, nondestructive testing, welding, and soldering.

H. Drawings and Change Control

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

2. Drawing changes shall be clearly delineated. Accomplished changes shall be clearly identified and associated drawings shall be marked for revision. Drawings that have been approved, or approved as noted, by the Contracting Officer shall be used for fabrication and inspection.

3. At completion of work, the Contractor shall furnish to the Government one marked print and/or sketch showing an accurate record of as-built conditions.

I. Quality Inspection

1. Government Inspections

a. Work performed under the general direction of the contracting Officer will be subject to inspection by authorized representatives. No representative is permitted to change specifications or drawings

without written authorization from the Contracting Officer.

b. Government in-process and end-item inspections may, at the Government's discretion, be performed on site and/or at the Contractor's, subcontractor's, or material supplier's facility by the Government representatives.

c. Government shall be notified with sufficient advance notice of Contractor work plans which will cover up or make inaccessible previously installed work which may require Government inspection, i.e., backfilling or encasing of any underground utility, concrete placement, etc.

d. Failure to provide such notification may require the work be uncovered to inspect the work. Uncovering and restoration of the work shall be at the Contractor's expense.

e. The Contractor's quality assurance/control program is subject to continuous evaluation, review, and verification by the Contracting Officer. The Contractor will be notified in writing of any noncompliance area and shall correct identified deficiencies within five working days.

2. Contractor's Quality Inspections

Contractor shall implement an inspection system. Documentation shall indicate quality control through records of inspections and tests. Contractor shall ensure that nonconforming products are discovered, documented, and controlled. Procedures eliminating future deficiencies shall be implemented.

Contractor's quality assurance system shall include the following:

a. Single Contractor's representative responsible for on-site / off-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 verifying material and equipment is compliant with plans and specifications.

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

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

f. Identification of test(s) to be performed, test procedures, test plans / reports, records, and independent organization used.

g. Documenting and maintaining certification or re-certification of procedures, personnel, and equipment.

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

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

The Contractor shall establish own system of scheduled or random sample inspections and audits to ensure objectives are met.

J. Manufacturer's Field Services

1. Responsibility for Inspection and Testing

Contractor is responsible for the performance of inspections and tests. Each shall be recorded. If the Contractor utilizes independent inspection and testing laboratories or services, they shall be acceptable to the Government.

2. Inspection and Test Records

The 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, test plans / reports, result of inspections or tests, nature of defects, causes for rejection, proposed remedial action, and corrective actions taken.

1.05 HANDLING AND STORAGE

A. The Contractor shall provide controls and procedures which meet requirements of each section of the specifications.

B. 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.

1.06 SEQUENCING AND SCHEDULING

A. Contractor shall notify the Government a minimum of 48 hours prior to scheduled inspections and tests.

B. Contractor shall provide 24 hour notice to the Government of the date when the contract work will begin at the site.

C. When Contractor suspends work for 5 working days or longer prior to completions, he shall notify the Contracting Officer. Work shall not resume without notification to the Contracting Officer.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION

SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Products.

B. Substitutions.

C. Transportation and handling.

D. Storage and protection.

1.02 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the work. Does not include machinery and equipment used for preparation, fabrication, conveying or erection of the Work. Products may also include existing materials or components required for reuse.

B. Do not use materials and equipment removed from the existing premises, except as specifically permitted by the Contract Documents.

1.03 SUBSTITUTIONS

A. Unless otherwise noted, all items are specified on an "Approved Equal" basis.

B. Document each request for substitution with complete data substantiating compliance of proposed Substitution with Contract Documents.

C. A request for substitution constitutes a representation that the Contractor:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.

2. Will provide the same warranty for the Substitution as for the specified product.

3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to the Government.

4. Waives claims for additional costs or time extension which may subsequently become apparent.

5. The Contractor shall be responsible for additional design cost required by substitutions.

D. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals without separate written request, or when acceptance will require revision to the Contract Documents.

1.04 TRANSPORTATION AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.05 STORAGE AND PROTECTION

A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.

B. For exterior storage of fabricated products, place on sloped supports, above ground.

C. Provide off-site storage and protection when site does not permit on-site storage or protection.

D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

E. Store loose granular materials on solid flat surfaces in a well-drained area. Protect from mixing with foreign matter.

F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

G. Arrange storage of products to permit access for inspection. Periodically inspect to ensure products are undamaged and are maintained under specified conditions.

1.06 REFERENCES

Publications, codes, standards and other documents referred to within the various Sections of this project manual shall form a part of the contract documents to the extent referenced and shall have the same force and effect as if bound into this project manual.

PART 2.0 PRODUCTS

Not Used.

PART 3.0 EXECUTION

Not Used.

END OF SECTION

SECTION 02 41 00

DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removal of materials and equipment from an existing building in preparation for remodeling

B. Demolition of structural members

C. Salvage of materials and equipment and delivery to the Government

D. Disposal of debris and equipment

1.02 RELATED SECTIONS

A. Section 01 35 43, Environmental Procedures
B. Section 02 82 00, Asbestos Remediation

1.03 REFERENCES

A. CODE OF FEDERAL REGULATIONS (CFR)
29 CFR 1926 Safety and Health Regulations for Construction

1.04 DEFINITIONS

A. Demolition: Removal or disturbance of a structural member or load bearing wall.

B. Removal: Relocation or displacement of materials or equipment including built-in non structural material.

1.05 SUBMITTALS

Submit for approval: All required submittals shall be submitted in accordance with Section 01 33 00, Submittals, in sufficient detail to show full compliance with the contract requirements. Items listed on the Schedule of Submittals may include but not necessarily limited to the following:

A. Demolition Plan: Submit a demolition plan to the A/E for approval at least 10 days prior to commencement of work. The plan shall be in accordance with OSHA regulations 29 CFR 1926.

B. Safety Plan: Submit a Safety Plan specific to this project.

C. Waste Management Plan per Section 01 35 43 – 1.02.

D. Waste Reduction Report per Sections 01 35 43 - 1.02 and 01 35 43 – 3.04.B.

1.06 OCCUPANCY OF BUILDING

A. The work on this project may be in areas that are to be occupied during construction operations. Coordinate with Government personnel to allow work to continue as scheduled.

B. If required, barricades and dust barriers shall be erected to separate construction areas from other work.

C. Existing utilities serving facilities occupied and used by the Government shall not be interrupted except when approved in writing and then only when temporary utility services have been provided and approved.

D. Where entire buildings are to be demolished, the Government will disconnect and seal utilities prior to the start of demolition.

1.07 PRECAUTIONS AGAINST MOVEMENT

A. Provide shoring and bracing as required to prevent movement, settlement, or collapse of a structure or part of a facility that will remain.

PART 2 PRODUCTS (Not used)

PART 3 EXECUTION

3.01 DUST ABATEMENT

A. Erect dust barriers to protect adjacent areas from dust and debris from construction and demolition operations. Remove upon completion.

B. Dust barriers shall be, as a minimum, six mil polyethylene on a wood frame.

3.02 BELOW GRADE CONSTRUCTION

A. Remove foundations, basement slabs on ground, and other below grade construction to a depth shown and remove demolished material.

B. Fill voids created by demolition and removal process with suitable approved and tested fill material.

3.03 DISPOSAL OF REMOVED MATERIAL

A. Remove debris, rubbish, and other materials resulting from demolition and removal operations. Removed materials shall not be stored on the site nor sold on Government property.

B. Material classified as hazardous or controlled waste shall be handled and disposed of as specified in Section 01 35 43, Environmental Procedures and other applicable specification Sections.

3.04 SALVAGED MATERIAL

A. All salvageable material and equipment shall remain the property of the Government unless specifically noted on the drawings. Material and equipment designated to be salvaged shall be delivered to the Government as noted on the drawings.

B. Salvageable material and equipment designated to become the property of the Contractor shall be removed from Government property prior to being cleaned, reconditioned or otherwise worked on.

END OF SECTION

SECTION 02 82 00

ASBESTOS REMEDIATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedure to be taken if Asbestos Containing Materials (ACM) identified on the drawings may be disturbed in the course of construction operations.

B. Procedure to be taken if material suspected of being ACM is encountered in the course of construction operations.

C. Procedure to be taken if work is required above ceilings where ACM is known or suspected to be present.

1.02 REFERENCES

A. 29 CFR 1910.1001 - OSHA Asbestos Standard for General Industry
B. 29 CFR 1926.1101 - OSHA Asbestos Standard for the Construction Industry
C. 40 CFR 61 Subpart M - NESHAP
D. 49 CFR 171, 172 & 173 - Department of Transportation (DOT)

1.03 RELATED SECTIONS

Section 01 35 43 “ENVIRONMENTAL PROCEDURES,” Procedures for removal and disposal of ACM.

1.04 DEFINITIONS

Air Monitoring: The process of measuring the fiber content in a specific volume of air in a stated period of time.

Asbestos: Chrysotile, amosite, crocidolite, tremolite, anthophyllite and actinolite.

ACM: Asbestos Containing Material(s)

EEOH: Environmental Engineering and Occupational Health mission service contractor at MSFC.

Friable: Capable of being crumpled or reduced to powder by hand pressure.

ADEM: Alabama Department of Environmental Management

EPA: The Environmental Protection Agency

NESHAP: National Emission Standards for Hazardous Air Pollutants

OSHA: The Occupational Safety and Health Administration

Personal air monitoring: The process of monitoring the fiber content of air in the breathing zone of a worker performing asbestos related work.

1.05 SUBMITTALS

Submit the following for all work involving asbestos abatement whether listed on the Schedule of Submittals or not:

A. TRAINING DOCUMENTATION

Submit evidence that all employees exposed to asbestos in excess of the permissible exposure limit have been trained in accordance with the requirements of 29 CFR 1926.1101 and have obtained EPA accreditation in accordance with their duties. Contractor/Supervisor shall obtain Contractor/Supervisor accreditation and workers shall obtain worker accreditation.

B. MEDICAL EXAMINATIONS

List of medical examinations. Also submit a list of all employees that have received medical examinations as required by OSHA regulations (see 1010.134(b) (10) and 1926.1101). This list shall be updated if new employees are hired after work begins. Do not submit medical records.

C. CONTRACTOR LICENSES/CERTIFICATIONS

If asbestos abatement is to be performed as part of this project the contractor shall be licensed in the State of Alabama for the performance of asbestos abatement work.

D. ASBESTOS REMOVAL PLAN

If asbestos work is a part of this contract, submit detailed plan within 10 days after receipt of Notice of Award detailing the Contractor proposed asbestos removal plan. The plan shall include location of asbestos control areas, location and layout of worker decontamination unit, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and encapsulant to be used. The plan shall be approved by the Contracting Officer prior to the start of any asbestos work.

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E. ASBESTOS MANAGEMENT INFORMATION SYSTEM UPDATE FORM (MSFC Form 4508)

As asbestos remediation work progresses, maintain a MSFC Form 4508 on the construction site. Record all locations of asbestos remediation as it occurs on the MSFC Form 4508. At the completion of the project, the Contractor shall submit the MSFC Form 4508 per the schedule of submittals. A form shall be completed for each room and area where ACM is removed. See Attachment A to this section for a copy of MSFC Form 4508.

F. PERMITS

Submit proof satisfactory to the Contracting Officer that all required permits, site location and arrangements for transport and disposal of asbestos-containing or contaminated waste materials and supplies have been obtained.

1.06 ADEM NOTIFICATION

The Contractor shall notify the following office in writing 10 days prior to beginning any asbestos removal operations; Alabama Department of Environmental Management (ADEM).

The Contractor shall supply the Alabama Department of Environmental Management (ADEM) with the following information:

Name and address of Contractor.

Address and description of the building, including size, age, prior use of the building, and square footage of asbestos-containing material to be removed.

Scheduled starting and completion dates for removal.

Name and address of landfill where the asbestos waste will be deposited.

Copy of a completed EPA Notification of Demolition and Renovation Form.

1.7 QUALITY ASSURANCE

A. Contractors performing work in areas containing ACM shall be qualified and accredited in accordance with OSHA, EPA, ADEM and other governing regulations.

B. Perform all work in accordance with OSHA, EPA, NESHAP, ADEM and other governing regulations.

C. Provide evidence acceptable to the COTR that workers in areas containing ACM or suspect ACM have been properly fitted with respirators

and have been properly trained in accordance with 40 CFR part 61 (NESHAP) and other governing regulations. Provide evidence acceptable to the COTR that workers in areas containing ACM or suspect ACM have been properly fitted with respirators and have been properly trained and accredited in accordance with OSHA, EPA and other governing regulations.

PART 2 PRODUCTS (not used)

PART 3 EXECUTION

3.01 MATERIALS IDENTIFIED AS ACM

A. If ACM is identified on the drawings as a product in a known location and the ACM must be removed to accomplish the contract, the removal and disposal shall be a part of this contract unless otherwise specifically stated in the contract documents. Examples are: 1) Asbestos containing pipe insulation where the contract requires removal or reworking of the pipe; 2) Asbestos containing siding or roof deck which must be removed or penetrated as part of the contract.

B. If ACM is identified on the drawings as a product in the vicinity of construction operations and which may accidentally be disturbed during construction, the contractor shall provide protective measures approved by the COTR to prevent its disturbance.

Example: Asbestos containing pipe insulation on pipes which are not to be removed or reworked as part of this contract.

C. If friable ACM is identified on the drawings as being present above ceilings, proper procedures (specified herein) shall be used before removal of any portion of the ceiling.

Example: Sprayed ACM insulation or fireproofing on structure above a ceiling.

3.02 MATERIAL SUSPECTED OF BEING ACM

A. If an unidentified material is suspected of being ACM:

1. Do not disturb the suspect material.
2. Notify the COTR at once and await instructions. The COTR will arrange for sampling and testing by the EEOH and will provide instructions concerning barricades and warning signs, etc.

3.03 WORK ABOVE CEILINGS

If the contract requires any work above a ceiling or removal of a ceiling or portion of a ceiling where friable ACM is known to be or suspected to be present above or on the ceiling, the following procedures shall be followed:

1. Notify the COTR of impending operations as soon as practicable (but at least one week) before operations are to begin including a complete schedule for the work.

2. The COTR will arrange for HVAC and other utility outages and other coordination with the Government.

3. Separate the work area from occupied areas by installing "asbestos" warning barricade tape and posting "asbestos" warning signs at entrances to the work area.

4. Wear proper respiratory protection and protective clothing at all times while working in areas where asbestos may be disturbed.

5. Seal the work area as required by OSHA, NESHAP, EPA and other requirements. Seals shall remain until area is cleared and approved by the COTR.

6. Place 6 mil. polyethylene over furniture and floor to collect debris that may fall from above the ceiling. Upon completion of each activity, remove the polyethylene and dispose of it as controlled waste. Ensure that no debris or dust will remain within the room. Remove dust and debris that may fall on furniture or floors using a vacuum equipped with a HEPA filter and properly dispose of the dust as controlled waste. No sweeping or dusting will be allowed. Use wet methods only.

7. COTR will arrange for the Government air monitoring, clearance testing and return of HVAC and other utilities to normal operation, if required. The Contractor shall be responsible for personal air monitoring in accordance with OSHA requirements. The Government will determine if area air monitoring and clearance testing is required for the particular project and if so, will provide this monitoring at no cost to the Contractor.

3.04 REMOVAL / REPLACEMENT OF CEILINGS

A. In areas where asbestos-containing insulation or fireproofing is installed on the structure or deck above ceilings, asbestos-containing debris has been found on top of the existing ceilings.

B. Removal and disposal of ceiling tiles or ceiling systems in these areas is classified by OSHA as Class II abatement work and shall be performed by workers trained to perform OSHA Class II abatement work.

C. Where the project is limited to removal of a small quantity of ceiling tiles that can be placed in one glove bag or disposal bag, the work is classified by OSHA as Class III work and shall be performed by workers trained in OSHA Class III work.

3.05 REMOVAL OF ASBESTOS-CONTAINING FLOOR TILE

A. Asbestos-containing floor tile, sheet flooring, and mastic shall be removed in accordance with 29 CFR 1926.1101 (g)(8)(i) and other applicable regulations.

B. A utility outage shall be obtained prior to performing this work and the work shall be done after hours unless approval has been obtained from the COTR for work to be done during normal hours.

3.06 REMOVAL OF CARPET THAT IS INSTALLED OVER ASBESTOS-CONTAINING FLOORING

A. If carpet is required to be removed and the asbestos-containing flooring is not required to be removed, the following work practices shall be employed, as a minimum, to prevent excessive breakage of the flooring below:

1. Wet methods shall be used.
2. Carpet shall be cut into small strips and carefully removed so as to prevent breaking or pulling up the flooring.
3. Vacuums equipped with a HEPA filter and a disposable dust bag shall be used to collect dust from broken flooring as the carpet is removed.
4. All broken tile shall be placed in a disposable glove bag or waste bag for disposal. The area shall be thoroughly vacuumed of all dust and waste after removal of carpet prior to the completion of the job.
5. Areas where broken flooring is removed shall be filled with a approved floor filler prior to installing new carpet.
6. When the flooring under the carpet is intended to be used as the finished floor, clean the flooring using accepted methods. No sanding

or use of a floor polisher with greater than 300 RPM shall be used. Remove all broken tiles and replace with approved tiles.

B. A utility outage shall be obtained prior to performing this work and the work shall be done after hours unless approval has been obtained from the COTR for work to be done during normal hours.

C. The Facilities Office has designated the removal of carpet installed over asbestos-containing flooring to be done in accordance with OSHA Class III requirements and procedures. The work shall be done by personnel trained and accredited for OSHA Class III work.

ATTACHMENT A

ASBESTOS MANAGEMENT INFORMATION SYSTEM (AMIS) UPDATE FORM

ASBESTOS MANAGEMENT INFORMATION (AMIS) SURVEY UPDATE	
Date:	Page of
Facility Name:	CoF Contract Number:
Building Number:	Local Construction FWR Number:
Organization:	Maintenance FWR Number:
Point of Contact:	Phone Number:
Project Start Date:	Project Completion Date:
Contractor Printed Name and Title:	
Signature:	Date:
Inspector Signature:	Date:
Room Number or Hallway Number (Not both):	Entry Wall Location for rooms (from the center of room viewpoint .i.e., North, South, East, West):
	End Wall(s) Location for Hallways (North, South, East, West), if applicable:

List type of material, quantity, and Location: Material - Please be very specific i.e., steam pipe insulation, brown 9" X 9" floor tile. Quantity of asbestos removed in linear feet, square feet, each. Note location i.e. F1, C13 etc., reference AMIS room grid (sheet 4).

Type of Material	Quantity	Location

Was an asbestos survey conducted for this project? If yes, provide survey information to Scott Pinkson in EEOH.

Comments:

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ASBESTOS MANAGEMENT INFORMATION (AMIS) SURVEY UPDATE (CONTINUATION SHEET)

Room Number or Hallway Number (Not both):	Entry Wall Location for rooms (from the center of room viewpoint .i.e., North, South, East, West):
	End Wall(s) Location for Hallways (North, South, East, West), if applicable:

List type of material, quantity, and Location: Material - Please be very specific i.e., steam pipe insulation, brown 9" X 9" floor tile. Quantity of asbestos removed in linear feet, square feet, each. Note location i.e. F1, C13 etc., reference AMIS room grid (sheet 4).

Type of Material	Quantity	Location

Was an asbestos survey conducted for this project? If yes, provide survey information to Scott Pinkson in EEOH.

Comments:

Room Number or Hallway Number (Not both):	Entry Wall Location for rooms (from the center of room viewpoint .i.e., North, South, East, West):
	End Wall(s) Location for Hallways (North, South, East, West), if applicable:

List type of material, quantity, and Location: Material - Please be very specific i.e., steam pipe insulation, brown 9" X 9" floor tile. Quantity of asbestos removed in linear feet, square feet, each. Note location i.e. F1, C13 etc., reference AMIS room grid (sheet 4).

Type of Material	Quantity	Location

Was an asbestos survey conducted for this project? If yes, provide survey information to Scott Pinkson in EEOH.

Comments:

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SAMPLE LIST OF SUSPECT ACM'S

- Cement Pipes
- Cement Wallboard
- Cement Siding
- Asphalt Floor Tile
- Vinyl Floor Tile
- Vinyl Sheet Flooring
- Flooring Backing
- Construction Mastics (floor tile, carpet, ceiling tile, etc.)
- Acoustical Plaster
- Decorative Plaster
- Textured Paints/Coatings
- Ceiling Tiles and Lay-in Panels
- Spray-Applied Insulations
- Blown-in Insulation
- Fireproofing Materials
- Taping Compounds (thermal)
- Packing Materials (for wall/floor penetrations)
- High Temperature Gaskets
- Elevator Equipment Panels
- Vinyl Wall Coverings
- Elevator Brake Shoes
- HVAC Duct Insulation
- Boiler Insulation
- Breeching Insulation
- Ductwork Flexible Fabric Connections
- Cooling Towers
- Pipe Insulation (corrugated air-cell, block, etc.)
- Heating and Electrical Ducts
- Electrical Panel Partitions
- Electrical Cloth
- Electrical Wiring Insulation
- Roofing Shingles
- Roofing Felt
- Base Flashing
- Fire Doors
- Caulking/Putties
- Adhesives
- Wallboard
- Joint Compounds
- Spackling Compounds

TYPES OF ASBESTOS CONDITIONS

Good - Material with no visible damage or deterioration, or showing only very limited damage or deterioration.

Damaged - Material with the surface crumbling, blistered, water-stained, gouged, marred or otherwise abraded over less than one tenth of the surface if the damage is evenly distributed (one quarter if the damage is localized).

Severely Damaged - Materials with one or more of the following characteristics:

The surface crumbling or blistered over at least one tenth of the surface (one quarter if damage is localized).

One tenth (one quarter, if localized) of material hanging from the surface, deteriorated, or showing adhesive failure.

Water stains gouges, or mars over at least one tenth of the surface (one quarter if localized).

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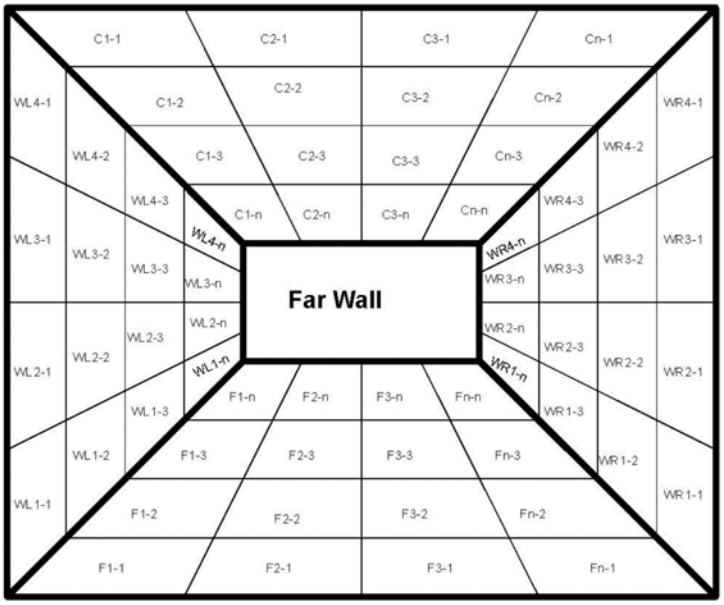
Asbestos Survey Room Grid

Note: Asbestos containing material above the ceiling should be noted on the ceiling grid



Far Wall

WF4-1	WF4-2	WF4-3	WF4-n
WF3-1	WF3-2	WF3-3	WF3-n
WF2-1	WF2-2	WF2-3	WF2-n
WF1-1	WF1-2	WF1-3	WF1-n

Entry Wall

WE4-n	WE4-3	WE4-2	WE4-1
WE3-n	WE3-3	WE3-2	WE3-1
WE2-n	WE2-3	WE2-2	WE2-1
WE1-n	WE1-3	WE1-2	WE1-1

1. Note: Entry wall depicted is as seen from inside the room, therefore grid WE4-n is located at the top left corner of wall. The main entry door is located within the entry wall.
2. Entry wall location shall be described as N (North) S (South) E (East) or W (West) as seen from the inside of the room. Utilizing the facilities data book, N is located at the top of page, S at bottom of page, E at right of page and W and left of page regardless of bearing shown on drawing for all buildings. (The directional bearing symbol is pointing to either NE or NW for approximately 29 buildings in the facilities data book. Consider these NE or NW bearings as being Plan N when identifying the direction of the entry wall.) The only exception is building 4705, this drawing shall be oriented towards North as shown on drawing.
3. Type of GRID System used depends on the Length (L) and Width (W) of the room.

   TYPE A - Either L or W is less than or equal to 32 feet, then n is equal to 4
   TYPE B - Either L or W is greater than 32 feet and less than or equal to 64 feet, then n is equal to 8
   Type C - Either L or W is greater than 64 feet and less than or equal to 96 feet, then n is equal to 12
   Type D - Either L or W is greater than 96 feet and less than or equal to 128 feet, then n is equal to 16
   Type E - Either L or W is greater than 128 feet and less than or equal to 160 feet, then n is equal to 20

Grid: C - ceiling, WF - far wall, WE - entry wall, WL - left wall, WR - right wall, F - floor

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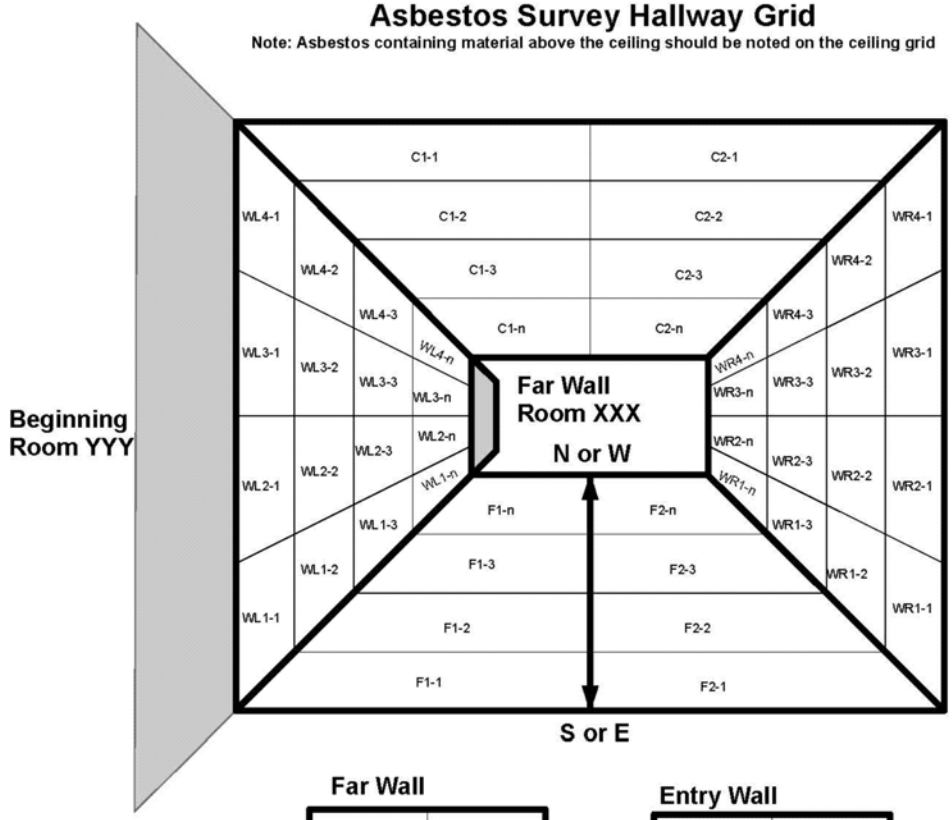
Asbestos Survey Hallway Grid

Note: Asbestos containing material above the ceiling should be noted on the ceiling grid



Far Wall

WF4-1	WF4-2
WF3-1	WF3-2
WF2-1	WF2-2
WF1-1	WF1-2

Entry Wall

WE4-1	WE4-2
WE3-1	WE3-2
WE2-1	WE2-2
WE1-1	WE1-2

1. Note: Entry wall and far wall are optional; there maybe neither that are identified in the hallway. Entry wall depicted is as seen from inside the room, therefore grid WE4-1 is located at the top left corner of wall.
2. The length of each hallway grid is to be assumed to be 8 feet. Length is the direction up and down the hallway. Round the total length of hallway to the nearest even multiple of 8. Ex. Length of hallway is 82 feet (round to 80 feet) therefore n will be equal to 10.
3. The identification of hallway segments will be determined by the end rooms. Hallways will be measured from South to North and from East to West Ex. Room most south of hallway is Room 107 and room most North of hallway is Room 200. Using H as the designation of hallway. The identification of hallway is HS107N200. Likewise from east to west would be HE107W200. The room number sequencing is arbitrary; Ex. HE200W107 would be acceptable.
   NS&EW are used to distinguish between vertical and horizontal run corridors on drawings.
4. Utilizing the facilities data book, N is located at the top of page, S at bottom of page, E at right of page and W and left of page regardless of bearing shown on drawing for all buildings. (The directional bearing symbol is pointing to either NE or NW for approximately 29 buildings in the facilities data book. Consider these NE or NW bearings as being Plan N when identifying the hallway number.) The only exception is building 4705, this drawing shall be oriented towards North as shown on drawing

Grid: C - ceiling, WF - far wall, WE - entry wall, WL - left wall, WR - right wall, F - floor

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END OF SECTION

SECTION 02 83 00

LEAD REMEDIATION

PART 1 GENERAL

1.01 SECTION INCLUDES

Surface preparation of exterior steel which is painted with lead-containing paint.

1.02 RELATED SECTIONS

Section 09 90 00 "Painting and Coating"

1.03 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z88.2	Respiratory Protection

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910.134	Respiratory Protection
29 CFR 1910.1200	Hazard Communication
29 CFR 1926. 62	Lead - Construction Industry
29 CFR 1926.57	Ventilation
29 CFR 1910.95	Occupational Noise Exposure

UNDERWRITERS LABORATORIES INC. (UL)

UL 586	High - Efficiency Particulate Air Filter Units
SSPC	The Society for Protective Coatings, 40 24th Street, 6th Floor, Pittsburgh, PA 15222
SSPC Technical Technical Guide No.6	"Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations"

1.04 DEFINITIONS

A. ACTION LEVEL
Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 - hour period.

B. LEAD CONTROL AREA
An enclosed area or structure with full containment to prevent the spread of lead dust, paint chips, or debris of lead-containing paint removal operations. The lead control area shall be isolated by physical boundaries to prevent unauthorized entry of personnel.

C. AREA MONITORING
Sampling of air to determine lead concentrations within the lead control area.

D. PHYSICAL BOUNDARY
Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel.

E. CERTIFIED INDUSTRIAL HYGIENIST (CIH)
As used in this section, refers to an Industrial Hygienist who is employed by the Contractor and is certified by the American Board of Industrial Hygiene in comprehensive practice.

F. CHANGE ROOMS AND SHOWER FACILITIES
Rooms within the designated physical boundary around the lead control area equipped with separate storage facilities for clean protective work clothing and equipment and for street clothes to prevent cross-contamination.

G. COMPETANT PERSON
Person employed by the Contractor who is trained in the recognition and control of lead hazards in accordance with current federal, state, and local regulations and has the authority to take prompt corrective actions to control the lead hazard. A Certified Industrial Hygienist (CIH) certified by the American Board of Industrial Hygiene or a Certified Safety professional (CSP) certified by the Board of Certified Safety Professionals is the best choice.

H. DECONTAMINATION ROOM
Room for removal of contaminated personal protective equipment (PPE).

I. EIGHT - HOUR TIME WEIGHTED AVERAGE (TWA)
Airborne concentration of lead averaged over an 8 - hour period.

J. HIGH EFFICIENCY PARTICULATE AIR (HEPA) FILTER EQUIPMENT
HEPA filtered vacuuming or exhaust ventilation equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated paint dust. A high efficiency particulate filter means 99.97 percent efficient against 0.3 micron size particles.

K. LEAD
Metallic lead, inorganic lead compounds, and organic lead soaps. Excluded from this definition are other organic lead compounds.

L. LEAD CONTROL AREA
A system of control methods to prevent the spread of lead dust, paint chips or debris to adjacent areas that may include temporary containment, floor or ground cover protection, physical boundaries, and warning signs to prevent unauthorized entry of personnel. HEPA filtered local exhaust equipment may be used as engineering controls to further reduce personnel exposures or building/outdoor environmental contamination.

M. LEAD PERMISSIBLE EXPOSURE LIMIT (PEL)
Fifty micrograms per cubic meter of air as an 8 - hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than 8 hours in a work day, the PEL shall be determined by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs. worked per day.

N. MATERIAL CONTAINING LEAD/PAINT WITH LEAD
Any material, including paint, which contains lead as determined by the testing laboratory using a valid test method. The requirements of this section does not apply if no detectable levels of lead are found using a quantitative method for analyzing paint or MCL using laboratory instruments with specific limits of detection (usually 0.01%). An X-Ray Fluorescence (XRF) instrument is not considered a valid test method.

O. PERSONAL MONITORING
Sampling of lead concentrations within the breathing zone of an employee to determine the 8 - hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and the center at the nose or mouth of an employee.

1.05 QUALITY ASSURANCE

A. In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, state, and local authorities regarding removing, handling and storing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

B. MEDICAL EXAMINATIONS
Before exposure to lead-contaminate dust, provide workers with a comprehensive medical examination as required by 29 CFR 1926.62 and 29 CFR 1910.1200.

C. MEDICAL RECORDS
Maintain complete and accurate medical records of employees for a period of at least 40 years or for the duration of employment plus 20 years, whichever is longer.

D. TRAINING
1. Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment, in accordance with 29 CFR 1910.1200.
2. Submit certifications signed and dated by the Contractor and by each employee stating that the employee has received training. Certify that the training course meets EPA requirements for the category of work assigned to the employee.

E. RESPIRATORY PROTECTION PROGRAM
1. Furnish each employee required to wear a negative pressure or other appropriate type respirator with a respirator fit test at the time of initial fitting and at least each year thereafter as required by 29 CFR 1926.62.
2. Establish and implement a respiratory protection program as required by 29 CFR 1910.134 and 29 CFR 1926.62.

F. HAZARD COMMUNICATION PROGRAM
Establish and implement a Hazard Communication Program as required by 29 CFR 1910.1200.

1.06 SAFETY AND HEALTH COMPLIANCE

In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of federal, state, and local authorities regarding removing, handling and storing of lead waste materials. Comply with the applicable requirements of the current issue of 29 CFR 1926.62. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most stringent requirement shall apply.

1.07 SUBMITTALS

A. Submit for approval items listed in the Schedule of Submittals in accordance with Section 01 33 00, SUBMITTALS.

B. In addition, submit the following for approval:

1. SD-08: Manufacturer's instructions for use of paint removal materials including material safety data sheet (MSDS).
2. SD-01: Respiratory protection program
3. SD-01: Hazard communication program
4. SD-01: Hearing conservation program
5. SD-01: Lead Compliance Plan Submit a detailed, job-specific plan of the work procedures to be used in the disturbance and/or removal of Material Containing Lead/Paint with Lead. The plan shall be prepared by a certified planner/project designer in the State of Alabama. Include as a minimum the following:
   a. Sketch showing the location, size and details of the control areas, critical barriers, physical boundaries, location and details of decontamination room, change room and shower facilities. Supplement with written description as required.
   b. Detailed description of mechanical ventilation.
   c. Description of equipment and materials, work practices, controls, and job responsibilities for each activity from which lead is emitted.
   d. Eating, drinking, smoking, hygiene facilities and sanitary procedures.
   e. Interface of trades and the sequencing of lead related work. This shall also include a description of arrangements made among contractors on multi-contractor worksites to inform affected employees and to clarify responsibilities to control exposures.
   f. Procedures for waste water collection, if applicable.

g. Procedures to capture dust containing lead and debris, to include blast media when applicable.
h. Procedures to monitor air samples to include occupational and environmental sampling, training and strategy, sampling and analysis strategy and methodology, frequency of sampling, duration of sampling, and qualifications of sampling personnel.
i. Personal blood, respirator, and personal protective equipment (PPE) monitoring procedures.
j. Method of containment to ensure that airborne concentrations of lead do not exceed 30 micrograms per cubic meter of air outside the lead control area.
k. Site preparation, clean-up, and clearance procedures.
l. For occupied buildings, include an occupant protection program that describes measures that the Contractor will take during the work to notify and protect the building occupants.

6. SD-01: Lead Waste Management Plan. Plan shall address the following:
   a. Identification and classification of wastes associated with the work.
   b. Estimated quantities of wastes to be generated and disposed of.
   c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact.
   d. Names and qualifications, to include experience and training, of personnel who will be working on-site with hazardous wastes.
   e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
   f. Spill prevention, containment, and clean-up contingency measures.
   g. Work plan and schedule for waste containment, removal, and disposal. Proper containment of waste includes using acceptable waste containers (e.g. 55-galn drums) as well as proper marking/labeling of containers. Wastes shall be cleaned up and containerized daily.
   h. Include any process that may alter or treat waste rendering a hazardous was non-hazardous.

7. SD-01: Safety Plan. See Section 01 35 23 “General Safety Requirements”
8. SD-01: PRECONSTRUCTION SUBMITTALS
   a. Certification of worker medical examinations
   b. Certification of employee training
   c. Employee exposure notification
   d. Competent person qualifications
   e. Lead waste management plan
   f. Written evidence that treatment, storage, disposal facility is approved for lead disposal.
9. SD-01 CLOSE-OUT SUBMITTALS
   a. Completed and signed hazardous waste manifest(s)
   b. Weigh turn-in tickets for non-hazardous waste disposed of at landfills

PART 2 PRODUCTS

2.01 PAINT REMOVAL PRODUCTS

A. Submit material safety data sheets (MSDS) for approval of paint removal products prior to use.

B. The soluble metal content and total metal content of abrasive materials shall not exceed values which would cause the material to be classified as hazardous waste.

2.02 EQUIPMENT

A. Have available for the A/E two complete sets of personal protective equipment (PPE) daily as required for entry into lead control area if needed. PPE shall include disposable whole body covering including foot, head, and hand protection.

B. Furnish workers appropriate NIOSH approved respirators for use in atmospheres containing lead dust. Comply with 29 CFR 1926.62 and 29 CFR 1910.134.

C. Furnish personal protective equipment (PPE) to workers exposed to lead-contaminated dust. PPE shall include whole body covering, foot covering and disposable plastic or rubber gloves.

D. The A/E and inspectors will provide their own respirators as required.

E. If rental equipment is used during lead-containing paint removal, handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Submit a copy of the notification to the A/E.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the facility and site to determine existing conditions.

B. The Contractor shall thoroughly clean the site of visible, existing Material Containing Lead/Paint with Lead that may be on the ground or in the proposed lead control area prior to the commencement of work.

C. Report conditions that differ from those described in the contract documents.

3.02 PROTECTION

A. Establish a lead control area approved by the A/E around each work site where surface preparation is being performed.

B. If surface preparation operations produce exposure to lead dust in excess of the PEL, provide containment which, together with powered negative air pressure inside the enclosure, will prevent lead-containing dust from entering the atmosphere outside the lead control area and which shall facilitate collection of dust and debris for disposal. The containment enclosure may be localized or enclose the entire work area.

C. Provide a change room, shower facility and hand washing facility for personnel exiting from the lead control area.

D. Protect adjacent facilities and area from damage and contamination by lead-contaminated dust. Clean, repair and restore surroundings to original condition or better.

E. Provide physical boundaries around work area designated on the drawings in accordance with 29 CFR 1926.62.

3.03 MECHANICAL VENTILATION SYSTEM

A. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.57.

B. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters approved by the A/E. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.

3.04 WARNING SIGNS

Provide warning signs at each approach to the lead control area. Follow 29 CFR 1926.62. Signs shall read:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

3.05 WORK PROCEDURES

A. Perform work in accordance with approved Lead Compliance Plan.

B. Provide engineering controls to limit exposure to lead.

C. Provide worker protection including work practice controls and administrative controls.

D. Provide a CIH or "Competent Person" trained in lead abatement procedures, health effects of lead, OSHA and EPA regulations. The CIH or Competent Person shall be present while work is being performed and shall ensure that all regulations are being properly carried out. Such person shall have the authority to stop work and make proper corrections if improper or unsafe conditions occur.

3.06 INITIAL EXPOSURE ASSESSMENT

A. Prior to beginning work assume that the worker exposure to lead dust will be in excess of 50 micrograms per cubic meter (PEL).

B. Perform personal monitoring of employees within the lead control area representative of a full shift including at least one sample for each job

classification in each work area either for each shift or for the shift with the highest exposure level. Follow 29 CFR 1926.62

C. Until the actual exposure is determined by personal monitoring, provide interim protection in accordance with 29 CFR 1926.62 as follows:
   1. Appropriate respiratory protection.
   2. Appropriate personal protective clothing.
   3. Change areas.
   4. Hand washing facilities.
   5. Biological monitoring to consist of blood sampling and analysis for lead and zinc protoporphyrin levels.
   6. Training
   7. Hazard communication

3.07 CONTINUAL MONITORING

A. If initial monitoring indicates exposure to lead in excess of the PEL, perform continual monitoring as required by 29 CFR 1926.62.

B. Conduct additional monitoring whenever there is a change of equipment, process, control, personnel or a new task initiated.

3.08 EMPLOYEE NOTIFICATION

A. Within 5 working days after completion of the exposure assessment notify each employee in writing the results which represent that employee's exposure.

B. Follow 29 CFR 1926.62.

3.09 HEARING PROTECTION

A. Provide hearing protection for employees exposed to noise levels in excess of 85 dBA over an 8 hour time weighted average.

B. Follow 29 CFR 1910.95.

3.10 METHODS OF COMPLIANCE

A. Provide engineering and work practice controls including administrative controls to reduce and maintain employee exposure to lead to or below the PEL to the extent that such controls are feasible. Supplement the engineering controls by the use of respiratory protection complying with 29 CFR 1926.62.

B. Establish and implement a written compliance program to achieve compliance with these specifications.

C. Follow 29 CFR 1926.62.

3.11 PERSONNEL EXITING PROCEDURES

A. Whenever personnel exit the lead control area, ensure that they perform the following:

1. Vacuum themselves off with HEPA filtered vacuums
2. Remove protective clothing in the decontamination room and place them in an approved impermeable disposal bag.
3. Shower and wash hands and face
4. Change into clean clothing in the change room prior to leaving the physical boundary of the job site.

3.12 EATING FACILITIES

A. Provide a lead free environment area outside the lead control area for eating and drinking.

B. Prior to entering the eating area ensure that employees perform the personal exiting procedures listed above. Showering is not required except at the end of the shift.

C. Ensure that no eating, drinking, chewing or smoking is allowed within the lead control area or decontamination area.

3.13 MEDICAL SURVEILLANCE

A. Provide initial medical surveillance of employees including biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels prior to exposure to lead.

B. Provide continuing biological monitoring of employees exposed to lead in excess of the action level in accordance with 29 CFR 1926.62.

C. Temporarily remove employees whose blood lead level is at or above 50 microgram per deciliter of whole blood. Removal, medical surveillance and return of removed employees shall be in accordance with 29 CFR 1926.62 including required medical removal protection benefits.

3.14 SURFACE PREPARATION

A. Clean surfaces of dirt, loose rust, and other gross contamination by any method outlined in SSPC-SP 1, Solvent Cleaning, or pressure water washing.

B. Remove loose rust by SSPC-SP 2, Hand Tool Cleaning, or SSPC-SP 3, Power Tool Cleaning. Feather edges around rust spots to produce a smooth painted surface. When using methods SP 2 or SP 3, contain and collect paint dust and debris using vacuums equipped with HEPA filters.

C. Spot prime rusted areas immediately after removing loose rust applying the specified primer at the specified thickness.

D. Roughen the entire existing paint surface with abrasive paper, hand wire brushing, power wire brushing or other approved method to produce a tooth for adhesion of new paint as required by the specified coating system. Contain and collect paint dust by using vacuums equipped with a HEPA filter.

E. Manual or power sanding or grinding of lead surfaces or materials is not permitted unless tools are equipped with HEPA attachments or wet methods are used. The dry sanding or grinding of surfaces that contain lead is prohibited. Provide methodology for removing lead in the Lead Compliance Plan.

3.15 INSPECTION

A. Notify the Government Inspector when surfaces are ready for inspection at the following stages of preparation:
   1. After removing rust before spot priming
   2. After final surface preparation before applying finish coating system

B. Do not proceed until approved by the Government Inspector.

3.16 ALTERNATE SURFACE PREPARATION

A. Rust may be removed and existing paint surface roughened by method SSPC-SP 7, Brush-off Blast Cleaning, provided the following are met:

   1. Contain and collect abrasives, paint dust and debris using a closed cycle vacuum recovery system equipped with HEPA filters.
   2. Handle and dispose of abrasives, paint dust and debris as specified in Section 01 35 43, Environmental Procedures.

3. Ensure that no visible emissions of lead-containing dust escape the enclosed vacuum recovery system.
4. Place two layers of 6 mil polyethylene under each work area extended twenty feet minimum beyond the work area in all directions to collect dust and debris that may escape the enclosed recovery system. Remove and dispose of the top layer as hazardous waste at the end of each shift. Contain and protect hazardous materials from escaping the lead control area due to wind or other means. Remove both layers of polyethylene upon completion.

3.17 CLEAN - UP

A. Maintain surfaces of the lead control area free of accumulation of dust and debris. Restrict the spread of dust and debris; keep waste from being distributed over the work area.

B. Do not dry sweep or use pressurized air to clean up the lead control area.

C. At end of each shift and when the lead operation has been completed, clean the controlled area of visible contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area, and wet wiping the area as indicated by the Lead Compliance Plan. After visible dust and debris is removed, wet wipe and HEPA vacuum all surfaces in the controlled area.

D. If adjacent areas become contaminated at any time during the work process - clean, visually inspect, and then wipe sample all contaminated areas.

E. For phased construction, clean each phase as completed.

F. The competent person shall submit certification in writing that the area has been cleaned of lead contamination prior to clearance testing. Clearance testing to be accomplished per the Lead Compliance Plan.

3.18 DISPOSAL

A. All material, whether hazardous or non-hazardous, shall be disposed of in accordance with all laws and provisions and all federal, State, or local regulations. Ensure all waste is properly characterized. The result of each waste characterization (Toxicity Characteristic Leaching Procedure

for Resource Conservation and Recovery Act materials) will dictate disposal requirements.

B. At the end of each day's work or prior to leaving the work site, the Contractor shall segregate waste. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and clothing that may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 262. Contractor shall furnish containers unless otherwise noted on the drawings that the Government will provide the containers. For Government provided containers, the Government will remove and properly dispose of containers as controlled or hazardous waste.

C. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon drums. For hazardous waste, the collection drums shall be marked and labeled in accordance with 40 CFR 262 during the accumulation and collection time frame. The Contracting Officer or authorized representative will assign an area for interim storage of the waste-containing drums. Drums containing hazardous waste shall not be maintained in interim storage longer than 90 calendar days from the date affixed to each drum.

D. For Contractor provided containers, dispose of lead-contaminated material classified as hazardous waste at an approved hazardous waste treatment, storage, or disposal facility off Government property.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ready-mix concrete.

B. Concrete admixtures.

C. Formwork and accessories as shown or as required.

D. Reinforcing materials.

E. Reinforcement supports.

F. Drainage fill.

G. Joint materials.

H. Curing and hardening.

I. Vapor barrier under slabs on grade.

J. Subbase under slabs on grade.

K. Water stop materials.

L. Epoxy Anchor Adhesives

M. Sampling and testing.

N. Construction Flow Chart.

O. Sample Inspection Report.

P. Development and Splice Lengths.

1.02 SUBMITTALS

Submit for Approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals. When required on the Schedule of Submittals, in accordance with Section 01 35 43, the Contractor shall include in the close-out submittal report purchases of cement and concrete products, such as admixtures with coal fly ash, covered under the EPA regulations for recoverable materials. When such specified products cannot be provided, the Contractor shall provide a non-compliance report stating the reason the product cannot be used and the nature of the products to be used. For an all-inclusive list of applicable products, see the latest EPA web site for construction products containing recoverable materials. When required on the Schedule of Submittals, Contractor shall submit an Inspection Report as described in 1.06 of this Section.

1.03 ABBREVIATIONS/ACRONYMS

Abbreviations and acronyms of most trade associations and sources of standards are listed in Section 01 42 00, Reference Standards and Definitions.

See ACI 116R-00 for Cement and Concrete Terminology.

1.04 REFERENCES

ACI 301-05 (2005) Specifications for Structural Concrete.

ACI 302.1R-04 (2004) Guide for Concrete Floor and Slab Construction

ACI 315-99 (1999) Details and Detailing of Concrete Reinforcement

ACI 318-05 (2005) Building Code Requirements for Structural Concrete and Commentary

ACI 347R-04 (2004) Guide to Formwork for Concrete

ACI 116R-00 (2000) Cement and Concrete Terminology

ACI 117-06 (2006) Specifications for Tolerances for Concrete Construction and Materials

ACI 207.1R-05 (2005) Guide to Mass Concrete

ACI 305-99 (1999) Hot Weather Concreting

ACI 306-88 (1988) Cold Weather Concreting

ASTM A 82 (2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement

ASTM A 185 (2007) Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

ASTM A 615 (2007) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM C 31 (2006) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C 39 (2005) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C 94 (2007) Standard Specification for Ready-Mixed Concrete

ASTM C 143a (2005) Standard Test Method for Slump of Hydraulic Cement Concrete

ASTM C 171 (2007) Standard Specification for Sheet Materials for Curing Concrete

ASTM C 172a (2007) Standard Practice for Sampling Freshly Mixed Concrete

ASTM C 231 (2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C 260 (2006) Standard Specification for Air-Entraining Admixtures for Concrete

ASTM C 309 (2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C 494 (2008) Standard Specification for Chemical Admixtures for Concrete

ASTM C881 (2002) Standard Specification for Epoxy-Resin-Based Bonding Systems for Concrete

ASTM C 1017 (2007) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete

ASTM C 1064 (2005) Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete

ASTM C 1116 (2008) Standard Specification for Fiber-Reinforced Concrete

ASTM C 1315 (2007) Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

ASTM D 1751 (2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752a (2004) Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM D 4397 (2002) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

CRSI 10 Place Placing Reinforcing Bars, 8th Edition

FS S-SS-200E (1993) Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

NRMCA National Ready Mixed Concrete Association

Concrete Works Program for Mass Concrete by Concrete Durability Center; website: www.texasconcreteworks.com

1.05 RELATED WORK SPECIFIED ELSEWHERE

Subgrade preparation - Section 31 20 00, Earth Moving

1.06 QUALITY ASSURANCE

A. All concrete work except slabs on grade shall be in accordance with ACI 301 and ACI 318 unless otherwise specified.

B. All concrete slab-on-grade work shall be in accordance with ACI 301 and contract drawings.

C. The Contractor and all Subcontractors associated with concrete placement shall review, discuss, and understand all concrete mixing, transporting, testing, placement, finishing, and curing requirements for the project prior to ordering concrete.

D. Notify all Contractor and Government inspection organizations associated with concrete work a minimum of 12 hours prior to planned time of concrete placement. Concrete placement shall not begin until Contractor inspection personnel have performed pre-pour inspections, and the Government has had the opportunity to monitor the Contractor's quality assurance inspections.

E. Concrete shall be manufactured and delivered to the site in accordance with ASTM C94 by a supplier experienced in ready-mixed concrete work who is a current member of NRMCA. Job mixed concrete shall not be used unless approved in writing by the Contracting Authority.

F. Concrete mix design shall be submitted for approval only if noted on the Schedule of Submittals. For practical purposes, footings or slabs that are three feet or more in thickness are considered mass concrete and shall also include temperature calculations by use of the Concrete Works Program.

G. Implement concrete inspection activities which address items included in the Concrete Construction Flow Chart, located at the end of this section. Perform and document the results of pre-placement, placement, and post-placement inspection. Include inspection attributes listed on the Sample Inspection Report, located at the end of this section. Fresh concrete which is properly sampled, tested, and determined non-compliant with specifications, does not qualify for placement. If non-conforming conditions are identified and not corrected prior to concrete placement, concrete placement activities are considered to proceed at risk, with the additional costs of testing, evaluation, and repair or replacement assumed by the Contractor in accordance with the provisions described in ACI 318.

H. Maintain a concrete inspection file on site (current from the day of initial concrete placement operations) with all documentation related to concrete inspection activities, including mix designs, delivery tickets, batch tickets, inspection reports, test reports, and

evaluations. File this data in a way that will provide ready access to the Government inspector for review.

1.07 CONCRETE SAMPLING AND TESTING

A. Cylinders for Strength Test: Unless otherwise noted on the drawings, acceptance testing for concrete shall utilize 6 x 12 inch test cylinders. Make and cure 1 set of 4 representative cylinders for each day's pour representing concrete placed throughout the day, or every 50 cubic yards, if more than 50 yards are poured in a single day. Secure composite concrete samples in accordance with ASTM C172. Make, cure, protect, and transport cylinders in accordance with ASTM C 31. Test cylinders in accordance with ASTM C 39. One cylinder shall be tested at 7 days, two cylinders shall be tested at 28 days and one cylinder shall be retained as a spare for duration of warranty period. If the average strength of the cylinders falls below the specified design strength, the Contracting Officer may require corrective action as necessary, in accordance with the requirements of ACI 318.

B. Slump tests: Upon initial delivery, perform slump test in accordance with ASTM C 143, and for each load from which test cylinders are made, or as required by the Government inspection organization. Perform tests in the presence of the Government inspection organization at point of placement.

C. Air entrainment tests: Upon initial delivery, perform air entrainment test in accordance with ASTM C 231, and for each load from which test cylinders are made, or as required by the Government inspection organization. Perform tests in the presence of the Government inspection organization at point of placement.

D. Temperature: Upon initial delivery, perform fresh concrete temperature test in accordance with ASTM C 1064, and for each load from which test cylinders are made, or as required by the Government inspection organization. Perform tests in the presence of the Government inspection organization at point of placement.

E. For small non-structural concrete pads, walks, etc., the Contractor may request a waiver of tests a minimum of five days before preparation for placement. The A/E will make a determination and grant or deny the waiver as appropriate.

PART 2 PRODUCTS

2.01 CONCRETE

A. Concrete: Ready-mixed concrete, conforming to ASTM C 94, having a minimum compressive strength of 4000 psi at 28 days, unless noted otherwise on drawings.

B. To the extent feasible, and in accordance with ASTM standards and applicable codes, use fly ash as a partial replacement for cement in concrete.

C. Maximum aggregate size: 1-1/2 inch, or as noted on drawings.

D. Air content, if not noted on drawings: concrete which will be exposed to outside atmospheric conditions when put in service, 4 to 7 percent; concrete which will not be exposed to outside atmospheric conditions when put in service, 0 to 4 percent.

E. Slump acceptance criteria (unless noted otherwise on drawings): slabs on grade, 3 to 5 inches; all other installations, 2 to 4 inches. Tolerances: Comply with ASTM C94. (Note: If a superplasticizing admixture is used, slump tests shall be taken as specified in Section 2.02.)

F. Fresh concrete temperature: Conform to requirements of ACI 301-05

2.02 CONCRETE ADMIXTURES

A. Air-entraining admixtures: Conform to ASTM C 260

B. Superplasticizer admixture (Site Added Only) : A superplasticizer admixture conforming to ASTM C 494 or C 1017 may be used to achieve flowable concrete. Conditions are as follows:

1. The submitted concrete design mix includes superplasticizer data and is approved.

2. A qualified technical representative provided by the concrete supplier shall be present at the job site during mixing and pouring operations to ensure proper application and mixing of admixture.

3. The concrete shall be batched and delivered with a pre-dose slump of 2 to 4 inches.

4. Immediately prior to discharge the required quantity of superplasticizer shall be added and properly mixed to achieve a post dose slump of 6 to 8 inches.

5. In no case shall water be added to the concrete after the superplasticizer has been added.

6. Slump tests shall be taken before and after the addition of superplasticizer to the mix.

7. Air entrainment tests and concrete test cylinders shall be made after the superplasticizer is added to the mix.

C. Superplasticizer admixture (Batch Plant Added): Considered on a case by case basis. Submit products, criteria, and installation procedures for approval.

D. Fibrous concrete reinforcement conforming to ASTM C 1116 may be used in lieu of welded wire fabric. Conditions are as follows:

1. The concrete design mix submitted for and receiving approval includes fibrous concrete reinforcement data, including the fiber manufacturer, recommended volume of reinforcement per cubic yard, and mixing & placing instructions.

2. Fibrous concrete reinforcement consists of 100 percent virgin polypropelene, fibrillated fibers containing no reprocessed olefin materials and is specifically manufactured to an optimum gradation for use as concrete secondary reinforcement.

3. The volume of fibrous reinforcement per cubic yard of concrete shall equal a minimum of 0.1 percent by weight (1.5 pounds).

E. No admixtures containing chlorides are allowed, unless approved by the Contracting Authority.

2.03 FORMS

Forms: wood, steel or other approved material.

2.04 REINFORCING MATERIALS

A. Reinforcing bars, except number 3 size bars: ASTM A 615, Grade 60.

B. Deformed number 3 bars: ASTM A 615 Grade 40 or 60.

C. Wire: ASTM A 82.

D. Welded wire reinforcing: ASTM A 185. Furnish in flat sheets, not rolls, unless approval for rolls is given by the Contracting Authority.

Designation: 6X6 - W2.0 x W2.0 WWR unless otherwise noted on drawings.

2.05 SUPPORTS FOR REINFORCEMENT

A. Supports in contact with formwork: wire bar type conforming to CRSI Placing Reinforcing Bars, Chapter 9, Class 3.

B. Legs of supports in contact with formwork: hot-dip galvanized or plastic coated after fabrication; or stainless steel.

C. Supports in contact with ground: precast concrete blocks having a nominal 2" x 2" bearing area, and a minimum compressive strength equivalent to concrete being placed.

D. Alternate supports conforming to requirements of ACI 301 may be submitted for approval.

2.06 DRAINAGE FILL

Drainage fill for slabs on grade: Unless noted otherwise, use AHD No. 78 stone, uniformly graded; an acceptable alternate, unless specifically prohibited, is to use AHD No. 57 stone washed and uniformly graded. No organic debris shall be present. Compact all stone to 95% Modified Proctor density, per ASTM D 1556.

2.07 JOINT MATERIALS

A. Preformed joint filler strips for exterior walks and slabs: Non-extruding resilient bituminous type conforming to ASTM D 1751.

B. Preformed joint filler strips for interior slabs on grade: Non-extruding and resilient non-bituminous type conforming to ASTM D 1752, Type I or II.

C. Joint sealant compound: Cold applied, 2 component, elastomeric polymer type conforming to FS -S-SS-200E.

2.08 CURING COMPOUND

Conform to ASTM C 309, TYPE 1. For Hot Weather Concreting conform to ASTM C 1315.

2.09 VAPOR BARRIER

Vapor barrier: polyethylene sheeting, 6-mil minimum thickness, conforming to ASTM D 4397, lapped and securely taped at joints.

2.10 SUBBASE

Subbase shall consist of natural sand or manufactured sand meeting fine aggregate requirements of ASTM C33, or a combination of sand and crushed stone meeting the following requirements: a maximum aggregate size of 1-1/4 inches, a maximum of 15% per cent passing the No. 200 sieve, a maximum Plasticity Index of 6, and a maximum Liquid Limit of 25. Subbase material conforming to ALDOT 823 Type A is acceptable for this purpose.

2.11 WATER STOPS

A. Type: Dumbell type unless otherwise shown.

B. Accessories: Use factory made splices at corners, tees, etc.

C. Field splices: Field splice at straight runs only.

2.12 EPOXY ANCHOR ADHESIVE

A. Unless otherwise noted, epoxy adhesive used for anchoring and other general purpose duties shall conform to the following:

1. Two-component, 100% solids (containing no solvents), non-sag, and insensitive to moisture.
2. Meets or exceeds ASTM C881 requirements for Type IV, Grade 3, Class B and C epoxies.
3. Shall be applied and installed per the manufacturer’s instructions.

2.13 MECHANICAL EQUIPMENT PADS

A. Concrete for equipment pads shall have a minimum compressive strength of 3000 psi at 28 days.

B. Reinforcement shall be 6x6 W2.0xW2.0 steel wire mesh, or #4 rebar laid on 6 inch centers each way.

C. Equipment pads shall have a minimum height of 4 inches above grade or finished floor, and shall be sized to provide a minimum 6-inch clear margin all around the equipment, unless otherwise noted.

D. All exterior equipment pads shall extend a minimum of 4 inches below grade. Pads supporting fixed or transient loads weighing over 500 pounds shall be constructed with thickened edges. Thickened edge depth shall equal twice the slab thickness. Alternatively, entire pad may be two times the required slab thickness.

E. Provide a 3/4 inch, 45 degree chamfer on exposed edges.

PART 3 EXECUTION

3.01 SUBBASE

Compact subbase per requirements of Section 31 20 00, Earth Moving.

3.02 FORM WORK

A. Construct forms to withstand construction loads without deformation in accordance with ACI 347R. Tolerances will not exceed Table 3.1 of ACI 347R

B. Chamfer all exposed concrete edges 3/4 inch.

C. Arrange internal ties so that when forms are removed, metals will be not less than 2 inches from concrete surfaces.

D. Coat forms with a non-staining water-based release agent shortly before placing concrete. No release agent shall come in contact with concrete reinforcing. Release agent coming in contact with reinforcement shall be thoroughly and completely removed prior to placing concrete.

3.03 REINFORCEMENT

A. Reinforcement: Free from loose, flaky rust and scale, and free from oil, grease, or other coating which might destroy or reduce bond of reinforcement with the concrete.

B. Shop fabricate steel reinforcing. Bend cold in accordance with ACI SP66, and in conformance to ACI 318.

C. Minimum cover for reinforcement: Conform to ACI 318, Chapter 7.

D. Splices: Lapped and securely wired together. Splice welded wire fabric by lapping not less than one spacing of cross wires and securely wiring the lapped ends together. Unless otherwise noted on the drawings, splice reinforcing bars in accordance with ACI 318. Splice lengths for most applications using 3,000 PSI and 4,000 PSI concrete are included at the end of this section.

E. Prior to placement of concrete, securely fasten all embedded items and provide support for reinforcement to resist displacement. Embedded items shall be free of oil or foreign matter which would impair bonding. No wood shall be embedded unless specifically authorized.

F. If fibrous concrete reinforcement is substituted for welded wire fabric, mix and place in accordance with manufacturer's written instructions.

G. Provide reinforcement consisting of a minimum of two each 24 inch long #4 bars placed at each re-entrant corner. Place reinforcing at 45 degree angle to the corner.

3.04 CONCRETE PLACING

A. Deliver, convey , and place concrete by methods which will prevent segregation or loss of ingredients.

B. Place concrete within 90 minutes, or before the drum has revolved 300 times, whichever comes first, after the introduction of mixing water to the cement and aggregates. These limitations may be waived by the CMI if at the time of placement the air, slump, and temperature meet specified requirements without the addition of water to the batch.

C. Place concrete on clean damp surfaces free from water, ice, frost, mud, debris or objectionable coatings. Consolidate concrete with

internal type mechanical vibrating equipment supplemented by hand spading and tamping. Avoid dragging vibrators through fresh concrete and causing segregation of aggregates and cement. Vibrating equipment shall be of the internal type.

D. Unless noted otherwise on contract drawings, place concrete in horizontal layers with a maximum lift of 18 inches and at a rate that will prevent the formation of cold joints

E. Do not place concrete during rain, sleet, or snow, unless adequate protection is provided and acceptance by the Contracting Authority is obtained.

F. Cold Weather Concreting: Conform to ACI 301-05. (1) Ambient temperature must be at least 40 degrees and rising at time of placement. (2) Concrete temperature must be at least 55 degrees at time of placement and maintained at that temperature for 72 hours after concrete is deposited. (3) Do not expose concrete to freezing temperatures for eight days after placing.

G. Hot Weather Concreting: Conform to ACI 301-05. When relative humidity is less than 40% and wind velocity exceeds 10 mph at time of concrete placement, take action approved by the COTR to prevent plastic shrinkage cracking of concrete.

3.05 FINISHING

A. Patch and repair defective concrete and voids left by tie rod removal immediately after removal of forms. Cut out unsatisfactory material and place new concrete which shall be secured with keys, dovetails or anchors. Patch small voids with dry patching mortar.

B. Unless otherwise shown on the drawings concrete shall have the following finishes:

1. Interior slabs: Smooth steel trowel finish.

2. Exterior walks and slabs: Light broom finish. Broom walks perpendicular to the direction of travel.

3. Exposed formed surfaces: Smooth rubbed finish conforming to ACI 301. Exposed surfaces extending below grade shall be rubbed a minimum of eight inches below the finished grade.

4. Surfaces concealed in the finished building: Remove sharp irregularities and patch defective areas as required to protect reinforcing steel or ties, otherwise no finish.

C. Slabs shall conform to the flatness / levelness specifications shown in the drawings, where so indicated. Where not indicated on drawings: (1) Conform to tolerances indicated in Sections 4.8.4 and 4.8.5 of ACI 117. (2) For carpeted office areas-Moderately Flat Floor Classification. (3) For warehouses, high bays, and fork lift areas- Flat Floor Classification.

D. No dusting of mortar or cement on concrete for trowel or rubbed finish will be allowed.

E. Protect finished surfaces from construction equipment, rain or running water, and other potentially damaging action.

3.06 Tolerances: Unless indicated otherwise on drawings, conform to ACI 117-06.

3.07 CRACK CONTROL JOINTS

Provide control joints in unreinforced concrete slabs on grade with areas exceeding 500 square feet and in unreinforced walls with lengths greater than 15 feet. If no joints for construction of this type are indicated on the drawings, contact COTR for disposition.

3.08 CURING AND HARDENING

A. To seal in moisture required for desired concrete properties, begin curing immediately after initial set, using curing materials and methods which will not damage finish.

B. For concrete surfaces not in contact with forms, one of the following curing procedures shall be applied immediately following finishing:

1. Application of a curing compound conforming to ASTM C 309, Type 1, at the rate and by the method recommended by the manufacturer. For Hot Weather Concreting, apply curing compound conforming to ASTM C 1315. After curing, apply a second coat in accordance with the manufacturer's recommendations for hardening of the concrete. Protect concrete from damage at all times.

2. Cover all exposed surfaces of concrete with wet burlap and maintain in continuous moist condition for a minimum of 7 days by use of a sprinkler system.

3. Cover finished, wetted concrete slab surface with polyethylene sheeting conforming to ASTM C 171. Lap a minimum of 3 inches at adjoining sheets. Prevent displacement of cover during curing period of 7 days minimum. Patch holes in cover with waterproof tape. Keep slab surface wet during curing period.

4. In lieu of the above, an alternate procedure conforming to requirements of ACI 301 may be submitted for approval.

C. Vertical surfaces placed against forms: Optionally cure by allowing form work to remain in place for 7 days. Forms exposed to drying conditions shall be kept wet until they can be removed or for the 7 day minimum.

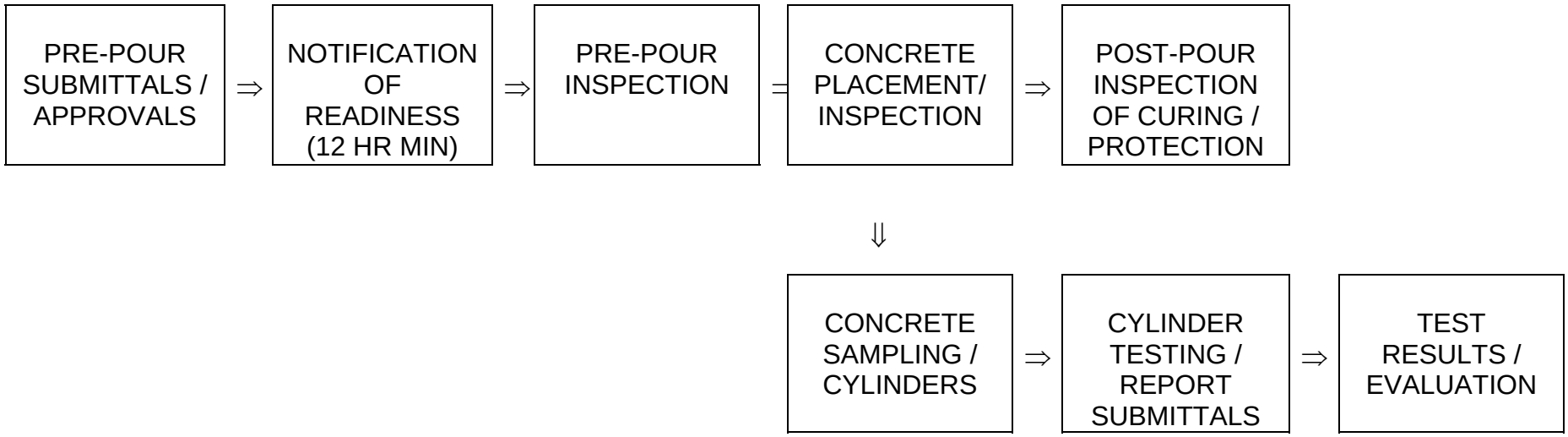
D. No backfill shall be placed against newly constructed concrete for a period of seven days unless authorized by the Contracting Authority.

3.09 MECHANICAL EQUIPMENT PADS

A. When pouring a pad on an existing concrete slab, roughen the surface of the slab to improve bonding with the new concrete. Provide 1/2-inch rebar dowels on 24-inch centers (maximum) to anchor the new pad to the existing slab. Use a minimum of four dowels, grouted a minimum of 3” into existing concrete extending into new slab, terminating 2” below top.

B. When pouring a pad in an asphalt paved area, sawcut and remove the asphalt in the new pad location. Compact existing gravel subbase prior to placement of new concrete.

CONCRETE CONSTRUCTION FLOW CHART



SAMPLE INSPECTION REPORT

The following inspections shall be in accordance with Project Specifications and applicable drawings.

ITEM	INSPECTION ATTRIBUTE	S	U	N/A	INIT.	DATE
1.	SUBMITTALS					
	Required submittals received					
	Submittals have been approved					
2.	FORMWORK					
	Formwork type					
	Form surfaces are true to line and grade; mortar joint is tight and rigid					
	Surface preparation					
	Form release agent					
3.	PREPLACEMENT					
	Size, configuration and location					
	Embedments installation is complete					
	Fabrication, splicing and support of rebar					
	Size/spacing of rebar					
	Wire fabric and installation					
	Water vapor barrier subgrade cover					
	Cleanliness and clearances in form work					
	Reinforcement cleanliness					

S - Satisfactory U - Unsatisfactory N/A - Not Applicable INIT. - Inspector's Initials

ITEM	INSPECTION ATTRIBUTE	S	U	N/A	INIT.	DATE
4.	PLACEMENT					
	Ready-mix concrete manufacturer meets qualifications					
	Contractor submits appropriate batch tickets and has an approved testing laboratory conducting concrete testing					
	Batch tickets confirm required concrete mix design is placed					
	Aggregates, cement, air-entrainment, water reducing admixtures, pozzolan, and water adequately mixed					
	General placement requirements					
	Conveying methods (do not cause segregation or loss of ingredients)					
	Time limits, consolidation and cleanliness					
	Lifts of placed concrete					
	Use of vibrating equipment					
	Finish					
5.	POST PLACEMENT					
	Minimum form release time is maintained					
	Curing methods and time periods					
	Chemical-hardener treatment is properly applied as required					
	Form removal					
	Absence of cold joints, cracks, honeycomb, and other defects					
	Defective concrete is repaired properly					
6.	TESTING					
	Sampling and testing requirements meet the project specifications					

S - Satisfactory U - Unsatisfactory N/A - Not Applicable INIT. - Inspector's Initials

DEVELOPMENT AND SPLICE LENGTHS (3000 PSI CONCRETE)

QUALIFYING PARAMETERS*:

Code: ACI 318-05
Class B Splice
Concrete Design Compressive Strength: 3000 psi
Minimum Yield strength of reinforcing steel: 60 ksi
Reinforcement Location Factor = Coating Factor = Aggregate Factor = 1.0

Bar Size	Development Length	Tension Splice Length	Compression Splice Length
# 3	17	23	12
# 4	22	29	15
# 5	28	37	19
# 6	33	43	23
# 7	48	63	27
# 8	55	72	30
# 9	62	81	34
# 10	69	90	38
# 11	76	99	42
# 14	96	125	53
# 18	124	162	68

Bar sizes are listed in nominal 1/8 inch increments. Lengths are given in inches.

*Note: If one or more actual conditions differs from the above parameters, refer to ACI 318-05, Chapter 12 for additional requirements

DEVELOPMENT AND SPLICE LENGTHS (4000 PSI CONCRETE)

QUALIFYING PARAMETERS*:

Code: ACI 318-05
Class B Splice
Concrete Design Compressive Strength: 4000 psi
Minimum Yield strength of reinforcing steel: 60 ksi
Reinforcement Location Factor = Coating Factor = Aggregate Factor = 1.0

Bar Size	Development Length	Tension Splice Length	Compression Splice Length
# 3	15	20	12
# 4	19	25	15
# 5	24	32	19
# 6	29	38	23
# 7	42	55	27
# 8	48	63	30
# 9	54	71	34
# 10	60	78	38
# 11	66	86	42
# 14	84	110	53
# 18	107	140	68

Bar sizes are listed in nominal 1/8 inch increments. Lengths are given in inches.

*Note: If one or more actual conditions differs from the above parameters, refer to ACI 318-05, Chapter 12 for additional requirements

END OF SECTION

SECTION 03 80 00

CONCRETE CORE DRILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

Specifications and guidelines for core drilling through suspended concrete slabs and decks. This specification covers hole sizes up to 6-inches in diameter: larger openings shall be made as shown in the plans, or referred to the Contracting Officer's Technical Representative (COTR) for direction.

1.02 SUBMITTALS

A. Submit for approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.03 RELATED SECTIONS

A. Section 02 82 00 - Asbestos Remediation.

B. Section 03 30 00 - Cast-In-Place Concrete.

C. Section 05 31 13 - Non-Composite Steel Form Deck

D. Section 05 36 00 - Composite Steel Deck

E. Section 05 31 23 - Steel Roof Decking

F. Section 07 84 00 - Firestopping

1.04 REFERENCES

The latest version of the applicable Technical Specifications of the Concrete Sawing and Drilling Association (CSDA).

1.05 QUALITY ASSURANCE

A. Contractor Qualifications: Contractor Qualifications: Current member of the Concrete Sawing and Drilling Association (CSDA) or submit documentation providing proof of qualifications for performing work in accordance with applicable standards, best practices and specifications of the CSDA and receive approval from the COTR prior to performing concrete core drilling work.

B. Codes and Standards: Comply with applicable provisions of the technical specifications of the CSDA for core drilling (CSDA-C-101) and with CSDA best management practices for control and cleanup of tailings, dust, and slurry (CSDA-BP-003).

PART 2 PRODUCTS

2.01 MATERIALS

A. All core drilling shall be done using diamond-tipped bits to provide for smooth entry and exit, and for clean, flush hole surfaces. Holes 1-inch and larger shall not be drilled with a percussion-type drill to minimize entry and exit spalling of concrete.

PART 3 EXECUTION

3.01 METHOD GUIDELINES

A. From the top of the slab, locate existing embedded conduits, piping, and reinforcing bars and strands, using an appropriate non-destructive test (NDT) method (i.e.: “Rebar Datascan”, or “HR 7000”, by James Instruments, or similar).

B. Carefully drill a 1/4”-maximum-diameter pilot hole at the center of the selected penetration point. Cease drilling if a reinforcing bar or strand, pipe, or conduit is hit.

C. If a reinforcing bar or strand, pipe, or conduit is hit, then relocate to a new penetration point and re-drill a new pilot hole. Repeat this procedure as required to obtain a clear hole coring location.

D. From the underside of the slab, using an appropriate NDT method, and allowing for core-drill bit clearance, locate existing embedded reinforcing bar or strand, pipe, and conduit in the area around the pilot hole location. Adjust the hole location as necessary to avoid embedded items. Allow at least 3/4” of clearance between the edge of the cored hole and the nearest reinforcing bar or strand.

E. Core drill the hole as required.

3.02 REPAIRS

A. Repairs to mis-drilled holes, and holes which have spalled edges, shall generally be by the use of a two-part epoxy-concrete patch

mix. Select the appropriate mix and make repairs as directed by the COTR.

3.03 SECTION NOTES

A. For slabs poured on form deck, steel reinforcement is often placed in the deepest part of the form flute (pan), so typically locate the hole to be cored in the thinnest portion of the slab (between the flutes, or pans).

B. As stated in Section 1.01, this specification is applicable to core-drilled holes up to a maximum of 6-inches in diameter. Unless otherwise directed by the COTR, a qualified Structural Engineer, registered in the State of Alabama, shall be employed by the Contractor to investigate and verify the adequacy of all existing concrete slabs and decks affected by core-drilled holes larger than 6-inches in diameter.

C. Investigate record ("As Built") drawings for the locations of known, existing, electrical and mechanical embeds.

D. For location purposes, keep in mind: the core-drilled hole size is often 1-inch larger than the nominal size of the penetration sleeve or conduit.

E. Typically, the most suitable location for a drilled penetration is at 0.20 times the slab span length in the shortest direction, or in the direction of the deck flutes (Example: at 5'-0" from the end of the slab for a 25'-0" member span).

F. If it is determined the a reinforcing bar or strand cannot be avoided, then prior to performing any core drilling at that point, a qualified structural engineer must investigate and verify the adequacy of the affected slab or beam.

G. Provide fire-stopping at the hole as required, and conforming to Section 07 84 00: FIRESTOPPING - contact the COTR for direction.

H. Prior to drilling and coring, the contractor shall verify that no asbestos-containing coatings or materials are present on the top or bottom of the slab in the area to be cored. If asbestos is present, contact the COTR for direction.

END OF SECTION

SECTION 04 20 00

UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Face brick
B. Concrete masonry units (CMU) and concrete brick
C. Mortar
D. Masonry ties and wall reinforcement
E. Flexible Flashing integrally installed with masonry
F. Accessories

1.02 RELATED ITEMS

Reinforcing bars are specified in Section 03 30 00, Cast-In-Place Concrete.

1.03 REFERENCES

ASTM C55 (2006) Standard Specification for Concrete Brick

ASTM C90b (2006) Standard Specification for Loadbearing Concrete Masonry Units

ASTM C404 (2007) Standard Specification for Aggregates for Masonry Grout

ASTM C270a (2007) Standard Specification for Mortar for Unit Masonry

1.04 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.05 STORAGE

Store masonry off the ground and keep covered from inclement weather.

Store mortar products in a clean, dry place

PART 2 PRODUCTS

2.01 FACE BRICK

Brick shall be the type and color shown on the drawings. Size shall be modular.

2.02 CONCRETE MASONRY UNIT

A. Concrete masonry units shall be of modular dimensions and shall include all special shapes and sizes to complete the work as shown. Units shall be sound and free from cracks, chipped edges, or other defects that would interfere with their proper setting or impair the strength or durability of the construction. Where used as the finished surface of exposed masonry walls, units shall be free from surface defects that would be noticeable and objectionable at a distance of 12 feet from the finished wall.

B. All concrete masonry units shall be delivered to the job in an air-dry condition with a moisture content less than 35 percent of total absorption.

C. Hollow regular concrete masonry units shall conform to ASTM C90. The units shall have a medium texture. Concrete U-blocks for masonry lintels shall have the same texture as the field units.

2.03 CONCRETE BRICK

Concrete brick shall conform to ASTM C55.

2.04 MORTAR

All mortar shall conform to ASTM C270, Types M or S, as well as to the requirements of the applicable building codes, except that plastic mortar may be used at the Contractor's option. Plastic mortar shall be the manufacturer's standard product consisting of Portland cement interground with carefully selected additives and plasticizers. Plastic mortar shall have the same strength specified for regular mortar. The manufacturer's name and pounds per package shall be clearly labled on each bag. When plastic or waterproof cement is used, hydrated lime or lime putty may be used, but not in excess of one-tenth the volume of cement.

2.05 MASONRY WALL REINFORCEMENT

Reinforce all masonry walls with continuous, galvanized-wire, truss-type, masonry wall reinforcing. Longitudinal wires shall be 9 gauge and cross wires shall be 12 gauge, minimum. Furnish in flat sections, not rolls. Width of the reinforcement shall be adequately sized for the width of the wall.

2.06 WALL TIES

Ties for brick veneer: 9" long by 3/4 inch wide, 12 gauge straps in combination with rectangular or triangular 3/16 inch wire ties. Attach to metal studs with No. 12 screws through sheathing. Fasteners, ties and straps shall be either hot-dip galvanized or stainless steel.

2.07 GROUT

Grout shall be of fluid consistency to permit pouring without segregation, and shall be mixed in a volumetric ratio of 1 part air-entraining cement, 2 parts fine aggregate, and 2 parts pea-gravel. The fine aggregate and pea-gravel shall conform to the requirements for fine aggregate size No. 2 and course aggregate size No. 8, respectively, as given in Aggregates for Masonry Grout, ASTM C404.

2.08 FLASHING

Thru-wall flashing shall consist of a sheet of copper weighing 5 oz. per square foot, bonded on both sides to heavy asphalt -saturated kraft paper which is reinforced with glass fibers. Bed flashing in mortar.

PART 3 EXECUTION

3.01 MORTAR MIXING & PLACING

A. Mortar shall be thoroughly machine mixed for a period of at least 5 minutes after all materials are in a mixer designed for this purpose. The requirement shall not be waived except for minor jobs and then only upon written approval of the COTR.

B. All mortar shall be used and placed in final position within 1-1/2 hours after mixing when air temperature is 80 degrees F or higher,and within 2-1/2 hours when air temperature is less than 80 degrees F. Mortar not used within these time limits shall be discarded.

C. Mortars that have stiffened within the allowable time because of evaporation of moisture from the mortar may be retempered to restore workability by adding water as frequently as needed. As much water may be added as necessary to produce proper workability.

D. Mortar shall be of the same type and brand for the entire job. Mortar for face brick or other unpainted masonry shall be of uniform appearance throughout the job.

E. Masonry work shall not be done when the temperature is below 40°F, or likely to freeze within 12 hours of placement.

3.02 LAYING UNIT MASONRY

A. Unit Masonry shall be laid dry and cut accurately to fit other construction. All cutting of units shall be done using power saws with abrasive blades.

B. Masonry work shall be plumb, level, and true to line and grade to the best standards of the masonry trade.

C. A running bond pattern shall be used, except where indicated otherwise on the drawings.

D. Mortar joints shall be 3/8 inch thick tooled concave joints. Full mortar coverage of bed joints shall be provided at shells and webs.

E. Relaid masonry shall be cleaned of mortar and laid in fresh mortar.

F. Weepholes: Provide fully open head joints at 2'-8" o.c. above all ledges, flashings and lintels.

G. Provide vertical expansion joints no greater than 30'-0" o.c. at approved locations.

3.03 PROTECTION

Cover the top of all walls with a waterproof material such as polyethylene at all times except when laying masonry to prevent the entry of excessive water during construction.

3.04 INSTALLING HORIZONTAL WALL REINFORCEMENT

A. Install continuous horizontal masonry wall reinforcement in all masonry walls. Space reinforcement 16 inches on center, measured vertically.

B. Where masonry wall consists of two wythes, the wall reinforcement shall span across the cavity to reinforce both wythes.

3.05 INSTALLING WALL TIES

A. Install wall ties in all brick veneer walls.

B. Space ties 16 inches on center, both vertically and horizontally.

3.06 GROUTING

A. Where grouting of cells is indicated, cells shall be grouted solid in maximum 4-foot lifts. The pour shall be stopped 1-1/2 inches below the top of the nearest block. Anchors, bolts, inserts, metal door frames, etc., shall be solidly grouted in place.

B. Fill head and jambs of metal door frames with mortar as the work progresses.

3.07 CONCRETE BLOCK LINTELS

A. Concrete block lintels shall consist of U-blocks of the same width as the wythe they support.

B. Unless otherwise shown all U-block lintels shall be reinforced with one number 5 longitudinal reinforcing bar completely encased in the concrete fill.

C. Lintels shall bear a minimum of 8 inches on each end.

3.08 CURING, PROTECTION, AND CLEANING

A. 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.

B. Exposed masonry surfaces shall be protected from mortar droppings.

C. Grout or mortar stains shall be cleaned by removing immediately with clear water, stiff fiber brushes, or wooden scrapers, and then rinsed.

D. Muriatic acid shall not be used to clean masonry. Clean in strict accordance with brick manufacturer's written instructions.

END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SUBMITTALS

A. Submit for Approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

B. Fabrication/Erection/Installation drawings shall indicate shop and erection details, including cuts, copes, connections, holes, bolts, and welds. Indicate welds, both shop and field, in accordance with ANSI/AWS A2.4.

1. Indicate on shop drawings the members and connection areas not to be painted and indicate size, length, and type of each weld and an erection procedure that includes sequence and temporary bracing.

2. Do not deliver material prior to receiving approved shop drawings.

C. Welder's Certificates: Submit certificate(s) for the type of welds required if so noted in the Schedule of Submittals.

1.02 ABBREVIATIONS/ACRONYMS

Abbreviations and acronyms of most trade associations and sources of standards are listed in Section 01 42 00, Reference Standards and Definitions.

1.03 REFERENCES

ASTM A36 (2005) Standard Specification for Carbon Structural Steel

ASTM A53 (2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A153 (2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

ASTM A307b (2007) Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

ASTM A325a (2007) Standard Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength

ASTM A500a (2007) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

ASTM A501 (2007) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

ASTM A992a (2006) Standard Specification for Steel for Structural Shapes

ASTM F1554a (2007) Standard Specification for Anchor Bolts, Steel, 36, 55 and 105 ksi Yield Strength

AISC M016 (1989) Manual of Steel Construction, ASD, Ninth Edition

AISC MO25 (2001) Manual of Steel Construction, LRFD, Third Edition

AISC/RCSC S348 (2004) Specification for Structural Joints Using ASTM A325 or A490 Bolts

AISC S303 (2005) Code of Standard Practice for Steel Buildings and Bridges

AWS D1.1-02 (2002) Structural Welding Code - Steel

AWS A2.4 (1998) Standard Specification for Welding, Brazing and Nondestructive Examination

1.04 FABRICATION AND ASSEMBLY

A. Fabricate and assemble in the shop to the greatest extent possible.

B. Weld shop connections unless noted otherwise.

C. Bolt field connections unless noted otherwise.

D. Shop prime steel with metal primer conforming to Section 09 90 00, Architectural Painting, except surfaces of steel to be encased in concrete, surfaces to be welded, faying surfaces of slip-critical connections, and running surfaces of crane rails.

1.05 PAINTING

Conform to requirements of Section 09 90 00, Architectural Painting.

PART 2 PRODUCTS

2.01 MATERIALS

Unless noted otherwise, all materials shall conform to the following specifications:

A. Structural Steel Members: Wide-flanged Sections: ASTM A 992; all other sections: ASTM A36.

B. Structural Tubing: ASTM A500, Grade B, or ASTM A501.

C. Structural Pipe: ASTM A53, Grade B, Type E or Type S.

D. Bolts: ASTM A325.

E. Anchor Bolts: ASTM F1554, Grade 36, galvanized.

F. Plates, Shapes and Bars: ASTM A36.

G. Grout: Non-shrink, readily flowable type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 7,000 psi at 28 days.

PART 3 EXECUTION

3.01 GENERAL

A. Fabricate, erect, and provide quality control of structural steel members in accordance with provisions of the AISC Manual of Steel Construction, ASD, or LRFD, Specification for Structural Steel Buildings Chapter M, and with provisions of the AISC Code of Standard Practice.

B. Weld in accordance with AWS D1.1.

C. Structural connections not detailed on the drawings shall be designed under direct supervision of, and certified by, a U.S. registered Professional Engineer experienced in design of this work.

3.02 INSPECTION

A. Determine that field conditions are acceptable and ready for work.

B. Beginning work means erector accepts existing conditions.

3.03 INSTALLATION OF ANCHOR BOLTS (RODS)

Bolts (rods) and anchors shall be accurately located and built onto connecting work and shall be preset by the use of templates or other methods as may be required to locate bolts and other connections. All anchor bolts shall be hot-dipped galvanized per ASTM A153, and shall include a 1/8” corrosion allowance in their sizing.

3.04 INSTALLATION OF COLUMN BASES OR BEARING PLATES

A. Clean concrete and masonry bearing surfaces.

B. Support and align base or bearing plate with steel wedges or shims. Shims of other materials are not acceptable. Shims may remain of covered by a minimum of 1 1/2 “ of grout.

C. Install grout using forms to retain the grout until sufficiently set to support itself.

D. Prior to erection of structural steel or placement of other structural loading onto new concrete, Contractor shall submit letter confirming that concrete strength meets or exceeds specified design value.

3.05 INSTALLATION OF STRUCTURAL STEEL MEMBERS

A. Erect structural steel members in a suitable and safe manner for workmen in accordance with OSHA regulations, and in accordance with the AISC Code of Standard Practice for Steel Buildings and Bridges, with modifications and additional requirements as specified.

B. Erect and maintain structure safe, plumb, and in true alignment through completion of work.

C. Do not field cut or alter new or existing structural members without written approval of the COTR. Do not modify bolt holes of structural members, secondary members, clips, or attachments with a cutting torch to accommodate alignment difficulties unless written approval is obtained from the COTR. Bolt holes may be hand-reamed as required.

D. Unless noted otherwise on the drawings, high-strength bolted connections are bearing type and shall be tightened to the snug tight condition as defined in AISC/RCSC Specification for Structural Joints, using ASTM A325 or A490 Bolts Section 8.1.

E. Inspect high-strength bolted connections in accordance with AISC/ RCSC Specification for Structural Joints using ASTM A325 or A490 Bolts, Section 9.

3.06 ARCHITECTURALLY EXPOSED STEEL

Materials and Methods for members designated as “Architecturaly Exposed Steel” shall conform to AISC Code of Standard Practice for Steel Buildings and Bridges, Section 10.

Select and fabricate materials for best appearance. Cut, fit and assemble steel with surfaces smooth, square and with complete contact at joints. Clean bearing surfaces and surfaces in permanent contact before assembly.

3.07 TOUCHUP PAINTING

After erection of structural steel, touch up bolt heads and nuts, field welds, gauges and abrasions in the shop coat.

3.08 TOLERANCES

Tolerances in fabrication and erection shall be in accordance with AISC Code of Standard Practice for Steel Buildings and Bridges, section 6.4.

END OF SECTION

SECTION 05 21 00

STEEL JOIST FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Open web steel joists with bridging, attached seats, and anchors.

B. Perform work in accordance with SJI Standard Specifications, Load Tables, and Weight Tables, including supplementary framing.

1.02 SUBMITTALS

A. Submit for Approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

B. Fabrication/Erection/Installation drawings shall indicate shop and erection details, including cuts, copes, connections, holes, bolts, and welds. Indicate welds, both shop and field, in accordance with ANSI/AWS A2.4.

1. Indicate on shop drawings the members and connection areas not to be painted and indicate size, length, and type of each weld and an erection procedure that includes sequencing and temporary bracing.

2. Delivery of material prior to receiving approved shop drawings constitutes that Contractor is proceeding at risk.

C. Welder's Certificates: Submit certificate(s) for the type of welds required if so noted in the Schedule of Submittals.

1.03 REFERENCES

ASTM A 108 (1999) Standard Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality

ASTM A 153 (2005) Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware

ASTM A 307b (2007) - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

ASTM A 325a(2007) - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

ASTM F1554a (2007) Standard Specification for Anchor Bolts, Steel, 36, 55 and 105 ksi yield strength.

AWS D1.1 - Structural Welding Code-Steel
FS TT-P-636 - Primer Coating, Alkyd, Wood and Ferrous Metal

SJI - Standard Specifications for Open Web Steel Joists, Fortieth Edition (1994).

SSPC - Steel Structures Painting Council Systems and Specifications, SSPC Painting Manual, Volume 2, Eighth Edition.

1.04 FABRICATION AND ASSEMBLY

A. Fabricate and assemble in the shop to the greatest extent possible.

B. Shop prime steel with metal primer conforming to Section 09 90 00, "Architectural Painting", except surfaces of steel to be encased in concrete, and surfaces to be welded in the field.

1.05 PAINTING

Conform to requirements of Section 09 90 00, Architectural Painting.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural Steel used in chord and web members shall conform to one of the ASTM Specifications listed in SJI Standard Specifications.

B. Bolts, Nuts, and Washers not specified on the design drawings shall be ASTM A307, and shall be no smaller than 3/8” diameter. Bolts 3/4" diameter and larger shall be ASTM A325.

C. Anchor Bolts: ASTM F1554, Grade36, galvanized.

D. Structural Steel for Supplementary Framing and Joist Leg Extensions: ASTM A 36.

E. Welding Materials: per AWS D1.1, : type required for base metals being welded.

PART 3 EXECUTION

3.01 INSPECTION

A. Determine that field conditions are acceptable and ready for work.

B. Beginning work means erector accepts existing conditions.

3.02 INSTALLATION OF STEEL JOISTS

A. Fabricate, deliver, and erect all joists and bridging per SJI-40 standard specifications and details, unless shown otherwise.

B. Provide sufficient temporary bracing to maintain framing safe, plumb, and in true alignment until completion of erection and installation of permanent bridging and bracing.

C. Do not field cut or alter new or existing structural members without written approval of the COTR. Do not modify bolt holes of structural members, secondary members, clips or attachments with a cutting torch to accommodate alignment difficulties unless written approval is obtained from the COTR.

D. Erect and bear joists on supports.

E. Frame openings greater than 18 inches with supplementary framing.

F. Erection of decking shall not begin until joists are in place and secured with permanent bridging and bracing.

G. After erection, prime scarred surfaces and surfaces not shop primed, except surfaces to be in contact with concrete.

3.03 INSTALLATION OF ANCHORS

Coordinate placement of anchors for securing bearing plates or angles.

3.04 ARCHITECTURALLY EXPOSED STEEL

Materials and Methods for members designated as “Architecturally Exposed Steel” shall conform to AISC Code of Standard Practice for Steel Buildings and Bridges, Section 10.

Select and fabricate materials for best appearance. Cut, fit, and assemble steel with surfaces smooth, and with complete contact at joints. Clean bearing surfaces and surfaces in permanent contact before assembly.

3.05 TOUCHUP PAINTING

After erection of structural steel, the Contractor shall touch up bolt heads and nuts, field welds, gouges and abrasions in the shop coat.

3.06 TOLERANCES

Tolerances in fabrication and erection shall be in accordance with SJI.

END OF SECTION

SECTION 05 31 13

NON-COMPOSITE STEEL FORM DECK

PART 1 GENERAL

1.01 SECTION INCLUDES

Plain and galvanized, smooth-surfaced steel form deck for concrete placement.

1.02 SUBMITTALS

A. Submit for approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.03 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete.

B. Section 05 12 00 - Structural Steel Framing

1.04 REFERENCES

ASTM A1008a (2007) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solutioned Hardened, and Bake Hardenable

ASTM A653 (2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 924 (2007) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

AWS D1.3-98 (1998) Structural Welding Code - Sheet Steel; American Welding Society (AWS).

Fire Resistance Directory; Underwriters Laboratories Inc. (UL).

SDI 31 (2001) Steel Deck Institute Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution; Steel Deck Institute, Inc. (SDI).

SDI DDM02 (1987) Diaphragm Design Manual; Steel Deck Institute, Inc. (SDI).

AISI - SG-973 - Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute (AISI).

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Member of the Steel Deck Institute.

B. Codes and Standards: Comply with applicable provisions of the following specifications:

1. American Iron and Steel Institute (AISI).
2. American Welding Society (AWS D1.3 Structural Welding Code - Sheet Steel).
3. Steel Deck Institute (SDI)

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage and handling.

B. If ground storage is needed, store deck bundles off the ground, with one end elevated to provide drainage. Protect bundles against condensation with a ventilated waterproof covering. Stack bundles so there is no danger of tipping, sliding, rolling, shifting or material damage. Check bundles periodically for tightness, and retighten as necessary so wind cannot loosen sheets.

C. Place deck bundles on the building frame near a main supporting beam at a column or wall. Do not place bundles on unbolted frames or on unattached or unbridged joists. Ensure that the structural frame is properly braced to receive the bundles.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet Steel for Galvanized Deck and Accessories: ASTM A 653 Structural Quality, minimum yield strength of 33 ksi. Galvanizing: ASTM A 924 with a minimum coating class of G30 as defined in ASTM A 653.

B. Sheet Steel for Deck and Accessories: ASTM A 1008 with a minimum yield strength of 33 ksi.

C. Deck Type and Thickness: As shown on the drawings.

D. Whenever possible, deck shall be multi-span, two-span minimum, and shall not require shoring during the concrete placement procedure.

E. Where fire resistance rated assemblies are required, provide UL-listed units, with UL Design Number as indicated on the drawings.

2.02 ACCESSORIES

A. Provide all accessories necessary to complete the decking scheme called for in the construction documents. Pour stops, column closures, end closures, cover plates, and girder fillers shall be the type required by the Steel Deck Institute.

B. Mechanical fasteners or welds are acceptable for accessory attachments.

PART 3 EXECUTION

3.01 PREPARATION

A. Place deck in accordance with approved placement plans.

B. Do not place deck panels on concrete support structure until concrete has cured and is dry.

C. Locate deck bundles to prevent overloading of support members.

3.02 INSTALLATION - GENERAL

A. Install deck panels and accessories according to Steel Deck Institute specifications and recommendations, and in accordance with construction drawings, or where required, with placement plans and requirements of this section.

B. Install temporary shoring, if required, before placing deck panels.

C. Cut and neatly fit deck units and accessories around openings and other work projecting through or adjacent to the decking.

D. Do not cut unscheduled openings through the deck without the approval of the COTR; reinforce openings as directed.

3.03 INSTALLATION - FORM DECK

A. Anchor deck units to steel supporting members according to Steel Deck Institute specifications and recommendations, and in accordance with construction plans and requirements of this section.

B. Install deck ends over supports with a minimum end bearing of 1.5 inches.

C. Fasten pour stops and girder fillers to supporting structure according to manufacturer's recommendations.

D. Fasten column closures, cell closures, and Z closures to deck to provide tight fitting closures at open ends of ribs and sides of decking. Fasten cell closures at changes of direction of deck units unless otherwise directed.

3.04 REPAIRS

A. Inspect deck for tears, dents, and other damage that may prevent the deck from acting as a tight and substantial form or that would impair structural capability during placement of concrete. Repair tears, dents, and other damage before concrete placement.

B. Determine the need for temporary shoring of deck before concrete placement.

END OF SECTION

SECTION 05 31 23

STEEL ROOF DECK

PART 1 GENERAL

1.01 SECTION INCLUDES

Plain and galvanized, smooth-surfaced, steel deck for roof sub-decking.

1.02 SUBMITTALS

A. Submit for approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.03 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete.

B. Section 05 12 00 - Structural Steel Framing

1.04 REFERENCES

ASTM A1008a (2007) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solutioned Hardened, and Bake Hardenable.

ASTM A653 (2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A 924 (2007) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

AWS D1.3-98 (1998) Structural Welding Code - Sheet Steel; American Welding Society (AWS).

Fire Resistance Directory; Underwriters Laboratories Inc. (UL).

SDI 31 (2001) Steel Deck Institute Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution; Steel Deck Institute, Inc. (SDI).

SDI DDM02 (1987) Diaphragm Design Manual; Steel Deck Institute, Inc. (SDI).

AISI - SG-973 - Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute (AISI).

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Member of the Steel Deck Institute.

B. Codes and Standards: Comply with applicable provisions of the following specifications:

1. American Iron and Steel Institute (AISI).
2. American Welding Society (AWS D1.3 Structural Welding Code - Sheet Steel).
3. Steel Deck Institute (SDI)

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage and handling.

B. If ground storage is needed, store deck bundles off the ground, with one end elevated to provide drainage. Protect bundles against condensation with a ventilated waterproof covering. Stack bundles so there is no danger of tipping, sliding, rolling, shifting or material damage. Check bundles periodically for tightness, and retighten as necessary so wind cannot loosen sheets.

C. Place deck bundles on the building frame near a main supporting beam at a column or wall. Do not place bundles on unbolted frames or on unattached or unbridged joists. Ensure that the structural frame is properly braced to receive the bundles.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Roof Deck: Provide the following types; with depth, design thickness, and design configuration as indicated on the drawings, and in accordance with the requirements of the SDI.

1. Intermediate Rib (Type F).
2. Wide Rib (Type B).
3. Deep Rib (Type N).
4. Long Span (Types J and H).

B. Sheet Steel for Galvanized Roof Deck and Accessories: ASTM A 653 Structural Quality, Grade 33 or higher. Galvanizing: ASTM A 924 with a minimum coating class of G30 as defined in A 653.

C. Sheet steel for prime-painted roof deck and accessories shall conform to ASTM A 1008 with a minimum yield strength of 33 ksi. Steel deck shall have a coat of manufacturer's standard shop primer paint.

D. Where fire resistance rated assemblies are required, provide UL-listed units, with UL Design Number as indicated on the drawings.

2.02 ACCESSORIES

A. Furnish ridge and valley plates, flat plates at change of deck direction, and sump pans, as shown on plans to provide a finished surface for the application of roof insulation and roof covering.

PART 3 EXECUTION

3.01 PREPARATION

A. Install deck panels and accessories according to Steel Deck Institute specifications and recommendations, and in accordance with construction drawings, or where required, with placement plans and requirements of this section.

B. Locate deck bundles to prevent overloading of support members.

3.02 INSTALLATION - GENERAL

A. Do not use deck units as a working platform or storage area until supporting structural members and deck units are permanently attached in position.

B. Do not impose construction loads that exceed load carrying capacity of deck.

C. Install deck panels and accessories according to Steel Deck Institute specifications and recommendations, SDI Manual of Construction with Steel Deck, and in accordance with the placement plans and requirements of this section.

D. Place deck panels on structural supports and adjust to final position with ends lapped or butted over structural supports with a minimum

end lapped or butted over structural supports with a minimum end bearing of 1.5 inches. Attach the deck panels firmly to the supports immediately after placement in order to form a safe working platform.

E. Cut and neatly fit deck and accessories at skew conditions, around openings, and at other work projecting through or adjacent tot he decking.

F. Do not cut unscheduled openings through the deck without the approval of the COTR; reinforce openings as directed.

3.03 ATTACHMENT

A. Anchor deck units to steel supporting members according to Steel Deck Institute specifications and recommendations, and in accordance with construction plans and requirements of this section.

B. Side lap attachment and perimeter edge attachment shall be in accordance with Steel Deck Institute specifications and recommendations, and in accordance with construction plans and requirements of this section.

C. Anchor accessories to supporting members by arc spot welds or self drilling screws at 12 inch maximum intervals, or as shown on design drawings.

3.04 REPAIRS

A. Before placement of roof insulation and roof covering, inspect the deck for tears, dents, or other damage that may prevent the deck from action as a structural roof base. Repair tears, dents, or other damage.

END OF SECTION

SECTION 05 36 00

COMPOSITE STEEL DECK

PART 1 GENERAL

1.01 SECTION INCLUDES

Galvanized, deformed-surfaced, steel form deck for concrete placement.

1.02 SUBMITTALS

A. Submit for approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.03 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete.

B. Section 05 12 00 - Structural Steel Framing.

1.04 REFERENCES

ASTM A1008a (2007) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solutioned Hardened, and Bake Hardenable.

ASTM A653 (2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

ASTM A 924 (2007) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

AWS D1.3-98 (1998) Structural Welding Code - Sheet Steel; American Welding Society (AWS).

Fire Resistance Directory; Underwriters Laboratories Inc. (UL).

SDI 31 (2001) Steel Deck Institute Design Manual for Composite Decks, Form Decks, Roof Decks, and Cellular Metal Floor Deck with Electrical Distribution; Steel Deck Institute, Inc. (SDI).

SDI DDM02 (1987) Diaphragm Design Manual; Steel Deck Institute, Inc. (SDI).

AISI - SG-973 - Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute (AISI).

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Member of the Steel Deck Institute.

B. Codes and Standards: Comply with applicable provisions of the following specifications:

1. American Iron and Steel Institute (AISI).
2. American Welding Society (AWS D1.3 Structural Welding Code – Sheet Steel).
3. Steel Deck Institute (SDI).

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage and handling.

B. If ground storage is needed, store deck bundles off the ground, with one end elevated to provide drainage. Protect bundles against condensation with a ventilated waterproof covering. Stack bundles so there is no danger of tipping, sliding, rolling, shifting or material damage. Check bundles periodically for tightness, and retighten as necessary so wind cannot loosen sheets.

C. Place deck bundles on the building frame near a main supporting beam at a column or wall. Do not place bundles on unbolted frames or on unattached or unbridged joists. Ensure that the structural frame is properly braced to receive the bundles.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet Steel for Galvanized Deck and Accessories: ASTM A 653 Structural Quality, minimum yield strength of 33 ksi. Galvanizing: ASTM A 924 with a minimum coating class of G30 as defined in ASTM A 653.

B. Sheet Steel for Deck and Accessories: ASTM A 1008 with a minimum yield strength of 33 ksi.

C. Deck Type and Thickness: As shown on the drawings.

D. Whenever possible, deck shall be multi-span, two-span minimum, and shall not require shoring during the concrete placement procedure.

E. Where fire resistance rated assemblies are required, provide UL-listed units, with UL Design Number as indicated on the drawings.

2.02 ACCESSORIES

A. Provide all accessories necessary to complete the decking scheme called for in the construction documents. Pour stops, column closures, end closures, cover plates, and girder fillers, and other accessories, shall be the type required by the Steel Deck Institute.

B. Mechanical fasteners or welds are acceptable for accessory attachments.

PART 3 EXECUTION

3.01 PREPARATION

A. Install deck panels and accessories according to Steel Deck Institute specifications and recommendations, and in accordance with construction drawings, or where required, with placement plans and requirements of this section.

B. Do not place deck panels on concrete support structure until concrete has cured and is dry.

C. Locate deck bundles to prevent overloading of support members.

3.02 INSTALLATION – GENERAL

A. Install deck panels and accessories according to Steel Deck Institute specifications and recommendations, and in accordance with placement plans and requirements of this section.

B. Install temporary shoring, if required, before placing deck panels.

C. Cut and neatly fit deck units and accessories around openings and other work projecting through or adjacent to the decking.

D. Do not cut unscheduled openings through the deck without the approval of the COTR; reinforce openings as directed.

3.03 INSTALLATION - FLOOR DECK

A. Anchor floor deck units to steel supporting members according to Steel Deck Institute specifications and recommendations, and in accordance with construction plans and requirements of this section.

B. Install deck ends over supports with a minimum end bearing of 1.5 inches.

C. Fasten pour stops and girder fillers to supporting structure according to the manufacturer's recommendations.

D. Fasten column closures, cell closures, and Z closures to deck to provide tight fitting closures at open ends of ribs and sides of decking. Fasten cell closures at changes of direction of floor deck units unless otherwise directed.

3.04 REPAIRS

A. Before concrete placement, inspect the deck for tears, dents, or other damage that may prevent the deck from acting as a tight and substantial form or that would impair structural capability. Repair tears, dents, or other damage.

B. Determine the need for temporary shoring of the deck before concrete placement.

END OF SECTION

SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Load bearing and non-load bearing partition, formed-steel- stud wall framing.

B. Formed steel joist framing and bridging.

C. Formed steel truss assemblies.

D. Metal building components and cladding.

E. Framing System shall accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

F. Framing System shall provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic temperature ranges.

1.02 RELATED WORK SPECIFIED ELSEWHERE

Section 04 20 00 Unit Masonry

Section 09 29 00, Gypsum Board

Section 13 34 19, Fabricated Engineered Metal Building Structure

1.03 SUBMITTALS

Submit for Approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.04 REFERENCES

ASTM A 90 – (2007) Standard Test Method for Weight [Mass] of Coating Iron and Steel Articles, with Zinc or Zinc-Alloy Coatings.

ASTM A653 –(2007) Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy – Coated (Galvannealed) by the Hot – Dip Process.

ASTM A370b – (2007) Standard Test Methods and Definitions for Mechanical Testing of Steel Products.

ASTM A1008a – (2007) Standard Specification for Steel, Sheet and Strip, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy with Improved Formability, Solutioned Hardened, and Bake Hardenable.

ASTM A1011 – (2007) Standard Specification for Steel, Sheet and Strip. Hot-Rolled, carbon, structural, High-Strength Low-Alloy ,High-Strength Low-Alloy with Improved Formability, and Ultra High-Strength.

NASFA NT13-95 (1995) Design Guide for Cold-Formed Steel Trusses.

AWS American Welding Society D1.3-00 (2000) Structural Welding Code – Sheet Steel.

AISI –SG-973 (1996) Cold-Formed Steel Design Manual

FS - Primer, paint, zinc-chromate, alkyd type (DODP-21035A).

FS FF – P – 395C Pin, Drive, Guided and Pin Drive Power Actuated.

FS FF – S – 107C Screws, Tapping and Drive.

1.05 FABRICATION AND ASSEMBLY

Fabricate and assemble in the shop to the greatest extent possible. Reinforce and brace assemblies to withstand shipping, handling, and erection.

PART 2 PRODUCTS

2.01 MATERIALS

A. Load Bearing Studs: Sized for placement and loading application in accordance with AISI Cold-Formed Steel Design Manual.

B. Formed steel joist framing and bridging: Sized for placement and loading applications in accordance with AISI Cold-Formed Steel Design Manual.

C. Track: Channel-shaped, with solid web and no flange lips, same width as studs, tight fit, sized to meet application.

D. Trusses: Manufacturer’s standard chord and web member profiles, designed and fabricated with mechanical properties as required for

structural loads per AISI “Design Guide for Cold-Formed Steel Trusses.” Determine mechanical properties by testing in accordance with ASTM A370.

E. Framing Accessories: Conforming to ASTM A653 G-90 for coating.

F. Screws: Corrosion-resistant, zinc-coated or 18-8 stainless steel, self-drilling and self-tapping, pan or hex washer head type, conforming to FS FF-S-107C. Size: no smaller than #10.

G. Powder-Actuated Fasteners: Manufactured from AISI 1061, 1062, or 1065 steel, or a proprietary hardened stainless steel, with a minimum hardness of 52HRc, and zinc-electroplated (for steel), conforming to FS FF-P-395C.

H. Metal building components and cladding: Conforming to requirements of Section 13 34 19, Fabricated Engineered Metal Building Structure

PART 3 EXECUTION

3.01 GENERAL

Fabrication and installation details shall conform to the latest technical guidelines published by the Light-Gauge Steel Engineers Association.

3.02 INSPECTION

A. Determine that field conditions are acceptable and ready for work.

B. Beginning work means erector accepts existing conditions.

3.03 INSTALLATION OF STUDDING

A. Install components in accordance with manufacturer's instructions. Studs shall be cut square and shall seat firmly in base and head tracks.

B. Align floor and ceiling tracks; locate to wall or partition layout. Secure in place with fasteners or welding at maximum 24 inches on center. Coordinate installation of sealant with floor tracks (and ceiling tracks where applicable). Fit-up and erection tolerances shall be: 1/8” in 10-feet (max) for plumb, level, and true to line; 1/8” (plus-or-minus, max.) for spacing and location.

C. Place studs at 16 inches o.c.; not more than 2 inches from abutting walls at each side of openings.

D. Construct corners using minimum three studs. Double studs at wall openings, doors, and window jambs.

E. Erect all studs one-piece, full-length. Splicing of studs is not permitted.

F. Install intermediate studs above and below openings to match wall stud spacing and pattern

G. For non-load bearing framing, provide deflection allowance in the top stud track of wall framing located directly below horizontal building framing. .H. For axially loaded studs, provide horizontal bracing consisting of cold rolled steel channels, spaced a maximum of 48” o.c. (measured vertically). For laterally loaded studs, provide gypsum board or sheathing on both sides of wall. Where field conditions prevent the above described bracing, contact COTR for action to be taken.

I. All welding shall conform to AWS D1.3 for sheet steel.

3.04 INSTALLATION OF OTHER COLD METAL FRAMING

Install components and cladding in accordance with manufacturer's instructions.

3.05 TOUCHUP

After erection, touch up field welds and damaged galvanized surfaces with zinc-chromate cold-galvanizing compound primer, conforming to FS TT-P-645.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Shop fabricated ferrous metal items formed, welded, and machined; galvanized and prime painted.

B. TV monitor ceiling-mounted pipe supports.

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 03 30 00, Cast-In-Place Concrete: Placement of metal fabrications in concrete.

B. Section 04 20 00, Unit Masonry: Placement of metal fabrications in masonry.

1.03 RELATED SECTIONS

A. Section 05 12 00, Structural Steel Framing.

B. Section 05 21 00, Steel Joists Framing

C. Section 09 90 00, Architectural Painting.

1.04 REFERENCES

A. ASTM A36- (2005) Standard Specification for Carbon Structural Steel.

B. ASTM A992a-(2006) Standard Specification for Steel for Structural Shapes for Use in Building Framing.

C. ASTM A53 (2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.C. ASTM A123- (2001) Standard Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel Products..

D. ASTM A153 (2005) Standard Specification for Zinc coating (Hot-Dip) on Iron and Steel Hardware.

E. ASTM A283 (2003 reapproved 2007) Standard Specification for Low and Intermediate Tensile StrengthCarbon Steel Plates, Shapes, and Bars.

F. ASTM A307b (2007) Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

G. ASTM A325a (2007) High strength Bolts for Structural Steel Joints.

H. ASTM A500a (2007) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

I. ASTM A501 (2007) Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

J. ASTM B177 (2001 reapproved 2006) Standard Guide for Engineering Chromium Electroplating.

K. AWS D1.1-02 (2002) Structural Welding Code - Steel.

L. SSPC- Steel Structures Painting Council.

1.05 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.06 FIELD MEASUREMENTS

Verify that field measurements are as indicated on drawings:

PART 2 PRODUCTS

2.01 MATERIALS

Unless noted otherwise, all materials shall conform to the following specifications:

A. Steel Sections: Wide-Flanged Sections: ASTM A992; all other sections: ASTM A36

B. Steel Tubing: ASTM A500, Grade B., or ASTM A501.

C. Plates: ASTM A283.

D. Pipe: ASTM A53, Grade B, Type E or Type S, unless indicated otherwise on drawings.

E. Fasteners: Bolts, Nuts, and Washers: ASTM A325, or A307, plain, or galvanized to ASTM A153 for galvanized components.

F. Welding Materials: AWS D1.1: type required for base metals being welded.

2.02 FABRICATION

A. Fit and shop assemble in largest practical section for maintenance of tolerances, structural integrity, and for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints abutt tight, flush, and hairline. Ease exposed edges to a small uniform radius.

D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

E. Supply components required for anchorage of fabrications, Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.03 FINISHES

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Do not prime surfaces in direct contact with concrete or where field welding is required, or faying surfaces of slip-critical connections.

C. Prime paint items in accordance with Section 09 90 00, Architectural Painting.

D. Galvanize in accordance with ASTM A123, structural steel members. Provide minimum 1.25 oz/sq ft. galvanized coating.

2.04 TV Monitor Ceiling-Mounted Pipe Support

A. Install above ceiling structure to provide a standard 1-1/2” Normal Pipe Thread (N.P.T.) Iron Pipe to protrude through ceiling for mounting a standard 20” TV/Monitor bracket.

B. Installation shall be stable and plumb, safety secured above ceiling. Minimum weight capacity of 150 pounds.

Pipe shall extend a maximum of 4” below finished ceiling with a minimum of 2” of N.P.T. on lower end. A ¼” hole shall be drilled at a distance ½” from lower end, for a safety pin.

C. Install pipe, a minimum of 18” from any wall or solid structure, unless otherwise specified.

Install a 110-volt AC duplex outlet, in finished ceiling above or near location of TV monitor, (unless otherwise specified), to be accessible below ceiling. (Outlet maybe mounted on wall behind TV if necessary).

PART 3 EXECUTION

3.O1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

B. Beginning of installation means erector accepts existing conditions.

3.02 PREPARATION

Supply items required to cast into concrete or embedded in masonry with setting templates, to appropriate sections.

3.03 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Field weld components indicated on drawings and/or shop drawings.

D. Perform field welding in accordance with AWS D1.1.

E. Obtain COTR approval prior to site cutting or making adjustments not scheduled.

F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 ERECTION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch per 10FT, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION

SECTION 05 52 13

PIPE AND TUBE RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

Steel, stainless steel, and aluminum pipe and tube handrails and railings, of round, rectangular, and oval or elliptical cross-section.

1.02 RELATED SECTIONS

Section 03 30 00, Cast-in-Place Concrete

Section 04 20 00, Unit Masonry

Section 05 50 00, Metal Fabrications

Section 09 90 00, Architectural Painting

1.03 REFERENCES

A. ADA 28 CFR Part 36 (1994) ADA Standards for Accessible Design

B. AISC M016 (1989) Manual of Steel Construction, ASD, Ninth Edition

C. AISI SG-973 (1996) Cold-Formed Steel Design Manual

D. ASTM A36 (2005) Standard Specification for Carbon Structural Steel

E. ASTM A53 (2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

F. ASTM A123 (2002) Standard Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel Products

G. ASTM A153 (2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

H. ASTM A500a (2007) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

I. ASTM A564 (2004) Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes

J. ASTM A780 (2001 reapproved 2006) Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

K. ASTM B221 (2006) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

L. AWS D1.1-02 (2002) Structural Welding Code – Steel

M. AWS D1.2-97 (1997) Structural Welding Code – Aluminum

N. AWS D1.6-99 (1999) Structural Welding Code – Stainless Steel

O. NAAMM Metal Finishes Manual - National Association of Architectural Metal Manufacturers

P. OSHA 29 CFR Part 1910 (1998) Occupational Safety and Health Standards

Q. IBC (2003) International Building Code

1.04. SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.05. FIELD MEASUREMENTS

Prior to ordering materials or beginning fabrication, verify that field and reference measurements are as indicated on the drawings.

1.06 PERFORMANCE REQUIREMENTS

A. General: Handrails and railings shall withstand the structural loads indicated. Determine allowable design working stresses of handrail and railing materials based on the following:

1. Cold-Formed Structural Steel: AISI SG-673

2. Steel and Stainless Steel Structural Sections: AISC - ASD

3. Aluminum Sections: Aluminum Design Manual

4. Welds: AWS D1.1, D 1.2, or D1.6, as applicable

B. Structural Performance of Handrails and Railings: Provide handrails and railings capable of withstanding all structural loads, as required by OSHA and by IBC, without exceeding the allowable design working stresses of materials for handrails, railings, anchors, and connections.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

D. Source Limitations: For uniformity, obtain each type of handrail and railing through one source from a single manufacturer.

1.07 COORDINATION

Coordinate installation of anchorages for handrails and railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to the Project Site in time for installation.

1.08 SCHEDULING

Schedule installation so handrails and railings are mounted only on completed walls or bases. Do not support temporarily by any means that does not satisfy the structural performance requirements.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Pipe: ASTM A 53; finish, type, and weight class, unless shown otherwise, as follows:

1. Galvanized finish for exterior installations and where indicated.

2. Grade A, standard wall (Schedule 40).

B. Steel Tubing: Cold-formed steel tubing, ASTM A 500, Grade B, unless another grade is required by structural loads.

C. Steel Plates, Shapes, and Bars: ASTM A 36.

D. Stainless Steel Pipe, Tubing, and Shapes: ASTM A564, Types 304, 304L, 316, and 316L.

E. Aluminum Pipe, Tubing, and Shapes: ASTM B221, Types 6061 and 6063.

F. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

G. Fasteners for Anchoring Handrails and Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction indicated, and capable of withstanding the design loads.

1. For steel handrails, railings, and fittings, use plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electro-deposited zinc coating.

2. For aluminum and stainless steel handrails, railings, and fittings, use stainless steel fasteners compatible with the mating base metals.

3. Fasteners for Interconnecting Handrail and Railing Components: Use fasteners fabricated from same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.

4. Cast-in-Place and Post-installed Anchors: Anchors of type indicated, fabricated from galvanized or stainless steel materials, with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry, and equal to four times the load imposed when installed in concrete.

2.02 FABRICATION

A. General: Fabricate handrails and railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support the design and imposed structural loads. Dimensional design shall conform to the drawings, and to OSHA, ADA, and IBC requirements.

B. Assemble handrails and railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Form changes in direction of railing members as follows:

1. As detailed.

2. By flush radius bends.

3. By mitering at elbow bends.

4. By any method indicated above, applicable to the change in direction involved.

D. Form simple curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical or rectangular cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

E. Welded Connections: Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously, and at exposed connections, grind and finish exposed surfaces smooth and blended so no roughness is felt after finishing and the welded surface matches contours of adjoining surfaces.

F. Shear, cut, and punch metals cleanly and accurately. Remove burrs from exposed cut edges. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the work.

G. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

H. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members that are to be galvanized, or are exposed to the exterior or to moisture from condensation or other sources.

I. Fabricate joints that will be exposed to weather in a watertight manner. Close exposed ends of handrail and railing members with prefabricated end fittings.

J. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns, unless clearance between end of railing and wall is 1/4 inch or less

K. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.03 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Aluminum handrails, railings, and fittings shall have an Architectural Class II clear anodized finish, unless shown otherwise.

C. Where necessary, protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Provide exposed fasteners with a finish matching the appearance, including color and texture, of handrails, railings, and fittings.

2.04 FINISHES

A. Galvanized Handrails and Railings: Hot-dip galvanize exterior steel and iron handrails and railings to comply with ASTM A 123. Hot-dip galvanize hardware for exterior steel and iron handrails and railings to comply with ASTM A 153.

B. For galvanized handrails and railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Stainless steel and aluminum handrails and railings shall have a brushed, or medium satin finish.

D. For paint finishes as called for in the drawings, see Section 09 90 00, Architectural Painting, for primer and finish coating requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and ready to receive work.

B. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.02 INSTALLATION

A. Perform cutting, drilling, and fitting required to install handrails and railings. Set handrails and railings accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.

B. Set posts plumb within a tolerance of 1/16 inch in 3-1/2 feet. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Corrosion Protection: Concealed surfaces of aluminum that will be in contact with dissimilar metals, grout, concrete, masonry, or wood, shall be coated with a heavy coat of bituminous paint.

D. Adjust handrails and railings before anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.

E. Secure wall brackets to building construction as follows:

1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

2. For hollow masonry anchorage, use toggle bolts.

3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.

4. For steel-framed gypsum board assemblies, use hanger or lag bolts set into wood backing between studs. Coordinate

with stud installation to locate backing members. Alternatively, for steel-framed gypsum board assemblies, fasten brackets directly to steel framing or concealed reinforcements using self-tapping screws of size and type required to support structural loads.

3.03 CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same primer and finish materials. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

C. Stainless Steel Surfaces: Clean with stainless steel wool and non-abrasive polish, and buff until adjacent surface textures match.

D. Anodized Aluminum Surfaces: Clean only with soap and water. Do not buff, polish, or attempt to repair any anodized finish, except that returning the affected part to the fabricator for re-anodizing shall be acceptable.

3.04 PROTECTION

A. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion.

END OF SECTION

SECTION 06 10 00

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Light framing lumber and studs.

B. Structural framing lumber.

C. Nailers, Blocking and Furring.

D. Underlayment.

E. Fasteners.

F. Wood decking and Sheathing.

1.02 RELATED ITEMS

A. Section 09 29 00: Gypsum Board

B. Section 06 20 00: Finish Carpentry

C. Section 09 90 00: Painting and Coating

1.03 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

PART 2 PRODUCTS

2.01 WOOD MATERIALS

A. 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.

B. Structural framing lumber shall be surfaced 4 sides, graded and stamped by either Southern Pine Inspection Bureau (SPIB), West Coast Lumber Inspection Bureau (WCLIB), or Western Wood Products Association (WWPA), to indicate the grade and the fiber stress in bending. Grade or minimum allowable unit stresses are shown on drawings.

C. LIGHT-FRAMING MATERIALS

Light framing materials and studs over 10 feet in length

SPECIES	GRADE
Southern yellow pine	No. 2KD dimension, SPIB
Douglas Fir, coast region: Western Larch: west coast Hemlock, White Fir, Ponderosa Pine, Western Red Cedar, Idaho White Pine, Sugar Pine.	Standard grade, WCLIB No. 17 and WWPA Grading Rules.
Sitka Spruce, Western Red Cedar	Standard grade WCLIB No. 17
Redwood	Construction grade, RIS

D. STUD FRAMING MATERIALS

Stud-framing materials for 2 by 4 inch studs, 10 feet or less in length:

SPECIES	GRADE
Southern Yellow Pine	No. 2KD stud grade, SPIB
Douglas Fir, coast region, Western Larch, Western Hemlock	West Coast Studs, WCLIB No. 17. No. 2 and better, WWPA Grading Rules
Sitka Spruce	Standard grade WCLIB No. 17

E. BOARD MATERIALS

SPECIES	GRADE
Southern Yellow Pine	No. 2 boards, SPIB
Western Red Cedar, West Coast Hemlock, Douglas Fir, Larch	Utility grade boards, WCLIB No. 17
White Fir, Ponderosa Pine, Western Cedar, Incense Cedar Idaho White Pine, Sugar Pine	Utility grade, WWPA Grading Rules

F. FASTENERS

Fasteners and Anchors: Hot dipped galvanized or Zinc electroplated steel for high humidity and treated wood locations, unfinished steel elsewhere. See drawings for specification application and type of fasteners and anchors.

2.02 PLYWOOD

A. Floor decking: APA rated 32/16, Exposure 1.

B. Roof decking: APA rated 32/16, exterior exposure.

C. Combination subfloor/underlayment: APA Sturd-I-Floor, exposure 1.

D. Wall sheathing: APA sheathing, C-D plugged, exterior exposure.

E. Backing panels: APA C-D plugged. Interior exposure.

2.03 BUILDING PAPER

Asphalt saturated felt, non-perforated, ASTM D226, type 1.

2.04 AIR INFILTRATION BARRIER

Six mil polyethylene fabric which permits passage of water vapor; DuPont Tyvek or approved equal.

2.05 TREATMENT

A. Structural and light framing lumber and plywood shall be fire retardant treated to a flame spread of 25 or less in accordance with AWPA standard C20 and tested in accordance with ASTM standard E-84 and dried after treatment in accordance with AWPA standard U1-07 for lumber and plywood.

B. Wood in contact with masonry, concrete or steel shall be pressure-preservative treated in accordance with AWPA, Standard U1-07 for lumber, timber, and plywood, and shall be dried to a maximum moisture content of 15 percent after treatment. Cut surfaces shall be brush coated with two coats of the same preservative used in pressure treatment.

C. Field Treatment: All field cuts of treated lumber shall be field treated in accordance with AWPA M4.

2.06 MOISTURE CONTENT

A. Boards and dimension lumber 2" thick and less: maximum 15 percent.

B. Other lumber: Conform to rules of the lumber association or inspection bureau under which the lumber is graded.

PART 3 EXECUTION

3.01 INSTALLATION

A, Provide nailers, blocking and grounds where required. Set work plumb, level and accurately cut.

B. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction. Coordinate with work of other sections.

C. Comply with manufacturer's requirements for storage, cutting, handling, fastening and working treated materials.

D. Restore damaged components. Protect work from damage.

END OF SECTION

SECTION 06 20 00

FINISH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Provide finish carpentry for woodwork items exposed to view:

1. Exterior running and standing trim.

2. Interior running and standing trim, including door and window casing.

3. Plywood panels.

4. Wood shelving and closet accessories.

1.02 RELATED ITEMS

A. Section 06 01 00: Rough Carpentry

B. Section 08 14 00: Wood Doors

C. Section 09 90 00: Painting and Coating

1.03 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

PART 2 PRODUCTS

2.01 MATERIALS

A. Quality standard for fabrication and products: Architectural Woodwork Institute Quality Standards, Custom grade unless noted otherwise.

B. Exterior finish carpentry:

1. Trim and boards for painted finish: Softwood suitable for exposure and loading. Use decay resistant species, such as redwood or western cedar, for exposure conditions requiring repeated wettings.

2. Plywood for painted finish: APA rated exterior, medium density overlay plywood.

C. Interior finish carpentry:

1. Trim, boards, and plywood for transparent finish: Specified on drawings.

2. Trim, boards, and plywood for painted finish: Softwood suitable for exposure and use.

D. Shelving: Hardwood, medium density particleboard with veneer on all exposed sides, or fir plywood with clear hardwood edge bands.

E. Closet bars: Telescoping steel with chrome finish.

F. Wood treatment:

1. Preservative treatment: Pressure-treated with waterborne preservatives for items in contact with roofing, flashing, waterproofing, masonry, concrete, or the ground. Vehicle for preservative compatible with finish.

2. Fire-retardant treatment: ASTM E 84, Class A, where required by drawings. Vehicle for preservative compatible with finish.

G. Fasteners and anchorages:

1. Provide nails, screws and other anchoring devices of the type size, material, and finish required for secure attachment of finish materials indicated on drawings. Conceal where possible.

2. Where finish carpentry is exposed to exterior or in areas of high relative humidity fasteners and anchors shall be hot-dipped galvanized (ASTM A 153).

PART 3 EXECUTION

3.01 INSTALLATION

A. Back prime work and install plumb, level and straight with tight joints; scribe work to fit.

B. Install trim with minimum number of joints. Cope at returns and miter corners. Scarf end to end joints. Stagger joints in adjacent and related members.

C. Anchor exposed work with concealed fasteners or fine finishing nails countersunk and filled.

3.02 ADJUSTMENT, CLEANING, FINISHING, AND PROTECTION

A. Repair or replace damaged work to eliminate functional and visual defects.

B. Clean and touch up work to provide a completely finished job.

C. Protect all work until final acceptance.

END OF SECTION

SECTION 06 41 00

ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Casework for transparent finish

B. Casework for opaque finish

C. Casework, laminate clad

D. Casework hardware

E. Casework tops

1.02 RELATED ITEMS

A. Section 06 10 00: Rough Carpentry

B. Section 06 20 00: Finish Carpentry

C. Section 09 90 00: Painting and Coating

1.03 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

PART 2 PRODUCTS

2.01 QUALITY

All work under this section shall be in accordance with Architectural Woodworking Institute (AWI) Quality Standards, for custom grade work unless more or less stringent standards are called for on the drawings.

2.02 CASEWORK FOR TRANSPARENT FINISH

A. AWI quality grade: Custom

B. Construction: Details shall conform to reveal overlay design

C. Exposed parts shall be of a species and cut as called for on the drawings

D. Semi-exposed parts as governed by custom grade AWI standards

2.03 CASEWORK FOR OPAQUE FINISH

A. AWI quality grade: Custom

B. Construction: Details shall conform to reveal overlay design

C. Exposed solid wood parts: Any species permitted by AWI custom grade standard

D. Exposed panel product parts: Any species and substrate permitted by AWI custom grade standard

E. Semi-exposed parts as governed by AWI custom grade standards

2.04 CASEWORK, LAMINATE CLAD

A. AWI quality grade: Custom

B. Construction: Details shall conform to reveal overlay design

C. Exposed surfaces shall be finished with solid color, suede finish, high pressure laminate materials in thicknesses determined by AWI custom grade standard. Acceptable manufacturers are Formica, Textolite, Wilson Art, Nevamar or equal. Colors as shown on drawings.

D. Semi-exposed surfaces as governed by AWI custom grade standards.

2.05 CASEWORK HARDWARE

A. All cabinet hardware shall be furnished and installed by the casework manufacturer.

B. Hardware shall be as scheduled or described on the drawings. In the absence of hardware information the casework manufacturer shall furnish his standard hardware consistent with the quality and anticipated normal use of the cabinet work supplied.

2.06 CASEWORK TOPS

A. AWI quality grade: Custom

B. Tops to be finished with high pressure laminates, in thicknesses as determined by AWI standards. Acceptable manufacturers are Formica, Textolite, Wilson Art, Nevamar or equal. Colors and textures as shown on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install cabinet work plumb, level, true and straight. Shim as required using concealed shims.

B. Scribe and cut woodwork to fit adjoining work.

C. Anchor cabinets to walls and floors with concealed fasteners. Use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork, and matching final finish where transparent finish is indicated.

D. Tops shall be anchored securely to base units and other support system as indicated.

3.02 FINISHING AND ADJUSTING

A. Finishes shall conform to AWI quality standards for grades and finishes specified. Painting shall be done in accordance with Section 09 90 00.

B. Cabinet finishes, including painting, should be done in the shop prior to installation.

C. Field touch-up shall be the responsibility of the installing contractor and shall include the filling and touch-up of exposed job made nail or screw holes, refinishing of raw surfaces resulting from job fittings, repair of job inflicted scratches and mars, and final cleaning up of the finished surfaces.

D. Adjust all operating parts for smooth operation and good fit. Adjust hinges, latches, drawer glides etc. so that doors and drawers are centered on openings and aligned with each other.

E. Clean all exposed and semi-exposed surfaces after installation and touch-up is complete.

END OF SECTION

SECTION 07 41 13

METAL ROOF PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured standing seam roof panel system.

B. Gutters, fascias, trim, etc. furnished with metal roof system.

1.02 RELATED SECTIONS

A. Section 13 34 19, Fabricated Engineered Metal Building Structure: Roof system furnished as a component of a pre-engineered building system.

B. Section 07 42 13, Metal Wall Panels.

C. Section 07 90 00, Joint Sealers.

1.03 REFERENCES

A. ASTM A653/A653M-07 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. ASTM A924/A924M-07 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

C. ASTM A606-04 Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance.

D. ASTM A792/A792M-06 Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

1.04 SYSTEM DESCRIPTION

A. System: Standing seam steel roof system; preformed and prefinished; site assembled.

B. System is for installation in a design which is not a component of a pre-engineered building system.

1.05 DESIGN REQUIREMENTS

A. Design and size components to withstand dead and live loads caused by positive and negative wind pressures (uplift), actual dead loads, and code required live loads.

B. Maximum allowable deflection of panel; 1/180 span.

C. System shall accommodate, without damage to components or deterioration of seals, planned movement within the system, anticipated movement between system and perimeter components subjected to seasonal temperature cycling, dynamic loading and unloading, and deflection of structural framing.

1.06 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.07 WARRANTY

Provide twenty year warranty against panel finish fading, chalking, blistering, peeling or cracking when exposed to normal atmospheric conditions. Warranties shall include the cost of labor and material.

PART 2 PRODUCTS

2.01 MATERIALS

A. Material: 24 ga. steel; 50 ksi min. yield strength.

B. Design: Standing seam with nominal 2 inch high rib, and minimum 16 inch coverage.

C. Coating: Hot-dip coating with 50% aluminum and 50% zinc (galvalume).

D. Panel length: Furnish full length from eave to ridge or hip without end laps.

2.02 FINISH

A. Finish: 70% Polyvinylidene Fluoride “KYNAR 500” Fluorocarbon resin, oven baked over an epoxy primer for a total thickness of one mil.

B. Back surface: standard backing coat of silicon polyester over an epoxy primer for a total thickness of one half mil.

C. Color: Selected from manufacturer's standards.

2.03 ATTACHMENT

A. Standard practice: Attach to structure with concealed clips.

B. Clips: Allow for 1 inch of thermal movement in two directions (2 inch total movement and 2 inch slot).

2.04 ACCESSORIES

A. Provide all accessories required for a complete installation including compressible and metal closures, metal trim, fascia, gutters, downspouts, etc.

B. Exposed metal trim: match roof panel in color. If the project includes new wall panels, downspouts shall match wall panels.

2.05 FASTENERS

A. Panel to secondary member connection: Self-drilling structural fasteners.

B. Standard fastener system: concealed system. Where exposed fasteners are unavoidable, fasteners shall have colored heads to match color of the material being fastened.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that framing members are ready to receive roof panel system.

B. Beginning installation means acceptance of existing conditions.

3.02 PREPARATION

Protect adjacent materials from damage during construction.

3.03 ERECTION

A. Install panels in accordance with manufacturer's instructions.

B. Size, space, and install fasteners as directed by manufacturer.

END OF SECTION

SECTION 07 42 13

METAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal wall panels

B. Liner panels.

C. Trim and accessories furnished with metal wall panels.

1.02 RELATED SECTIONS

A. Section 07 41 13, Metal Roof Panels

B. Section 13 34 19, Fabricated Engineered Metal Building Structure: Wall system furnished as a component of a pre-engineered building system.

1.03 REFERENCES

A. ASTM A653/Ad53M-07 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. ASTM A924/A924M-07 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

C. ASTM A606-04 Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance.

D. ASTM A792/A792M-06a Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

1.04 SYSTEM DESCRIPTION

A. System: Preformed and pre-finished steel siding system of vertical profile; site assembled.

B. System is for a design which is not a component of a pre-engineered building system.

1.05 DESIGN REQUIREMENTS

A. Design and size components to withstand live loads caused by positive and negative wind pressure (suction) acting normal to plane of wall as calculated in accordance with the IBC, actual dead loads, and code-required live loads.

B. Maximum allowable deflection of panel: 1/180

C. System shall accommodate, without damage to components or deterioration of seals, planned movement within the system, anticipated movement between system and perimeter components subjected to seasonal temperature cycling, dynamic loading and unloading, and deflection of structural framing.

D. For moisture entering or condensation occurring within panel system, provide channel to exterior drainage system.

1.06 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.07 WARRANTY

A. Provide ten year warranty against exterior panel finish chalking, fading or cracking when exposed to normal atmospheric conditions.

B. Provide five year warranty against interior panel finish chalking, fading, or cracking when exposed to normal atmospheric conditions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Material: 24 gauge steel; 50 ksi min. yield strength.

B. Design: Preformed to profile shown on drawings.

C. Panel Length: Furnish full length to eave or sill without end laps.

2.02 FINISH

A. Primer: Oven baked epoxy on exterior and interior.

B. Finish: Silicone polyester coating baked over the primer.

C. Exposed Finish Thickness: One mil.

D. Unexposed Finish Thickness: One-half mil.

E. Primer and finish for liner panels: Same as for exterior panels.

2.03 TRIM AND ACCESSORIES

A. Gauge: Min. 26 gauge (heavier if required by design)

B. Finish: Same as wall panels.

C. Color: Match wall panels.

2.04 ATTACHMENT

Standard practice: Attach to structure with concealed fastening system.

2.05 FASTENERS

A. Panel to secondary member connection: Self-drilling structural fasteners.

B. Panel to Panel Connectors: Self-tapping screws.

C. When exposed fasteners are unavoidable, fasteners shall have colored heads to match color of the material being fastened.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that framing members are ready to receive wall panel system.

B. Beginning installation means acceptance of existing conditions.

3.02 PREPARATION

Protect adjacent materials from damage during construction.

3.03 ERECTION

A. Install panels in accordance with manufacturer's instructions.

B. Size, space, and install fasteners as directed by manufacturer.

END OF SECTION

SECTION 07 51 00

BUILT-UP MODIFIED BITUMINOUS ROOFING

PART 1 GENERAL

1.01 SUMMARY

Provide hot-applied, 4-Ply, SBS (Styrene-Butadiene-Styrene) Modified Bituminous Roofing system.

1.02 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.03 REFERENCES

ASTM D312-00 (2006) Standard Specification for Asphalt Used in Roofing.

1.04 STORAGE

Store all roof materials, including felts and insulation, off the ground and covered from rain but well ventilated to prevent damage from moisture including condensation.

1.05 WARRANTY

A. Provide 10 year warranty from roofing manufacturer. Warranty shall cover leaks which result from either material or workmanship defects, shall not be subject to a deductable, and shall not be pro-rated. Warranty shall include repairs to the roofing system to the extent necessary to return the roofing system to a watertight condition.

B. Provide a two-year workmanship warranty from the installer.

1.06 REGULATORY REQUIREMENTS

A. Roofing system shall have Underwriters Laboratories, Inc. (UL) Class A Fire Hazard Classification.

B. For application on metal roof deck the roof assembly shall have Factory Mutual Engineering Corporation (FM) Class 1 Construction, wind uplift requirement of I-90 consistent with FM Construction Bulletin 1-28 and Bulletin 1-29.

1.07 PERFORMANCE REQUIREMENTS

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

PART 2 PRODUCTS

2.01 MATERIALS

A. The roof system shall be a 4-ply, hot mopped, SBS modified bitumen, mineral surfaced roofing system. Provide Johns Manville 4CID/4FID/4PID, or approved equal.:

1. First ply: Compatible with the existing surface to which it will be applied as defined by the roofing manufacturer's standard written recommendations for the proprietary roofing system used.
2. Ply felts: 2 plies consistent written recommendations for the proprietary roofing system used.
4. SBS granulated modified bitumen cap sheet.

PART 3 EXECUTION

3.01 INSTALLATION

A. The roof system and all components shall be procured, delivered, stored, moved, installed and completed in a manner consistent with the material and roofing manufacturer's standard written recommendations applicable to the roofing system used and in a manner consistent with procedures and inspections necessary to obtain the specified warranties.

B. Inspect substrate and report unsatisfactory conditions in writing. Beginning work means acceptance of substrate. Coordinate installation with other trades, including carpentry, flashing and penetrating work.

C. Install insulation in a manner consistent with the insulation manufacturer, the roofing manufacturer, and NRCA best practices and methods..

D. Install walkway protection membrane at locations indicated and where required to provide access to roof mounted equipment.

E. Comply with NRCA Roofing and Waterproofing Manual (latest edition) and manufacturer's standard printed installation instructions.

F. Restore or replace damaged components. Protect work from damage.

G. Work only in dry weather. No ice, frost or standing water shall be on the roof during installation. Store felts and membranes above 40 degrees F. during cold weather.

H. Remove and install new materials in an area no larger than can be completed in the same day.

3.02 CANTS

Fiber cants and pressure treated wood cants shall have a minimum installed height of 5 inches.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 GENERAL

1.01 SUMMARY

A. Provide fire and smoke barrier penetration seals for openings in floors, walls and other elements of construction.

B. Provide at all penetrations, through fire rated construction, and additionally where noted.

1.02 RELATED SECTIONS

Section 03 30 00: Cast-in-Place Concrete
Section 04 21 00: Unit Masonry
Section 07 90 00: Joint Protection
Section 09 29 00: Gypsum Board
Section 21 05 00: Common Work Results for Fire Suppression
Section 22 05 00: Common Work Results for Plumbing
Section 23 05 00: Common Work Results for HVAC
Section 26 05 00: Common Work Results for Electrical

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM) publications:

1. E 814-06 Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

2. E 119-07a Standard Test Methods for Fire Tests of Building Construction and Materials.

3. E 84-08 Standard Test Method for Surface Burning Characteristics of Building Materials.

4. C 719-93 (2005) Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movements (Hockman Cycle).

5. C920-05 Standard Specification for Elastomeric Joint Sealants.

B. Underwriters Laboratories Inc. (UL) Publications:

1. UL 1479 Fire Tests of Through-Penetration Firestops

2. UL 263 Fire Tests of Building Construction and Materials

3. UL 723 Test for Surface Burning Characteristics of Building Materials.

4. Underwriters Laboratories "Fire Resistance Directory" (Current Year).

C. Factory Mutual Corporation (FM) Publications:

1. Factory Mutual Approval Guide (Current Year)

1.04 DEFINITIONS

A. Fire Rated Assembly: Includes all fire walls, floors, floor/ceiling and roof systems assemblies. Rating shall be per ASTM E 119-07a Standard Test Methods for Fire Tests of Building Construction and Materials" or UL 263 "Fire Tests of Building Construction and Materials."

B. Firestop System: Through-Penetration Firestop Systems are designed to prevent the spread of fire through openings in fire rated assemblies for a specified period of time. Incorporating the use of specific products installed in a specific manner, they shall only be installed in configurations for which they have been specifically tested and listed by Underwriters Laboratories (UL) or Factory Mutual (FM) per ASTM E 814 or UL1479.

C. Flame Spread/Smoke Developed Ratings: Numerical Value of a material when tested in accordance with ASTM E 84-08 "Standard Test Method for Surface Burning Characteristics of Building Materials."

1.05 SUBMITTALS

Submit for approval: All required submittals in accordance with Section 01 33 00, Submittals.

1.06 QUALITY ASSURANCE

A. Manufacturer: Use Firestop Systems, for the entire project from a single Manufacturer to the greatest extent possible. For

installations or configurations not covered by a tested Firestop System, submit a recommendation from the Manufacturer for the specific application.

B. Contractor Qualification: A minimum of two years experience installing UL listed or Factory Mutual approved Firestop Systems in similar type construction.

1.07 PROJECT CONDITIONS

A. Do not proceed with installation of Firestop Systems when job site conditions are outside the limits permitted by the Manufacturer. Consult the COTR for instructions.

B. Do not use materials that show signs of damage.

C. Do not use materials that are beyond their shelf life.

1.08 SEQUENCING AND SCHEDULING

A. Sequence: Perform work of this and other sections in proper sequence to prevent damage to the Firestop Systems and to ensure that their installation will occur prior to enclosing or concealing work.

B. Install all Firestop Systems after voids and joints are prepared sufficiently to accept the applicable Firestop System.

C. Do not cover Firestop Systems until they have been properly inspected and accepted by the Government Inspector.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the requirements, provide products of one of the following manufacturers.

1. Grace construction Products.

2. Minnesota Mining and Manufacturing Company. (3M)

3. Hilti.

B. Other manufacturers will be approved provided the firestopping system and product is listed in the UL Fire Resistance Directory.

2.02 MATERIALS

A. Provide materials classified by UL to provide Fire Barrier equal to time rating of construction being penetrated.

B. Provide asbestos free materials that comply with applicable codes and have been tested in accordance with UL 1479 or ASTM E-814.

2.03 FIRESTOPPING SYSTEM

A. Firestopping system shall be as listed in the UL Fire Resistance Directory, latest edition or approved by Factory Mutual.

B. Firestop Pillows: Specified Technologies Inc. “SpecSeal” Series SSB Firestop Pillows or approved equal

PART 3 EXECUTION

3.01 EXAMINATION

Examine openings, voids or joints where firestop systems are to be installed. Beginning work means acceptance of existing conditions.

3.02 PREPARATION

A. Follow manufacturer's instructions for surface preparation.

B. Prevent system materials from contaminating adjacent surfaces.

C. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.03 INSTALLATION

A. Install firestop system in accordance with manufacturer's instruction and UL Fire Resistance Directory or as approved by Factory Mutual.

B. Seal holes or voids to ensure an effective smoke barrier.

C. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading. Install fire stopping materials capable of supporting same loading as floor.

D. Protect installed system from damage.

3.04 FIELD QUALITY CONTROL

A. Examine firestop system installation before concealing or enclosing to ensure proper installation.

B. Keep installation accessible until inspection by the Government and other authorities.

C. Patch and repair installation damaged during construction.

3.05 CLEANING

A. Remove construction debris and clean adjacent surfaces of excess sealant.

B. Clean area whether concealed or exposed in finished building.

END OF SECTION

SECTION 07 90 00

JOINT PROTECTION

PART 1 GENERAL

1.01 SUMMARY

Provide sealants at intersection of building components.

1.02 RELATED SECTIONS

Section 07 84 00, Firestopping

1.03 SUBMITTALS

Submit for approval: All required submittals shall be submitted in accordance with Section 01 33 00, Submittals.

1.04 QUALITY ASSURANCE

Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Joints designed for expansion and movement conditions at site:

1. Exterior joints on vertical surfaces: Non-sag polyurethane; Pecora Dynatrol II or Tremco Dymeric 240FC, or approved equal.

2. Horizontal paving joints, interior and exterior: Self-leveling polyurethane; Tremco THC 900/901 or approved equal.

3. Ceramic tile, toilet fixture joints: Dow 786, acrylic latex w/silicone, or approved equal.

4. Interior joints, joints at mirrors: Acrylic latex; Tremco “Tremflex 834” Acrylic Latex or approved equal.

5. Acoustical sealant: Tremco “Tremflex 834” Acoustical sealant, non-drying, or approved equal. For unexposed joints only.

6. Precompressed expanding sealant tape: Illbruck "illmod 600" 600, or approved equal.

7. Pavement joint filler: Resilient, premolded asphalt impregnated fiberboard.

8. Primers, bond breakers, and backer rods: compatible with sealant and adjacent surfaces.

9. Fire-retardant sealant: See Section 07 84 00, Firestopping.

10. Butyl Rubber: Tremco “Butyl Sealant” or approved equal.

2.02 COLORS

A. Colors will be selected from manufacturer's standards.

B. Submit color samples as listed on Schedule of Submittals.

C. If no color is selected, match substrate color.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that joint openings are ready to receive work and field measurements are shown on drawing and recommendation by the manufacturer.

B. Beginning of installation means installer accepts existing substrate.

3.02 PREPARATION

A. Clean and prime joints in accordance with manufacturer's written instructions.

B. Remove loose materials and foreign matter which might impair adhesion of sealant.

3.03 INSTALLATION

A. Install sealant in accordance with manufacturer's standard written instructions.

B. Measure joint dimensions and size materials to achieve required width/depth ratios.

C. Install joint backing to achieve a neck dimension no greater than 1/3 the joint width.

D. Install bond breaker where joint backing is not used.

E. Apply sealant within recommended application temperature ranges consistent with the manufacturer’s written instructions. Consult manufacturer when sealant cannot be applied within these temperature ranges.

F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

G. Tool joints concave.

3.04 CLEANING AND REPAIRING

A. Clean work upon completion prior to final acceptance.

B. Clean adjacent soiled surfaces.

C. Repair or replace defaced or disfigured finishes caused by work of this section.

3.05 PROTECTION OF FINISHED WORK

Protect sealants until cured.

END OF SECTION

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Provide steel doors, where shown.

B. Provide hollow metal door frames.

1.02 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

PART 2 PRODUCTS

2.01 MATERIALS

A. Doors: 1-3/4" thick seamless flush doors.

1. Interior doors: 18 gage ASTM A568 cold-rolled steel.

2. Exterior doors: Insulated, 16 gage ASTM A653 steel with ASTM A653 G60 galvanizing. Insulate exterior doors with polystyrene core giving a R value of R-7 or better unless noted otherwise on the drawings.

B. Frames: Welded construction with mitered corners; gage as follows:

1. Interior frames: 16 gage up to 5' wide, 14 gage over 5' wide.

2. Exterior frames: 14 gage.

C. Knocked-down frames may be installed in existing non load bearing gypsum board interior walls. All new walls, all load bearing walls, and all exterior walls shall have welded frames.

D. Louvers: Sightproof, stationary type, 24 gage cold rolled steel in 20 gage frame.

E. Finish: Rust-inhibiting primer.

F. Fire rating: UL labeled, fire-rated assembly where required.

PART 3 EXECUTION

3.01 INSTALLATION

A. Fabricate work to be rigid, neat and free from seams, defects, dents, warps, buckles, and exposed fasteners. Install doors and frames in compliance with SDI-100 and NFPA 80.

B. Hardware: Prepare doors and frames to receive hardware on final schedule. Provide for 3 silencers on single door frames; 2 on double door frames.

C. Shop Finish: Clean, treat and prime paint all work with rust-inhibiting primer compatible with finish paint specified in Section 09 90 00. Provide asphalt emulsion sound deadening coating on concealed frame interiors.

D. Touch-up damaged coatings and leave ready to receive finish painting.

END OF SECTION

SECTION 08 14 00

WOOD DOORS

PART 1 GENERAL

1.01 SUMMARY

Provide wood doors, where shown.

1.02 SUBMITTALS

Submit for approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

PART 2 PRODUCTS

2.01 MATERIALS

A. Wood doors for transparent finish: Solid core flush wood door with particleboard core for interior use; AWI custom grade.

   Face: Birch

B. Wood doors for painted finish: Solid core flush wood door with particleboard core for interior use; AWI custom grade.

   Face: Birch or gum

C. Laminate Faced Doors: Solid core flush door with particleboard core for interior use, AWI premium grade, with plastic laminate face, NEMA LD-3, 0.050" thick, solid color.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with WDMA I.S.-1 and AWI quality standard. Prefit doors to frames. Premachine doors for hardware listed on final schedules. Factory bevel doors.

B. Install doors with not more than 1/8" clearance at top and sides, 1/4" at bottom. Comply with NFPA 80 for rated assemblies.

C. Shop Finish: Sand and provide 1st coat of finish system specified in Section 09 90 00, Architectural Painting. Wrap and protect.

D. Adjust, clean, and protect.

END OF SECTION

SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

Hardware for wood and hollow steel doors.

1.02 WORK INSTALLED BUT FURNISHED BY OTHERS

Cylinders and keys will be furnished by the government.

1.03 RELATED WORK

A. Section 08 14 00, Wood Doors

B. Section 08 11 13, Hollow Metal Doors and Frames

1.04 REFERENCES

A. ICC/ANSI A117.1 - Accessible and Useable Buildings and Facilities.

B. ANSI/NFPA 80 – Standard for Fire Doors and Other Opening Protectives.

C. AWI - Architectural Woodwork Institute.

D. BHMA - Builder's Hardware Manufacturers Association.

E. DHI - Door and Hardware Institute.

F. NAAMM - National Association of Architectural Metal Manufacturers.

G. NFPA 101 - Life Safety Code.

H. SDI - Steel Door Institute

1.05 QUALITY ASSURANCE

A. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC), or approved qualified person to assist in the work of this Section.

B. The consultant (AHC) shall prepare a detailed hardware schedule including all items required to meet applicable codes and provide a complete hardware installation.

1.06 SUBMITTALS

A. Submit for approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Locksets, Latches and Exit Devices: SARGENT, no substitution.

B. Other hardware items: Manufacturer as approved.

2.02 PRODUCTS

A. Locksets and Latches: Series 8200 as listed on schedule.

B. Exit devices: Series 8900

C. Other products: As specified on the hardware schedule.

2.03 FINISHES

As specified on the hardware schedule.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify that doors and frames are ready to receive work.

B. Verify that power supply is available to power operating devices.

C. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions and requirements of BHMA.

B. Use the templates provided by hardware item manufacturer.

C. Conform to ICC/ANSI A117.1 for positioning requirements for the handicapped.

3.03 SCHEDULE

A. The Hardware Schedule shall be as shown on the drawings.

B. The schedule will list basic items only. Provide all accessories and incidental items to produce a complete workable installation and meet applicable codes.

END OF SECTION

SECTION 08 74 00

ELECTRONIC ACCESS CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

Electronic access control systems for wood and hollow steel doors.

1.02 WORK INSTALLED BUT FURNISHED BY OTHERS

See drawings for items that will be furnished by the government.

1.03 RELATED WORK

A. Section 08 14 00, Wood Doors

B. Section 08 11 13, Hollow Metal Doors and Frames

C. Section 08 71 00, Door Hardware

1.04 REFERENCES

A. ICC/ANSI A117.1 - Accessible and Useable Buildings and Facilities Accessible to and Usable by Physically Handicapped People.

B. ANSI/NFPA 80 – Standard for Fire Doors and Other Opening Protectives.

C. AWI - Architectural Woodwork Institute.

D. BHMA - Builder's Hardware Manufacturers Association.

E. DHI - Door and Hardware Institute.

F. NAAMM - National Association of Architectural Metal Manufacturers.

G. NFPA 101 - Life Safety Code.

H. SDI - Steel Door Institute

1.05 QUALITY ASSURANCE

A. Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC), or approved qualified person to assist in the work of this Section.

B. The consultant (AHC) shall prepare a detailed hardware schedule including all items required to meet applicable codes and provide a complete hardware installation.

1.06 SUBMITTALS

A. Submit for approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

B. Submit manufacturer's wiring diagrams for all electric/electronic devices specified to be furnished and installed by the Contractor. Diagrams shall be prepared specifically for each job.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Where manufacturers and specific products are specified with the designation "no substitution", these products are required to coordinate with the NASA Security Office hardware system and shall be furnished as specified.

B. Other hardware items: Manufacturer as approved.

2.02 PRODUCTS

A. Magnetic locks: Securitron model M32SC-12, no substitution.

B. Touch Sense Bar: Securitron TSB-3CL, 36", no substitution.

C. Electronic transfer hinges: McKinney TA 2714 CC6, six wire for power transfer. Finish as specified for other hinges. Approved equal to match other hinges.

D. Automatic door opening devices (where shown): Horton 7000 series for standard weight doors up to 3' X 7' in size or Horton 4000 series for heavier doors, exterior doors subject to wind conditions, and doors larger than 3' X 7' in size. Approved equal products may

be submitted. Operators shall have push button activation. Push buttons shall be as specified on drawings.

E. Other hardware shown on drawings: as approved

2.03 FINISHES

As specified on the hardware schedule.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify that doors and frames are ready to receive work.

B. Verify that power supply is available to power operating devices.

C. Beginning of installation means acceptance of existing conditions.

3.02 INSTALLATION

A. Coordinate all electric/ electronic hardware installations with the MSFC Security Office to ensure compatibility with latest requirements.

B. Use the templates provided by hardware item manufacturer. Install hardware in accordance with manufacturer's instructions and requirements of BHMA.

C. Conform to ANSI A117.1 and the Architectural Barriers Act latest guidelines for positioning requirements for the handicapped.

3.03 SCHEDULE

A. The Hardware Schedule shall be as shown on the drawings.

B. The schedule will list basic items only. Provide all accessories and incidental items to produce a complete workable installation and meet applicable codes.

END OF SECTION

SECTION 09 29 00

GYPSUM BOARD

PART 1 GENERAL

1.01 SUMMARY

Provide gypsum board drywall work including metal support systems, interior walls, partitions and ceilings as shown.

1.02 RELATED SECTIONS

A. Section 05 40 00, Cold-Formed Metal Framing: Load bearing cold formed metal framing.

1.03 SUBMITTALS

A. Submit for approval: All required submittals shall be submitted in accordance with Section 01 33 00, Submittals.

B. In accordance with Section 01 35 43, the Contractor shall submit a report for insulating products covered under the EPA regulations for recoverable materials. When such products cannot be provided, the contractor shall provide a non-compliance report stating the reason the product cannot be used and the nature of the product to be used. For an all-inclusive list of products and recoverable material contents see the latest EPA web site for construction products containing recoverable materials.

1.04 QUALITY ASSURANCE

A. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

B. Tolerances: Not more than 1/16" difference in true plane at joints between adjacent boards before finishing. After finishing, joints shall be invisible. No gaps or voids between gypsum board units or between drywall and adjacent work, unless detailed otherwise. Not more than 1/8" in 10' deviation from true plane plumb and level in finished work.

C. Furnish each type of gypsum board and related joint treatment materials from a single manufacturer.

PART 2 PRODUCTS

2.01 MATERIALS

Provide materials indicated on the drawings, or if not indicated on the drawings, as noted below:

A. Gypsum board:

1. Interior use: ASTM C1396, 1/2" thick regular for walls 5/8" thick regular for ceilings; by U.S. Gypsum or approved equal.

2. Fire rated use: ASTM C1396, 5/8" thick fire rated types; by U.S. Gypsum or approval equal.

3. Moisture resistant gypsum board (MR Board): ASTM C1396.

4. Abuse Resistant: ASTM C1629, ASTM E136, 5/8” thick.

B. Backer boards: Glass mesh reinforced portland cement backer board for ceramic tile; Durock, Wonderboard or approved equal.

C. Steel studs: Screw-type steel studs, ASTM C645, 16 inches o.c. 25 gage or heavier gage as required by the drawings.

D. Drywall ceiling suspension and furring materials: A complete system consisting of 12 ft long main tees with 4 ft long cross tees spaced 2 ft o.c. Maximum deflection: 1/360 span.

E. Joint reinforcement: ASTM C587 paper tape and ready-mixed vinyl compound.

F. Accessories: Galvanized steel corner beads, casing beads, control joints.

G. Acoustical insulation and sealant: Unfaced mineral fiber blanket or batts cut to full center-to-center stud dimension; U.S. Gypsum Acoustical Sealant or approved equal.

H. Insulation between exterior wall studs and between roof joists: Mineral fiber flexible blankets or batts with a vapor barrier facing the winter-heated side of the wall. R-rating shall be R-11 for walls and R-19 for roof unless shown otherwise. Vapor barrier shall be vinyl, .0032 inch thick with a flame spread of 25 or less and a smoke developed rating of 50 or less.

I. Sound attenuation insulation between studs of interior walls: Unfaced mineral fiber blankets with an NRC rating of .95 unless shown otherwise.

J. Vapor barrier membrane: 4 Mil polyethylene film.

K. Fasteners: Provide fasteners of type material, size, corrosion resistance, holding power and other properties required to secure materials to substrates involved. Comply with standards specified and manufacturer's standard written instructions.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with ASTM C840; except as otherwise indicated, extend fire rated partitions to underside of deck above ceiling. Seal gaps and penetrations.

B. Install framing system at 16" o.c., including blocking for grab bars, accessories and similar items.

C. Install vapor barrier to outside of face of studs of exterior walls. Seal joints with vapor barrier tape at perimeter of insulation cutouts, end joints between batts and tears or ruptures in membrane facing.

D. Provide fire-rated systems where indicated.

E. Install boards vertically. Position joints to fall over framing members.

F. Install trim and joint treatment in strict compliance with manufacturer's standard written instructions and recommendations. Sand smooth and leave ready for finish painting.

G. Seal around exterior doors and windows.

3.02 GYPSUM BOARD FINISH

A. Finish the gypsum board to the level specified on the drawings.

B. If no finish level is specified, comply with the finish guidance specified below for each finish level.

C. Gypsum board finish behind built-in cabinets or fixtures shall match the exposed portions of the wall.

3.03 LEVELS OF GYPSUM BOARD FINISH

A. Level 0: No taping, finishing or accessories required.

B. Level 1: Use in plenum areas above ceilings where gypsum board is concealed.

1. Joints: Tape set in joint compound.

2. Interior angles: Tape set in joint compound.

3. Surface: Tool marks acceptable. Surface free of joint compound.

C. Level 2: Use where water-resistant backing board is used as a substrate for tile.

1. Joints: Tape embedded in joint compound and wiped with a joint knife, leaving a thin coat of compound over tape.

2. Interior angles: Tape embedded in joint compound and wiped with a joint knife, leaving a thin coat of compound over tape.

3. Accessories: Cover with one separate coat of joint compound.

4. Fasteners: Cover with one separate coat of joint compound.

5. Surface: Surface shall be free of excess joint compound. Tool marks and ridges acceptable. Joint compound applied over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.

D. Level 3: Use where wall is to receive heavy or medium texture (hand or spray-applied) finished before final painting, or where heavy-grade wallcoverings are to be applied as the final decoration. Do not use where smooth painted surfaces or light to medium grade wallcoverings are to be applied.

1. Joints: Taped as in Level 2, then covered with one separate coat of joint compound.

2. Interior angles: Taped as in Level 2, then covered with one separate coat of joint compound.

3. Accessories: Cover with two separate coats of joint compound.

4. Fasteners: Cover with two separate coats of joint compound.

5. Surface: Joint compound shall be free of tool marks and ridges.

E. Level 4: Use where flat paints, light textures or wallcoverings are to be applied. Do not use where gloss or semi-gloss paint is to be used.

1. Joints: Taped as in Level 2, then covered with two separate coats of joint compound.

2. Interior angles: Taped as in Level 2, then covered with one separate coat of joint compound.

3. Accessories: Taped as in Level 2, then covered with three separate coats of joint compound.

4. Fasteners: Taped as in Level 2, then covered with three separate coats of joint compound.

5. Surface: Joint compound shall be free of tool marks and ridges.

F. Level 5: Use where gloss or semi-gloss paint is to be applied or where severe lighting conditions occur.

1. Joints: Taped as in Level 2, then covered with two separate coats of joint compound.

2. Interior angles: Taped as in Level 2, then covered with one separate coat of joint compound.

3. Accessories: Taped as in Level 2, then covered with three separate coats of joint compound.

4. Fasteners: Taped as in Level 2, then covered with three separate coats of joint compound.

5. Surface: A thin coat of joint compound, or material manufactured especially for this purpose, shall be applied to the entire surface. The surface shall be free of tool marks and ridges.

END OF SECTION

SECTION 09 30 13

CERAMIC TILING

PART 1 GENERAL

1.01 SUMMARY

A. Glazed Wall Tile installed by the thinset application method.

B. Ceramic floor tile and base shall be installed by the thin set application method.

1.02 REFERENCES

A. ANSI A108.5 – Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.

B. ANSI A108.10 - Installation of Grout in Tile work.

C. ANSI A118.1 - Dry-Set Mortar.

D. ANSI A118.4 - Latex-Portland Cement Mortar.

E. ANSI A118.6 - Ceramic Tile Grouts.

F. ANSI A137.1 - Ceramic Tile.

1.03 SUBMITTALS

A. Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

B. Submit one sample tile for each color, pattern and type of tile intended to be used. Obtain approval of job sample submittals before delivering any products to the job site.

1.04 QUALITY ASSURANCE

A. Conform to ANSI A137.1.

B. Conform to TCA Handbook for Ceramic Tile Installation.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in the manufacture of products specified in this section with minimum three years experience.

B. Installer: Company specializing in applying the work of this Section with minimum three years experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Section 01 60 00.

B. Store and protect products under provisions of Section 01 60 00.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature at 50°F (10°C) minimum during tile work and for 7 days after completion.

PART 2 PRODUCTS

2.01 CERAMIC TILE

A. Furnish Standard Grade glazed wall tile meeting ANSI A137.1, conforming to the following:

Size	4 1/4 x 4 1/4 x 1/4 inch
Surface Finish	Bright Glazed
Color	See Drawings

B. Furnish only Standard Grade Ceramic base and floor tile meeting ANSI A137.1, conforming to the following:

Size	1 x 1 x 1/4 in. and 2 x 2 x 1/4 in.
Surface Finish	Unglazed
Color	See Drawings

C. Base: Match mosaic floor tile for moisture absorption, surface finish, and color; 4 x 4 tile size with coved internal corners and bullnose top edge.

2.02 MORTAR MATERIALS

A. Mortar: ANSI A118.1 Dry-Set Mortar - Used as a bond coat for setting tiles

B. Mortar: ANSI A118.4 Latex Portland Cement Mortar - Used as a bond coat for setting tiles.

C. For wall applications use a non-sagging mortar complying with the appropriate referenced standard listed above.

2.03 GROUT MATERIALS

A. Grout: ANSI A118.6 Ceramic Tile Grouts. Latex-Portland cement grout.

B. Color Admixture: Color as selected.

2.04 MORTAR MIX AND GROUT MIX

Mix and proportion pre-mix setting bed and grout materials in accordance with manufacturer's instructions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Beginning of installation means installer accepts condition of existing surfaces.

3.02 PREPARATION

A. Protect surrounding work from damage or disfiguration.

B. Vacuum clean existing surfaces and damp clean.

C. Seal substrate surface cracks with filler.

D. Apply sealer to surfaces as recommended by adhesive manufacturer.

3.03 INSTALLATION - THIN SET METHOD

A. Install bond coat, tile, and grout in accordance with manufacturer's instructions.

B. Lay tile in accordance with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials specified.

C. Lay out all tile work so as to minimize cuts less than one-half tile in size. When a run of cut tiles must be placed next to a wall provide tiles of similar size at opposite wall – Achieve symmetry when practicable.

D. Cut and fit tile tight to penetrations through tile. Form corners and bases neatly. Align floor, base, and wall joints.

E. Use all products in strict accordance with latest ANSI Standard Specifications.

F. Smooth all exposed cut tile edges.

G. All cut tile edges shall be clean before installing.

H. Locate tile cuts in both walls and floors so as to be least conspicuous.

I. Align all wall joints to give straight uniform grout lines, plumb and level.

J. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight without voids, cracks, excess mortar, or excess grout.

K. Sound tile after setting. Replace hollow sounding units.

L. Allow tile to set for a minimum of 48 hours prior to grouting.

M Grout tile joints in accordance with ANSI A108.10.

N. Apply sealant to junction of tile and dissimilar materials and at junction of dissimilar planes.

3.04 CLEANING

Clean tile surfaces. Be sure all tile work is free of grout film upon completion.

3.05 PROTECTION FROM TRAFFIC

A. Protect finished installation.

B. Protect all tile surfaces from damage prior to final completion.

END OF SECTION

SECTION 09 51 00

ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SUMMARY

A. New ceiling systems: exposed grid, suspended, lay-in type.

B. Entire system shall be class A rated as installed.

1.02 REFERENCES

A. ASTM C635/C635M-07 Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings

B. ASTM C636/C636M-06 Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels

C. ASTM E580/E580M-06 Standard Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels in Areas Requiring Seismic Restraint

D. ASTM E1264-98 (2005) Standard Classification for Acoustical Ceiling Products

1.03 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

PART 2 PRODUCTS

2.01 CEILING

A. Tile: 5/8" thick mineral fiber sized as shown.

B. NRC Range : .50 - .60

C. CAC Range: 30 - 35

D. Light reflectance: 080 or Above)

E. Flame spread:0-25 (ASTM E1264)

F. Sag Resistance: Humidity resistant equal to Armstrong ‘Humi Guard Plus’

G. Appearance: Equal to Armstrong ’Georgian’ pattern

H. Recycled Content: 40% or better

2.02 SUSPENSION SYSTEM

Suspension system: intermediate duty fire rated steel system consisting of 1-1/2" high x 12' long main tees with single controlled expansion point combined with 1 inch or 1-1/2" high fire rated cross tees listed and labeled by Underwriters Laboratories Inc. Finish shall be pre-painted white.

PART 3 EXECUTION

3.01 INSPECTION

Examine the area where ceilings are to be installed for conditions which will adversely effect installation. Do not start work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Install acoustical material and suspension system square and true. Level the system to within 1/8" in 12'-0".

B. Measure and layout to avoid less than 1/2 panel units.

C. Provide hold-down clips where required for fire rated classification.

D. Support the suspension system from the structure above with no. 12 gauge hanger wire located 6" from the ends and a maximum spacing of 4'-0" O.C.

E. Support lay-in fixtures on each corner with hanger wire as indicated in Section 26 05 29.

F. Unless noted otherwise on drawings or specifications, comply with ASTM E580.

END OF SECTION

SECTION 09 65 00

RESILIENT FLOORING

PART 1 GENERAL

1.01 SUMMARY

A. Provide resilient flooring.
B. Provide rubber base.

1.02 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.03 QUALITY ASSURANCE

Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Tile flooring:

1. Vinyl composition tile: 12" by 12" by 1/8"; Armstrong Contract Interiors, Imperial Excelon. Color No. 51858 Sandrift White or approved equal.

B. Accessories:

1. Wall base: 4" high, 1/8" thick, rubber base.
2. Outside & Inside Corners: preformed.
3. Color: Flexco Rubber Base, Color:WF-037, Dark Beige.
4. Adhesive: Waterproof.
5. Resilient Edge Strips: Equal gauge to the flooring, homogeneous vinyl or rubber composition, tapered or bullnose edge, black in color or as indicated on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with manufacturer's instructions and recommendations.

B. Prepare surfaces by cleaning, leveling and priming. Level to 1/8" in 10' tolerance.

C. Install tile with tight joints and with two-way pattern. Scribe cut and fit resilient flooring to permanent fixtures, built-in furniture and cabinets, pipes, outlets and permanent columns, walls, and partitions. Lay out to prevent less than 1/2 tile units.

D. Install base and trim accessories to minimize joints.

E. Clean, polish, and protect.

END OF SECTION

SECTION 09 68 00

CARPETING

PART 1 GENERAL

1.01 SUMMARY

A. Carpet will be carpet tile furnished by the Government and installed under this contract unless otherwise shown on the drawings.

B. Provide proper surface preparation for carpet underlayment.

1.02 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

1.03 QUALITY ASSURANCE

A. Use experienced installers.

B. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 Carpet

A. Offices, Corridors and General Use Areas: Unless noted on the drawings, the carpet will be Government Furnished Contractor installed, 24" x 24" carpet tiles, Lees Commercial Carpets – Pattern, Attribute: # DL453, Color: # 467, Hummingbird.

B. Senior Management and Specially Approved Areas: The carpet and pad will be Contractor Furnished, Contractor Installed. Carpet shall be Lees Commercial broadloom Carpet, Pattern and Color shall be as specified in the design documents. Pad shall be Lees Commercial Carpets 'Uniplus II'.

2.02 Adhesive

A. Carpet Adhesive for Carpet Tiles: The adhesive shall be Contractor Furnished Contractor Installed. The Adhesive for the carpet to the floor surface shall be Lees Commercial Carpets, Pressure Sensitive Adhesive.

B. Carpet and Pad Adhesive for Broadloom Carpet: The adhesive for the pad and carpet shall be Contractor Furnished, Contractor Installed. Install carpet and pad using the double-adhesive system. The adhesive for the pad to the floor surface shall be Lees Commercial Carpet 'Pressure-Sensitive Adhesive'. The adhesive for the broadloom carpet to the pad shall be Lees Commercial Carpet 'Wet Set Adhesive'.

PART 3 EXECUTION

3.01 Surface Preparation

A. Ensure that floor is dry, sound, smooth, and level and free of depressions or protrusions. Fill imperfections in the floor with latex underlayment.

B. Clean floor of all paint, wax, old adhesive, parting compounds, oil, grease, and other contaminants that may hinder good adhesion of the carpet.

C. Patch holes in raised floor with sheet metal of at least 18 gauge. If holes are larger than three inches in any direction, replace the raised floor panel with a matching panel without holes.

3.02 Tests for Concrete Floors

Moisture Test: On all new concrete slabs, tape to the concrete a 2' X 2' sheet of polyethylene plastic with duct tape sealing all edges. If after 24 hours, moisture is present on the plastic or covered concrete, postpone carpet installation until concrete is dry. This test is not required on existing slabs.

3.03 Installation

A. Install adhesive in accordance with manufacturer's instructions.

B. Clean excess adhesive as recommended by the manufacturer.

3.04 Carpet Replacement

A. Where carpet is installed adjacent to walls with existing rubber or vinyl base, remove the base and install new base, in accordance with Section 09 65 00, after carpet installation.

B. Broadloom carpet only: Field-cut seam shall be placed along the interior wall opposite the door. Assure that all seams in the middle of the room are formed from two factory-cut edges to minimize seam appearance in the middle of the room. Carpet has a definite nap. Assure that the nap runs in the same direction among all sections of carpet during carpet placement.

3.05 Clean Up

Clean carpet before final acceptance.

END OF SECTION

SECTION 09 69 00

ACCESS FLOORING

PART 1 GENERAL

1.01 SUMMARY

Furnish and install a complete access floor system consisting of wood core floor panels, adjustable pedestals, a rigid grid type stringer system and all accessories required for a complete installation.

1.02 SUBMITTALS

Submit for approval: All required submittals shall be submitted in accordance with Section 01 33 00, Submittals.

1.03 REFERENCES

ASTM A36/A36M-05 Standard Specification for Carbon Structural Steel

ASTM B26/B26-05 Standard Specification for Aluminum-Alloy Sand Castings

1.04 FIELD MEASUREMENTS

Perform field measurements required for the preparation of shop drawings, fabrication and installation of the system.

1.05 SYSTEM DESIGN

A. The design of the access floor system shall be one of the following options:

1. Structural floor panels supported by adjustable pedestals which are laterally braced by a rigid grid system.

2. Floor panels supported by a rigid grid system which is supported by and provides lateral bracing to adjustable pedestals.

B. The stringers shall be rigidly fastened to the pedestals with bolts or screws.

1.06 PERFORMANCE REQUIREMENTS

A. Access Floor Panels: The elevated floor panels shall be capable of supporting a uniform live load of a minimum 250 pounds per square foot with a deflection not to exceed 0.040 inch. Floor shall also be capable of supporting a minimum 1,000-pound load concentrated on 1 square inch at any point on the panel area without deflecting more than 0.080 inch, with a safety factor of not less than 3, based on yield strength of the material being used. Floor system shall be laterally stable in all directions whether panels are in place or not. Finished assembly shall be rigid and free of vibration and rocking panels.

B. Pedestals: Each pedestal, with components as assembled for the specified heights, shall be capable of carrying a 5,000-pound axial load without permanent deformation. The pedestal base shall be capable of carrying a minimum allowable moment of 1000 inch-pounds without cracking or excessive deformation. Bases shall be drilled through at a minimum of four points, equally spaced circumferentially, to receive 1/4” minimum-diameter mechanical fasteners.

C. Mechanical Anchoring of Pedestal Base: Mechanical fasteners for pedestal bases shall have tensile and pull-out strengths in the existing subfloor base material capable of resisting an overturning moment of 1,000 inch-pounds when a force is applied to the top of the pedestal in any direction. The minimum size for mechanical base anchors shall be 1/4” diameter. Unless otherwise noted on the drawings, contractor shall install four (4) each mechanical anchors anchoring each pedestal base to the supporting floor below.

PART 2 PRODUCTS

2.01 GENERAL

A. The floor, as installed, shall be completely planar within plus or minus 0.060 inch in 10 feet, 0.100 inch for the entire floor, and 0.030 inch across panel joints.

B. Floor-panel joint-width tolerances shall be 0.008 inch as measured with a feeler gage at any point in any joint when

the panels are in the pressure contact required in final installation.

2.02 PANELS

Unless specified otherwise elsewhere, panels shall consist of a 1-inch thick particle board core, totally encased by a galvanized steel top sheet and bottom pan or top and bottom sheets welded to 16 gauge perimeter channels. Floor panels shall be surfaced with a 1/8 inch thick high-pressure laminate.

2.03 REGISTERS AND GRILLES

Registers and grilles shall be furnished and installed where indicated and shall be the dimensions and free-area sizes shown. Construction shall be extruded aluminum, in mill finish, to sustain point loads of 250 pounds per vane without failure or permanent deformation. No part of a grille or register shall project more than 1/8-inch above the floor.

2.04 CUTOUTS

A. The indicated cable cutouts shall be finished with rigid polyvinylchloride or molded polypropylene edging to conform to the appearance level of the floor surface and to cover raw edges of the cutout panel. This extrusion shall be of a configuration to permit its effective and convenient use when new cable openings are required. At least 24 feet of additional extrusion shall be provided for future use.

B. Cutting of panels, including cutouts, shall be performed outside of the building.

C. If size of cutout reduces the performance requirement of panel, the Contractor shall provide intermediate stringers and pedestals adjacent to cutouts.

2.05 STRINGERS

Stringers shall be roll-formed, painted or galvanized steel channel sections, or extruded-aluminum channels, having either vinyl rib or a flat vinyl gasket cemented on top surface of stringers to effect a complete air seal between the panels and the stringers, and to prevent slippage of floor panels horizontally.

2.06 EDGE STRIPS

An extruded, rigid, polyvinylchloride or vinyl edge strip shall be mechanically and adhesively secured to the panel in a manner to preclude detachment under foot and wheel traffic. The top of the strip shall be flush with the top of the floor covering. Dimensional accuracy of the floor panel with the edge strip in place shall be such that, when installed, jointing shall be characterized by the interference fit of panel to panel.

2.07 PEDESTALS

A. Pedestal shall consist of a round or polygonal steel base, of at least 4 inches minimum dimension, that is designed to be attached to the subfloor with mechanical fasteners for the intended installation, as required by Section 1.05.C of this Specification.

B. Vertical adjustment of pedestals shall be by threaded steel rod with a positively-locking elevating nut to control the height of the pedestal head.

C. Pedestal rods shall be cast-in with the base or welded to the base. Mechanical connections will not be permitted. All sliding surfaces in the elevating mechanism, such as threads, collars, sockets, and shafts, shall be machined to an interference fit.

D. Pedestal components, except rods and bearing pads, shall be diecast aluminum alloy or steel. Steel rods shall be rust-proofed, after machining, by galvanizing in accordance with manufacturer's standards.

E. Pedestal cap shall be of cast aluminum with integral slots for fastenings for securing floor stringers to caps, or a flat steel bracket cap with a suitable arrangement for fastening floor stringers. Cast aluminum shall conform to ASTM B26. Steel cap shall conform to ASTM A36.

F. Any nonmetallic pads used on pedestal heads as bearing surfaces for floor panels shall be rigid, conductive polyvinylchloride or vinyl.

G. Bolts, nuts, washers, and screws shall be cadmium-plated items.

H. At the periphery of the floor, full support shall be provided to the floor's extreme edge to ensure continuance of the specified strengths. The support system provided for this purpose shall not interfere with the free removal of affected panels.

PART 3 EXECUTION

3.01 INSTALLATION

A. The layout for the installation shall keep to a minimum the number of cut panels at the floor's periphery, and around permanent protruding obstructions.

B. The panel assembly shall be scribed into place at the periphery so that no voids occur between the floor panels and the contiguous vertical surface trim. The position of every pedestal shall be accurately located, and any necessary changes in subfloor surfaces shall be made before other installation work is started.

C. Before installation proceeds, the subfloor shall be cleared of dust and construction debris, including a final cleaning with high-suction industrial vacuum equipment. No cutting, trimming, or other debris-producing operation shall be conducted within the room where the floor is being installed. As the installation of floor panels proceeds, the area under the installed floor shall be vacuum cleaned as each row of panels is completed. Cleaning shall extend at least 4 feet back from the completed edge where possible.

D. Pedestals shall be installed with mechanical fasteners meeting the performance requirements established in this Specification. The installation shall provide for full bearing of the pedestal base on the subfloor. Where the contour of the floor does not permit this, the base shall be securely shimmed to provide for the required minimum bearing capacity.

E. Installation shall be such that a surveyor's level shall show the floor to be level within 0.100 inch across the entire floor.

F. After installation has been completed, the floor shall be vacuum cleaned and covered with a continuous sheet of paper or plastic of sufficient strength to withstand traffic

which may be imposed upon the floor before the final acceptance. Should any break in this covering occur. the covering shall be immediately repaired by cementing a sheet over the damaged area; otherwise the entire covering shall be immediately replaced.

3.02 ACCEPTANCE PROVISIONS

A. Repairing: Damaged and unacceptable portions of the completed work shall be removed and replaced with new work.

B. 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 09 90 00

PAINTING AND COATING

PART 1 GENERAL

1.01 SUMMARY

A. Provide painting and finishing work within the area encompassed by the contract.

B. The term paint as used herein or on the drawings includes emulsions, paint, stains, varnishes, sealers, surface filler-sealer and coatings whether used as prime, intermediate or finish coats.

C. Existing surfaces which presently have transparent or natural finish shall be finished with transparent or natural finish rather than opaque finish even if the term paint is used herein except where an opaque finish is specifically designated.

1.02 SUBMITTALS

Submit for approval: All required submittals shall be submitted in accordance with Section 01 33 00,Submittals.

1.03 WORK INCLUDED

Paint all surfaces of all items within the area covered by the contract unless specifically excluded. The following items are specifically included as part of the work:

1. Items on walls and ceilings of finished spaces such as pipes, conduit, hangers, duct and pipe covering brackets, supports, wiremold, etc. Do not paint these items in mechanical rooms and utility spaces such as test stands.

2. Interior of cabinets.

3. Remove chalkboards, whiteboards, tackboards, bulletin boards, signs, room numbers, etc. before painting the wall. Replace after painting.

4. Repaint or replace all safety markings such as floor striping, warning signs, numbers, lettering and identification of all kinds

which require repainting or are painted over or damaged in the work in this contract.

1.04 WORK NOT INCLUDED

Do not paint the following items unless specifically noted otherwise on the drawings:

1. Glass, unless previously painted.

2. Vinyl wall covering, unless previously painted.

3. Prefinished paneling, laminated plastic, ceramic tile.

4. Items with factory finish such as mechanical equipment, diffusers, grilles, furniture, toilet partitions.

5. Flooring of all types, rubber, vinyl or aluminum base.

6. Acoustical ceilings.

7. Electrical equipment such as switches, panels, fire alarm panels, lights, receptacle covers.

8. Surfaces permanently concealed from view such as the backs of built-in cabinets, items above the ceiling, etc.

1.05 RELATED WORK SPECIFIED ELSEWHERE

Section	05 12 00:	Structural Steel Framing
Section	05 50 00:	Metal Fabrications
Section	06 20 00:	Finish Carpentry
Section	07 90 00:	Joint Protection

1.06 DELIVERY, HANDLING, AND STORAGE

A. Materials shall be delivered in their original containers bearing manufacturer's name, label, product identification, batch number, and paint formulation. Containers shall be new and unopened.

B. Coating materials shall be stored in tightly closed containers in a covered, well-ventilated area where they will not be exposed to excessive heat, sparks, flame or direct sunlight. Water-based coatings shall be protected against freezing or temperatures above 90 degrees F.

C. Paint solvents, thinners, and cleaners shall be stored with the same care as the coating materials.

1.07 FIELD TESTS

The Contracting officer may take dry-film tests on finished surfaces. Provide additional coatings to surfaces where there is less than the minimum specified dry-film thickness, as directed by the Contracting Officer (at no additional cost). Repaint test areas.

1.08 INSPECTION OF SURFACES

Before starting any work, examine surfaces to receive paint finishes for defects which cannot be corrected by the procedures specified herein under "PREPARATION OF SURFACES" and which might prevent satisfactory painting results. Work shall not proceed until such damages are corrected. The commencing of work in a specific area shall be construed as acceptance of the surfaces, and thereafter the contractor shall be fully responsible for satisfactory work as required herein.

1.09 PROTECTION AND SAFETY PRECAUTIONS

A. Protect adjacent materials and equipment against damage from cleaning, spillage, dripping and spatter. Leave building materials and equipment clean, with damaged surfaces corrected. Post "WET PAINT" signs, to indicate newly painted surfaces.

B. Dispose of rags used to wipe up coating materials, solvents, and thinners by drenching them with water and placing in a metal container with a tight fitting metal cover at the end of each day.

C. Spray painting and sandblasting on exteriors will be permitted only when wind conditions are acceptable as determined by the Contracting Officer. Obtain prior approval for all spray painting and sandblasting from the Contracting Officer before commencement of each day's work. The Contractor shall be liable for any and all damage caused by him to automobiles or other property of third parties.

D. Take necessary precautions in accordance with OSHA regulations to ensure safety of personnel engaged in these operations and personnel who may be affected by such operations. Some of the materials to be handled may be combustible or toxic, or both. Using material safety information provided by the Manufacturer, the Contractor shall be responsible for providing equipment as required

for safe application and instructing the users regarding the hazards and proper handling procedures to prevent health hazards or possible explosion.

1.10 JOB, WEATHER AND TEMPERATURE CONDITIONS

A. Apply paint only when surface temperatures are within the range recommended in the manufacturer's written instruction.

B. Apply paint on exterior surfaces only when conditions are within parameters established in the paint manufacturer’s standard written instructions including temperature and humidity levels. Do not apply paint outdoors when there is a threat of rain or when humidity is 90 percent or higher.

1.11 PERSONNEL QUALIFICATION

The Contractor assigned to the work shall have adequate previous experience in the successful application of paints and coatings similar to those specified.

PART 2 PRODUCTS

2.01 PAINT MATERIALS

A. The Coating Systems in this Specification mention specific manufacturer's paint products followed by the phrase "or approved equal". Paint products submitted "as equal" to those specified must be reviewed and approved by the Contracting Officer; Contracting Officer will use the following criteria to determine if those submitted paint products are equal to the manufacturer's paint products specified:

1. Vehicle
2. Solids content (weight and volume percentages)
3. Drying time
4. Percentage of Titanium Dioxide
5. Viscosity
6. Color

NOTE: Contracting Officer reserves the right to require that the above criteria for a submitted paint product be certified by an independent testing lab.

B. All painting materials shall be approved by the Contracting Officer prior to the commencement of work.

C. Paint shall not be badly settled, caked or thickened in the container, shall be readily dispersed with a paddle to a smooth consistency and shall have excellent application properties.

D. Paint shall arrive on the job color-mixed except for tinting of undercoats and possible thinning.

E. All thinning and tinting materials shall be as recommended by the manufacturer for the particular material thinned or tinted.

F. It shall be the responsibility of the applicator to see that all mixed colors match the color selections.

2.02 APPLICATION EQUIPMENT

Application equipment is not required to be new, but shall be adequate for the work and workmanship required herein.

2.03 ACCESSORY MATERIAL

Furnish all required ladders, scaffolding, drop cloths, maskings, scrapers, tools, dusters, cleaning solvents and waste containers, required to perform the work and achieve the results herein specified.

PART 3 EXECUTION

3.01 WORKMANSHIP, GENERAL

A. Employ only skilled mechanics. Application may be by brush, roller or spray in accordance with paint manufacturer's instruction. (Spray application is restricted as specified in Paragraph entitled "Application, Restriction" and "Protection and Safety Precautions" of this Section).

B. Protect the work at all times, and protect all adjacent work and materials by suitable covering or other method during progress of the work.

C. Protect hardware, accessories, device plates, lighting fixtures, factory finished work, and similar items.

D. Apply materials under adequate illumination, evenly spread and apply smoothly to avoid runs, sags, holidays, brush marks, air bubbles and excessive roller stipple.

E. Coverage and hide shall be complete. When color, stain, dirt or undercoats show through final coat of paint, cover the surface with additional coats until the paint film is of uniform finish, color appearance and coverage, at no additional cost to the Government.

F. All coats shall be dry to manufacturer's written recommendations before applying succeeding coats.

G. Doors shall have tops, bottoms and side edges finished the same as the faces of these doors.

H. The new coating system shall be compatible with the existing coating. If an incompatibility occurs, contact the COTR for instructions.

I. Each of the coats within the particular coating systems for individual substrates shall be by the same manufacturer. Mixing of manufacturer's products within a coating system will not be allowed. Install coating system in strict accordance with paint manufacturer's instructions.

J. The unit measure for paint is “installed dry mils.” Number of coats necessary to meet this specification shall be in accordance with the paint manufacturer's instructions. The Contracting Officer, will at his discretion inspect the paint thickness with Tooke Scratch Gauges and Magnetic Film Thickness Indicators. Contractor shall retouch all test scratches.

K. Provide regulators and gauges in good working order on both air and material lines. Use operation pressures in accordance with those indicated for the particular product.

L. Hold spray guns perpendicular to the surface being painted and handle and adjust in such a manner that dry overspray is kept to a minimum.

M. Avoid contamination of cleaned surfaces, and avoid between coat contamination. Clean surfaces contaminated before applying the next coat.

N. Work each application of material into corners, crevices, joints, etc., and distribute evenly over flat surfaces. Use spray techniques that

result in a uniform wet pattern and avoid dry spraying. Remove dry spray prior to applying sound coating.

3.02 PREPARATION OF SURFACES, GENERAL

A. Clean, dry and adequately protect surfaces from dampness.

B. Remove foreign materials which will adversely affect adhesion or appearance of applied coating.

C. Remove mildew and neutralize the surface per the coating manufacturer's recommendations.

D. Remove efflorescence from all areas before painting.

E. After surface has been patched and loose paint has been removed, all edges of remaining paint shall be feathered (by sanding) so that a uniform finish coat will not show evidence of any previous paint coats or patching.

F. Remove all unused nails, screws, brackets and other obsolete protrusions.

G. Fill all cracks, pits, holes, and other similar surface imperfections with a material appropriate to the surface (per paint manufacturer's recommendations). Once dry, sand these materials flush with the existing surface. All surfaces shall have a slight tooth.

H. All priming shall be done on the same day as cleaning to prevent re-rusting and contamination.

3.03 PREPARATION OF SURFACES, METHODS

A. The following surface preparation specifications shall be used in accordance with Volume 2, "Systems and Specifications, Third Edition", by the Steel Structures Painting Council (SSPC):

Solvent Cleaning: SSPC-SP-1-63
Hand Tool Cleaning: SSPC-SP-2-63
Power Tool Cleaning: SSPC-SP-3-63
Commercial Blast Cleaning: SSPC-SP-6-63
Brush Blast Cleaning: SSPC-SP-7-63

B. Waterblast Cleaning

1. The Waterblast Cleaning equipment shall be capable of operating at a minimum pressure of 3,000 PSI continuously. The nozzle shall be able to produce a cone pattern or a flat fan pattern to make it suitable for all types of cleaning operation.

2. Capacity of the waterblasting equipment shall be in the range of 6 to 10 gallons per minutes. The water supply shall be clean potable water without any extraneous matter that would be detrimental to coating adhesion. The waterblasting shall remove all surface contaminants and loose paint. Paint films that are properly adhered and not embrittled need not be removed.

3. All surfaces cleaned by waterblasting shall be thoroughly dry before painting can be started; Contracting Officer will determine if surfaces are dry.

C. Abrasive material used in Commercial Blast Cleaning (SSPC-SP-6-63) and Brush Blast Cleaning (SSPC-SP-7-63) shall contain no more than 10 percent free silica. Only "virgin" abrasive materials shall be used.

3.04 APPLICATION, RESTRICTION

Do not use the spray method of application for exterior painting when the wind is measured at greater than 5 miles per hour at the level of application and is blowing in the direction of a parking lot or an occupied area; the Contracting Officer will make the decision. Contractor will not receive additional compensation for time lost due to adverse wind conditions.

3.05 EXTERIOR COATING SCHEDULE

A. Exterior Wood Surfaces

1. Surface Preparation: Clean previously painted surfaces by method SSPC-SP-2-63. Areas with heavy paint build-up shall be cleaned by method SSPC-SP-63.15.

Seal knots with “Sherwin Williams” Preprite Odorless Primer, B49W30 “ICI” Ultra-Hide Gripper 3210 Series or approved equal.

Patch and fill all holes and cracks with putty or plastic wood; fillers must be compatible with coating system.

Feather, by sanding, all edges of patched areas and edges of remaining paint.

Backprime all new wood prior to installation; after installed, prime exposed surface(s).

Dull all glossy or smooth surfaces by sanding in order to provide a "tooth".

2. Coating System: Only bare or unpainted wood shall be primed.

Primer =
Approved Primers: (Acrylic) "ICI" 2010-1200 Ultra-Hide Durus, 2.1 dry mils
(Acrylic) "Sherwin Williams" A/100 Exterior Latex Wood Primer B42W41, 2.8 dry mils

Do not begin finish coat until Contracting Officer has reviewed completed prime coat.

Finish Coat =
Approved Finish Coats: (Alkyd) "ICI" 1508 Dulux Ultra Advanced Alkyd Gloss Enamel, 4.0 dry mils
(Acrylic) “Sherwin Williams" A-100 Exterior Gloss A8 Series, 2.8 Mils dry

B. Exterior Galvanized Metal Surfaces

1. Surface Preparation: Clean surface by method SSPC-SP-2-63, then use method SSPC-SP-3-63 to remove all contaminants and loose paint on previously painted surfaces. Next, use method SSPC-SP-3-63 to remove heavy rust and areas where heavy build-up of paint exists on previously painted surfaces.

Patch holes less than 1 inch in diameter with a sealant. (Sealant must be compatible with coating system); patch holes greater than 1 inch in diameter with a material identical

to the surface being patched. Mechanically fasten "patch" to surface; caulk, with sealant around patch.

Feather, by sanding, all edges of remaining paint.

Clean all new or unpainted galvanized metal surfaces by method SSPC-SP-1-63 only.

Dull all glossy or smooth surfaces by sanding in order to provide a "tooth".

2. Coating System: Only bare or unpainted galvanized metal shall be primed.

Primer =
Approved Primers: (Acrylic) “ICI” Devflex 4020, 3.5 dry mils
(Solvent Based Acrylic) “Sherwin Williams” Galvite HS B50WZ30, 4.5 Mils

Do not begin finish coat until Contracting Officer has reviewed completed prime coat.

Finish Coat =
Approved Finish Coats: (Acrylic) “ICI” Devflex 4216, Semi-gloss enamel, 4.0 dry mils
(Alkyd) “Sherwin Williams” Industrial Enamel HS (VOC) B54Z Series, 4.0 dry mils

C. Exterior Metal Siding Surfaces

1. Surface Preparation: Clean previously painted surfaces by the Waterblast Cleaning method. Use method SSPC-SP-7-63 to remove rust and heavy build-up of paint.

   Do not paint siding which has a factory-painted finish unless noted on drawings.

   Holes less than 1/2 inch in diameter shall be patched with a sealant (Sealant shall be compatible with coating system); holes greater than 1/2 inch in diameter shall be patched with a material identical to the surface being patched. Mechanically fasten "patch" to surface; caulk, with sealant, around patch.

   Feather, by sanding, all edges of remaining, existing paint.

   Clean bare or unpainted siding by method SSPC-SP-1-63 if surface contaminants exist.

   Dull all glossy or smooth surfaces by sanding in order to provide a "tooth".

2. Coating System:

   Approved Primer: Acrylic Sherwin Williams
   D.T.M. Bonding Primer,B66A50 or
   Alkyd Kem Kromik Universal Metal Primer, B50NZ6, 3.0 Mils dry.
   (Acrylic) “ICI” Devflex DTM 4020 Flat Int/Ext primer

   Approved Finish Coats:
   Sherwin Williams (Acrylic) DTM Semi-Gloss Acrylic Coating Series. B66 – 200 Series 8.0 Mils dry
   (Acrylic) “ICI” Devflex Semi-Gloss Enamel 4216 , 6.0 dry Mils

D. Exterior Ferrous Metal (Steel and Iron) Surfaces

1. Surface Preparation: Clean previously painted surfaces by method SSPC-SP-6-63. After the completion of the above cleaning method, substrate shall be inspected by the

Contracting Officer; if areas of heavy build-up of paint and/or rust exist, method SSPC-SP-7-63 or SSPC-SP-3-63 will be used to prepare those problem areas.

Any significant cracks or signs of structural member failure shall be brought to the attention of the Contracting Officer.

Feather edges of existing paint so that a uniform coating system can be achieved.

Dull all glossy or smooth surfaces by sanding in order to provide a "tooth."

2. Coating System: Prime all ferrous metal surfaces.

Approved Primers: (Acrylic) "ICI" Devflex 4020, 3.0 dry mils, (Alkyd)"Sherwin Wiiliams" Kem Kromik Universal Metal Primer, 4.0 dry mils, Do not begin finish coat until the Contracting Officer has reviewed completed prime coat.

Approved Finish Coats: (Acrylic) "ICI" Devflex 4216, 4.0 dry mils (Alkyd)"Sherwin Williams" Industrial Enamel HS B54Z Series, 4.0 dry mils.

E. Exterior Concrete and Masonry Surfaces (Except Floors And Walks)

1. Surface Preparation: Clean previously painted surfaces by waterblast cleaning method. Use method SSPC-SP-7-63 to remove stains and heavy build-up of paint.

Patch all holes with a non-shrink grout. Patched areas shall be flush with adjacent areas and shall resemble adjacent areas in appearance.

Dull all glossy or smooth surfaces by sanding to provide a "tooth".

2. Coating System: Finish coat shall not begin until Contracting Officer has reviewed completed prime coat (if primer is required).

Primer (for previously painted surfaces): Waterproofing Sealer 41952
Approved Primers: (Acrylic) "ICI" No surface film 91983, Bond and Prep Waterproofing (Alkyd)"Sherwin Williams" Conditioner (A24V100), 200-300 sq ft/gal.

Primer (for unpainted masonry surfaces):
Approved Primers: (Acrylic) "ICI" 3210 Prep and Prime Gripper Int/Ext Water-Based Block filler, 50-75 sq ft/gal.
(Acrylic) "Sherwin Williams" PREPRITE Block Filler B25W25 , (75-125 sq ft/gal)

Finish Coat:
Approved finish coat: (Acrylic) "ICI" 2200 Dulux Pro, 3.0 dry mils.
(Latex) "Sherwin Williams" A-100 Exterior Flat (A6 Series), 2.6 dry mils.

F. Exterior Cement Asbestos Panel Surfaces

1. Surface Preparation: Clean surface by the Waterblast Cleaning method. DO NOT SANDBLAST!!

Patch holes with sealant that is compatible with the coating system.

2. Coating System: Prime all cement asbestos siding surfaces.

Primer =
Approved Primers: Synthetic Rubber"ICI" Bond-Prep Int/Ext Waterborne Pigmented Bonding Primer 3030-1200, 1.5dry mils.
(Acrylic) "Sherwin Williams" A24W300 Loxon Ext. Acrylic Masonry Primer, 3.2 dry mils.

Do not begin finish coat until the Contracting Officer has reviewed the completed prime coat.

Approved Finish Coats: (Acrylic) "ICI" Ultra-Hide Durus 2200 Ext. Acrylic Flat Masonry Finish ,3.2 dry mils.
(Acrylic) "Sherwin Williams"Loxon Masonary Coating A24 Series, 3.7 dry mils.

G. Exterior Water Tanks and Chain Link Fence Surfaces

1. Surface Preparation: Clean previously painted surfaces by method SSPC-SP-6-23. Supplement cleaning for areas of heavy rust and paint build-up shall be accomplished by method SSPC-SP-7-23.

All significant cracks or signs of structural failure shall be brought to the attention of the Contracting Officer.

Feather edges of existing paint (except on fence fabric) by sanding, so that a uniform coating system can be achieved.

Dull all glossy or smooth surfaces by sanding in order to provide a "tooth".

2. Coating System: Prime all surfaces.

Approved Primers: (Acrylic) "ICI" Devflex 4020 Metal Primer, 2.0 dry mils.
(Alkyd) “Sherwin Williams” Kem Kromik Universal Metal Primer, B50NZ6, 4.0 dry mils.

Do not begin finish coat until the Contracting Officer has reviewed the completed prime coat.

Approved Finish Coats: “ICI”, Devguard Pure Aluminim Finish 4308-9020, 2.0 dry mils.
(Alkyd)“Sherwin Williams” B59S2 Silver-Brite Heavy Duty Aluminum Paint, B5952 3.0 dry mils.

H. Exterior Gypsum Wallboard Surfaces

1. Surface Preparation: Clean previously painted surfaces by method SSPC-SP-2-63. Avoid breaking the outer layer of paper; if broken, repair by taping, mudding and sanding (sand flush with adjacent surface).

   Replace damaged joint tape and patch all damaged areas (on existing surfaces).

2. Coating System: Prime all gypsum wallboard surfaces.

   Approved Primers: (Acrylic) “ICI” 2010 Prep and Prime, exterior primer, 1.3 dry mils.
   (Acrylic) “Sherwin Williams” B42W41 A Pro-Block Latex Sealer, B51 Series, 1.4 dry mils.

   Do not begin finish coat until Contracting Officer has reviewed completed prime coat.

   Approved Finish Coats: (Alkyd) “ICI” 1508 Dulux Advanced Oil, 4.0 dry mils.
   (Acrylic) “Sherwin Williams” A-100 Gloss Industrial Enamel, A8 Series 2.6 dry mils.

3.06 INTERIOR COATING SCHEDULE

A. Interior Wood Surfaces (Painted)

1. Surface Preparation: Same as for Exterior Wood Surfaces.

2. Coating System: Only bare or unpainted wood shall be primed.

   Approved Primers: (Acrylic) “ICI” Ultra-Hide Interior Acrylic Wood Undercoat 1020, 2-2.5 dry mills.
   (Latex) Preprite Classic Primer B28W101, 1.6 dry mils

Approved Finish Coats:
(No V.O.C Acrylic) “Lifemaster 2000 Eggshell Enamel LM9300 2-2.5 dry mils.
Or (Low V.O.C. Acrylic) “ICI” Dulux Pro 1427, 2.0 dry mils
(No V.O.C. Acrylic) “Sherwin Williams” Harmony Eggshell B9 Series, 2.5 dry mils
Or (Low V.O.C.Acrylic) “Sherwin Williams” B20W651 ProGreen 200 Egshell, 3.6 dry mils.

Finish Coat (on doors and door trim):
(Alkyd) “ICI” 1508 Dulux Advanced Oil, 4.0 dry mils.

B. Interior Wood Surfaces (Stained Bare Wood)

1. Surface Preparation: Surfaces shall be dry and free of dirt, grease, wax, and marks.

   Patch and fill all holes, cracks, and open grains with Acrylic wood putty filer; filler must be compatible with coating system.

   Sand wood smooth.

2. Coating System: Stained surface shall be uniform in appearance
   Approved Primers: (Oil Base Stain) “ICI 1700-xxxx Wood Pride Interior Oil Stain
   (Oil Base Stain) “Minwax” Stain
   <u>(Oil Base Stain) “MAB” 954-xxx</u>
   <u>“McCloskey” Tungseal Stain</u>

   Approved Finish Coats: (Acrylic Based) “ICI” 1802-0000 Wood Pride Int. Waterborne Poly. Satin Varnish, 2.0 dry mils.
   (Polyurethane) “Minwax” Polyurethane Satin, 2.0 dry mils.
   (Polyurethane) “MAB” 954-xxx “McCloskey” Heirloom Crystal Clear, 2.0 dry mils.

Wood Classics Fast Dri
Polyurethane A67 Series

C. Interior Gypsum Wallboard, Vinyl Wallcovering, and Plaster

1. Surface Preparation: Remove all contaminants, patch all holes, and repair all imperfections.

   Sand all surfaces smooth.

2. Coating System: Only bare or unpainted surfaces shall be primed.

   Approved Primers: (No V.O.C Acrylic) "ICI" Lifemaster 2000 Primer LM9116 1.5-2, dry mils.
   (Low V.O.C. Latex) "Sherwin Williams" B28W601 Preprite High Build Int. Latex Primer , 2.0 dry mils.

   Finish Coat
   Approved Finish Coats: (No V.O.C. Acrylic) "ICI" LM9300 Lifemaster 2000 Eggshell Latex Enamel, 2-2.5 dry mils.
   (No V.O.C. Latex) "Sherwin Williams" Harmony Eggshell B9 Series, 3.4 dry mils.

   Finish Coat (on corridor and restroom surfaces) = minimum film thickness shall be 4 dry mils.
   Approved Finish Coats: (No V.O.C. Acrylic) ICI Lifemaster 2000 Semi-Gloss Acrylic Enamel LM9200, 1.5-2 dry mils.
   (Latex) "Sherwin Williams" Harmony Semi-Gloss B10 Series, 3.0 dry mils.

D. Interior Concrete and Masonry Surfaces (except floors)

1. Surface Preparation: Remove all contaminants, patch all holes, and repair all imperfections to match adjacent surfaces.

   Clean heavy build-up of paint on previously painted surfaces by method SSPC-SP-2-63 or method SSPC-SP-3-63.

Feather edges of existing paint by sanding, so that a uniform coating system can be achieved.

2. Coating System: Only bare or unpainted surfaces shall be primed.

Approved Primers: (Vinyl Acrylic) “ICI” 3010-1200 Ultra-Hide Vinyl-Acrylic Block Filler, 12 dry mils.
(Acrylic) “Sherwin Williams” B25W25 Preprite Block Filler, 8.0 dry mils.

Finish Coat (on corridor and restroom walls) =
Approved Finish Coats: (No V.O.C. Acrylic) “ICI” Lifemaster 2000 Semi-Gloss Acrylic Enamel LM9200 1.5-2 dry mils.
(No V.O.C. Acrylic) “Sherwin Williams” Harmony Semi-Gloss B10 Series.

Finish Coat (on all other walls) =
Approved Finish Coats: (No V.O.C Acrylic) “ICI” Lifemaster LM9100, 2-2.5 dry mils.
(No V.O.C. Acrylic) “Sherwin Williams” B5W900 Harmony Int. Latex Flat, 2.8 dry mils.

E. Interior Metal Surfaces

1. Surface Preparation: Clean previously painted surfaces by method SSPC-SP-2-63; if areas of heavy paint build-up and/or rust exist, method SSPC-SP-3-63 shall be used to prepare those problem areas.

Remove all contaminants, patch all holes, and repair all imperfections to match adjacent surfaces.

Feather edges of existing paint so that a uniform coating system can be achieved.

Dull all glossy or smooth surfaces by sanding in order to provide a "tooth".

Immediately before painting, clean surfaces with mineral spirits.

2. Coating System: Only bare or unpainted surfaces shall be primed.

Approved Primers: (Waterborne Acrylic) ICI Devflex DTM Int/Ext Flat Waterborne Primer and Finish 4020, 2.2-3.5 dry mils. (Acrylic) “Sherwin Williams”, D.T.M. Acrylic Primer/Finish B66W1, 2.5 dry mils.

Approved Finish Coats: (Low V.O.C. Alkyd) ICI Dulux Advanced Alkyd Semi-Gloss Enamel 1506, 1.5-2 dry mils. (Acrylic) ”Sherwin Williams”, D.T.M. Semigloss coating B66W 200 Series 3.0 Dry Mils.

3.07 ACCEPTANCE PROVISIONS

A. Clean-Up Responsibilities

Upon completion of the work, remove all paint spots and paint chips from glass and other unpainted surfaces. Remove from the premises, all rubbish and accumulated materials of whatever nature not caused by others and leave the work in a clean, orderly and acceptable condition.

B. Rejection

Work with poor workmanship will be rejected. Poor workmanship is defined as inadequate drying or curing, dirt or other foreign material imbedded in the coating film, overspray, pinholes, runs, sags, untrue edges, or other inadequate film build up. Correct rejected work at no additional cost.

Acceptable finish work shall be free of abrasions and shall be uniform in color and appearance.

C. Repairing

Damaged and unacceptable portions of completed work shall be removed and replaced with new work at no additional cost to the Government.

END OF SECTION

SECTION 10 14 00

SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

This section specifies interior room signage and directories to be used throughout MSFC.

1.02 SUBMITTALS

Submit for approval items listed in the Schedule of Submittals in accordance with Section 01 33 00, SUBMITTALS.

1.03 STORAGE OF MATERIALS

Deliver materials to the job site in manufacturer's original packaging and store in a clean, dry area in accordance with the manufacturer's instructions.

1.04 COMPLIANCE

Signage manufacture and installation shall comply with Americans with Disabilities Act (ADA) and Uniform Federal Accessibility Standard (UFAS).

PART 2 PRODUCTS

2.01 MANUFACTURER

Interior signs: Innerface Architectural Signage. No substitution.

Innerface Architectural Signage
5320 Webb Parkway
Lilburn, GA 30047
800-445-4796
770-921-5566

2.02 PRODUCT DESCRIPTION

A. Interior signage: "Innerdot" type with Braille characters to the right of the room numbers. Signs shall not be supplied with inserts, unless called for by the drawings.

Frame Color:	Slate Gray
Letter Style	Helvetica Medium

Raised Number Size	¾” Tall
Raised Copy Color	White
Insert Color	Slate Gray
Insert Letter Color	White
Letter Use	Upper and Lower Case (U&L)
Format	F/1 (Flush Upper Left without symbol)
Shape	Radius Corner (R)

B. Provide directories with blank strip inserts.

C. See Drawings for additional signage types.

2.03 SIGN TYPES

A. Room Number
Module 4.0

B. Large Room Number
Module 7.0

C. Restroom
Module 6.0

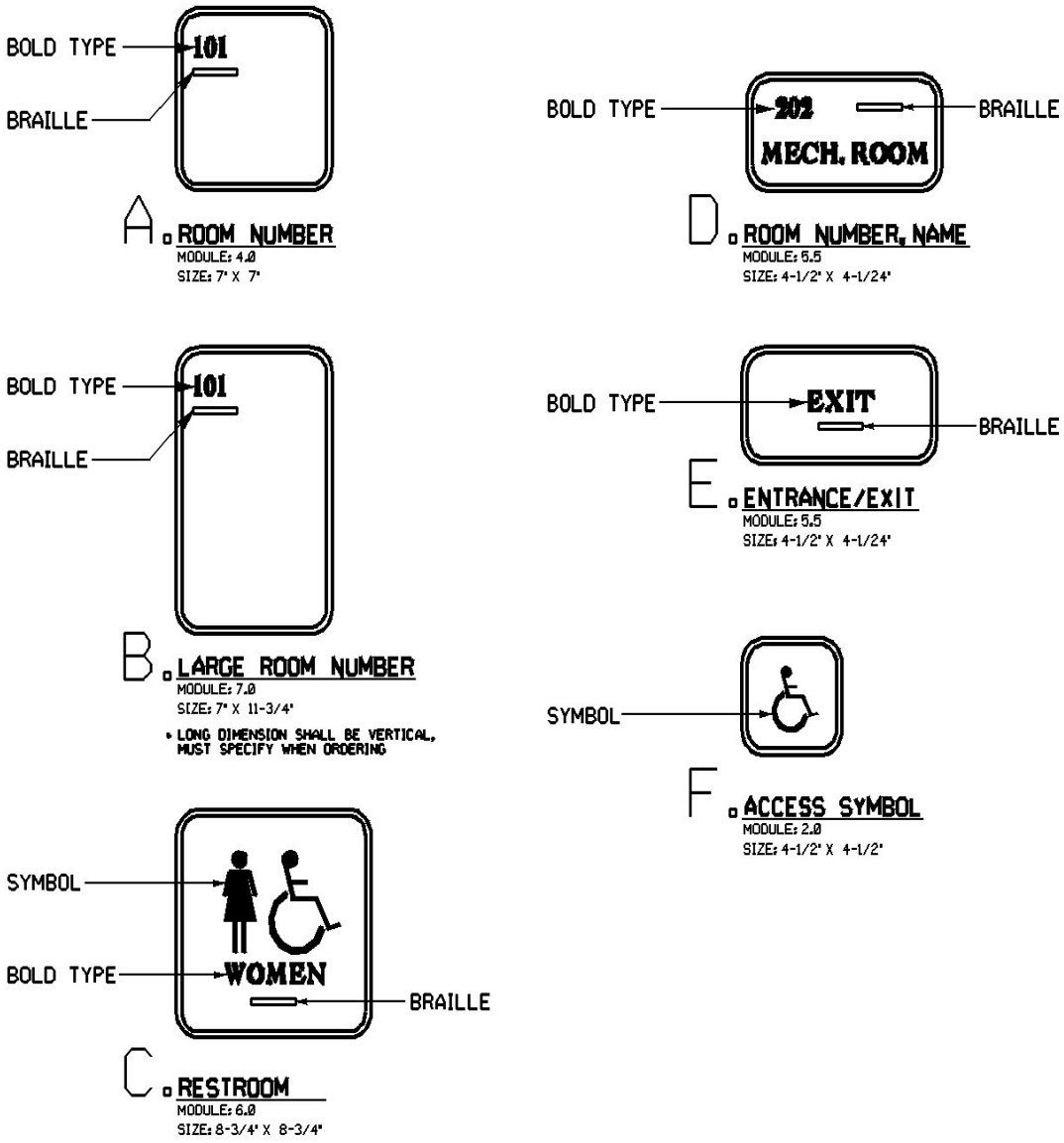
D. Room No., Name
Mechanical/Electrical/Com. Rooms
Module 5.5

E. Entrance/Exit
Module 5.5

F. Access Symbol
Module 2.0

SIGN TYPES

NOT-TO-SCALE



PART 3 INSTALLATION

3.01 GENERAL

A. Sign Location: See Drawings for sign locations.

B. Sign types and quantities: Schedule in Drawings.

3.02 MOUNTING

A. Mounting Location: On wall, 5’-0” above finish floor to centerline of sign adjacent to the latch side of the door, unless otherwise directed by the drawings or the COTR.

B. Mounting Orientation

Module 7.0: Install long dimension vertically.
Module 5.5: Horizontally.
Module 4.0: Top loading.

C. Mounting Method: Flat Surface Mounted (FSM). Install signs level and plumb.

D. Mounting Material: Velcro Tape for “FSM” (with both hook and loop components)

3.02 CLEANING

Clean and protect.

END OF SECTION

SECTION 10 21 13

TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Extent of toilet partitions is indicated on drawings.

B. Types of toilet compartments include:
Plastic laminate finish.

C. Styles of toilet compartments include:
Floor-anchored, overhead braced.

D. Styles of screens include:
Floor-anchored.
Wall-hung.

E. Toilet Accessories, such as toilet paper holders, grab bars, purse shelves, are specified in Section 10 80 00, Toilet, Bath and Laundry Accessories.

1.02 SUBMITTALS

Submit for approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, SUBMITTALS and Section 01 35 43, Environmental Procedures. In accordance with Section 01 35 43, the Contractor shall submit a report for Toilet Partition Products, containing recovered plastic or steel, covered under the EPA regulations for recoverable materials. When such products cannot be provided the Contractor shall provide a non-compliance report stating the reason the product cannot be used and the nature of the products to be used. For an all-inclusive list of products and recoverable material contents see the latest EPA web site for construction products containing recoverable materials.

1.03 QUALITY ASSURANCE

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication where possible, to ensure proper fitting of work.

B. Coordination: Furnish inserts and anchorages which must be built into other work for installation of toilet partitions and related work; coordinate delivery with other work to avoid delay.

PART 2 PRODUCTS

2.01 MATERIALS

A. Plastic Laminate: NEMA Std. LD-3, minimum 0.050" thick, color and pattern as indicated or, if not indicated, as selected by COTR from manufacturer's standards.

B. Core Material for Plastic Laminate: Manufacturer's standard particleboard, in thickness to provide nominal dimension of 1" minimum for all components.

C. Pilaster Shoes: ASTM A167, Type 302/304 stainless steel, not less than 3" high, 20 gage, finished to match hardware.

D. Panel Brackets: Manufacturer's continuous full length heavy duty brackets for attaching panels to walls and pilasters, either chromium-plated non-ferrous cast alloy ("Zamac") or anodized aluminum.

E. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories of chromium-plated non-ferrous cast alloy ("Zamac").

F. Overhead-Bracing: Continuous extruded aluminum, anti-grip profile, with clear anodized finish.

G. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, chromium-plated steel, or brass finished to match hardware, with theft-resistant type heads and nuts. For concealed anchors, use hot-dip galvanized, cadmium-plated, or other rust-resistant protective-coated steel.

2.02 FABRICATION

A. General: Furnish standard doors, panels, screens, and pilasters fabricated for partition system, unless otherwise indicated. Furnish units with cutouts, drilled holes, and internal reinforcement to receive partition-mounted hardware, accessories, and grab bars, as indicated.

B. Doors Dimensions: Unless otherwise indicated, furnish 24" wide inswinging doors for ordinary toilet stalls and 32" wide (clear opening) outswinging doors at stalls equipped for use by handicapped.

C. Plastic Laminate Partitions and Screens:

1. General: Pressure-laminate one-piece face sheets to core material with no splices or joints, and with edges straight and sealed. Seal exposed core material at cutouts to protect against moisture.

2. Overhead-Braced Partitions: Furnish galvanized steel supports and leveling bolts at pilasters, as recommended by manufacturer to suit floor conditions. Make provisions for securing continuous extruded aluminum anti-grip overhead-bracing at top of each pilaster. Furnish shoe at each pilaster to conceal supports and leveling mechanism.

3. Wall-Hung Screen: Furnish panel units in sizes indicated, of same construction and finish as partition system panels.

4. Floor-Supported Screens: Furnish pilasters not less than 1" thickness, panels and pilasters of same construction and finish as toilet partitions. Furnish galvanized steel anchorage devices, complete with threaded rods, lock washers, and leveling adjusting nuts at pilasters, to permit structural connection to floor. Furnish shoe at pilaster to conceal anchorage.

D. Hardware: Furnish hardware for each compartment in partition system, as follows:

1. Hinges: Cutout inset type, adjustable to hold door open at any angle up to 90 degrees. Provide gravity type, spring-action cam type, or concealed torsion rod type, to suit manufacturer's standards.

2. Latch and Keeper: Manufacturer's standard surface-mounted latch unit, designed for emergency access, with combination rubber-faced door strike and keeper.

3. Coat Hook: Manufacturer's standard unit, combination hook and rubber-tipped bumper, sized to prevent door hitting mounted accessories.

4. Door Pull: Manufacturer's standard unit for out-swing doors.

5. Wall Bracket for Screen: Continuous wall bracket for wall-mounted screens.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Comply with manufacturer's recommended procedures and installation sequence. Install partitions rigid, straight, plumb, and level. Provide clearances of not more than 1/2" between pilasters and panels, and not more than 1" between panels and walls. Secure panels to walls with not less than two stirrup brackets attached near top and bottom of panel. Locate wall brackets so that holes for wall anchorages occur in masonry or tile joints. Secure panels to pilasters with not less than two stirrup brackets located to align with stirrup brackets at wall. Secure panels in position with manufacturer's recommended anchoring devices.

B. Overhead-Braced Partitions: Secure pilaster to floor and level, plumb, and tighten installation with devices furnished. Secure overhead-brace to each pilaster with not less than two fasteners. Hang doors and adjust so that tops of doors are parallel with overhead-brace when doors are in closed position.

C. Screens: Attach with continuous brackets recommended by manufacturer to suit supporting structure. Set units to provide support and to resist lateral impact.

3.02 ADJUST AND CLEAN

A. Hardware Adjustment: Adjust and lubricate hardware for proper operation. Set hinges on inswinging doors to hold open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors (and entrance swing doors) to return to fully closed position.

B. Clean exposed surfaces of partition systems using materials and methods recommended by manufacturer, and provide protection as necessary to prevent damage during remainder of construction period.

END OF SECTION

SECTION 10 28 00

TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Extent of each type of toilet accessory is indicated on drawings and schedules.

B. Types of toilet accessories which may be required include the following:

Paper towel dispenser.
Toilet tissue dispenser.
Waste receptacle.
Grab bar.
Sanitary napkin disposal unit.
Soap dispenser.
Seat cover dispenser.
Combination utility shelf unit.
Mirrors.

1.02 RELATED DOCUMENTS

Toilet partitions are specified in Section 10 21 13, Toilet Compartments.

1.03 QUALITY ASSURANCE

A. Inserts and Anchorages: Furnish inserts and anchoring devices which must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.

B. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.

C. Products: Provide products of same manufacturer for each type of accessory unit and for units exposed in same areas.

1.04 SUBMITTALS

Submit for approval: Items listed on the Schedule of Submittals in accordance with Section 01 33 00, Submittals.

PART 2 PRODUCTS

2.01 MATERIAL, GENERAL

A. Stainless Steel: AISI Type 302/304, with polished No. 4 finish, 22 gage (.034") minimum, unless otherwise indicated.

B. Brass: Leaded and unleaded, flat products, FS QQ-B-613; Rods, shapes, forgings, and flat products with finished edges, FS QQ-B-626.

C. Sheet Steel: Cold-rolled, commercial quality ASTM A366, 20-gage (.040") minimum, unless otherwise indicated. Surface preparation and metal pretreatment as required for applied finish.

D. Galvanized Steel Sheet: ASTM A527, G60.

E. Chromium Plating: Nickel and chromium electro-deposition on base metal, ASTM B456, Type SC 2.

F. Baked Enamel Finish: Factory-applied, gloss white, baked acrylic enamel coating.

G. Mirror Glass: FS DD-G-451, Type I, Class 1, Quality q2, 1/4" thick, with silver coating, copper protective coating, and non-metallic paint coating complying with FS DD-M-411.

H. Galvanized Steel Mounting Devices: ASTM A153, hot-dip galvanized after fabrication.

I. Fasteners: Screws, bolts, and other devices of same material as accessory unit or of galvanized steel where concealed.

2.02 PAPER TOWEL DISPENSERS

Surfaced-Mounted Towel Dispensers: Furnished and installed by Contractor. Equal to Bobrick, B-262.

2.03 TOILET TISSUE DISPENSERS

Furnished and installed by Contractor. Equal to Bobrick,B-6867.

2.04 WASTE RECEPTACLES

Surface-Mounted Waste Receptacle: Fabricate of stainless steel with seamless exposed walls and continuously welded bottom pan. Furnish heavy-duty vinyl removable liner, secured to receptacle at not less than 4 points by means of grommets, stainless steel hooks; minimum 20.0 gallon capacity. Equal to Bobrick B-275.

2.05 GRAB BARS:

A. Stainless Steel Type: Provide grab bars with wall thickness not less than 18 (.050") gage.

B. Mounting: Exposed, manufacturer's standard flanges and anchorages.

C. Clearance: 1-1/2" clearance between wall surface and inside face of bar.

D. Gripping Surfaces: Smooth, satin finish.

E. Size: Outside diameter of 1-1/2".

2.06 SANITARY NAPKIN DISPOSAL UNITS

One of the following types as shown on the drawings.

A. Recessed Type: Fabricate of stainless steel for nominal 4" wall depth. Provide self-closing door and removable stainless steel receptacle of all-welded construction.

B. Partition-Mounted Dual-Access Type: Fabricate of stainless steel equipped with adjustable flanges to permit partition mounting to service 2 toilet compartments. Provide self-closing door and all-welded stainless steel receptacle removable from one side.

C. Surface-Mounted Type: Fabricate of stainless steel with seamless exposed walls, tightly self-closing top cover and locking bottom panel with continuous stainless steel piano hinge.

2.07 SOAP DISPENSERS

GFE Furnished, installed by others.

2.08 SEAT COVER DISPENSERS

GFE Furnished, installed by others.

2.09 MIRRORS

A. Stainless steel framed mirrors of size shown on drawings.

B. Frame to be 302/304 stainless steel meeting FS DD-M-411.

C. Glass: mirror glass meeting FS DD-G-45lb type 1 class 1. Guarantee 15 years against silver spoilage.

D. Where shelf is shown, it shall be stainless steel 18 ga. weld to full width of frame. Width 5 inches.

2.10 FABRICATION

A. General: Only an unobtrusive stamped logo of manufacturer, as approved by COTR, is permitted on exposed face of toilet or bath accessory units. On either interior surface not exposed to view or back surface, provide additional identification by means of either a printed, waterproof label or a stamped nameplate, indicating manufacturer's name and product model number.

B. Surface-Mounted Toilet Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage wherever possible.

C. Recessed Toilet Accessories, General: Except where otherwise indicated, fabricate units of all welded construction, without mitered corners. Hang doors or access panels with full-length stainless steel piano hinge. Provide anchorage which is fully concealed when unit is closed.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install toilet accessory units in accordance with manufacturers' instructions, using fasteners which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored in locations and at heights indicated.

B. ADJUSTING AND CLEANING:

1. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.

2. Clean and polish all exposed surfaces after removing temporary labels and protection coatings.

END OF SECTION

SECTION 13 34 19

FABRICATED ENGINEERED METAL BUILDING STRUCTURE

PART 1 GENERAL

1.01 SUMMARY

A. Fabricated Engineered Metal Building Structure shall include the primary and secondary framing, roof and wall covering, bracing, connections, trim, doors and windows, and accessories required for a complete building.

B. Walls and roof system shall be engineered with the building frame for complete structural integrity.

1.02 ABBREVIATIONS, CODES AND STANDARDS

Refer to Section 01 42 00, Reference Standards and Definitions for abbreviations and codes applicable to this work.

1.03 SUBMITTALS

A. Submit for approval: Items listed in the Schedule for Submittals in accordance with Section 01 33 00, Submittals.

B. Submit for approval: Design Analysis, calculations, and shop drawings stamped by Professional Engineer registered in the State of Alabama.

C. Submit for approval: Manufacturer's standard warranties for building components and systems. Roof and wall panel finish warranties shall have a minimum duration of 20 years.

1.04 REFERENCES

ASTM A36 (2005) Standard Specification for Carbon Structural Steel

ASTM A307b (2007) Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

ASTM A325a (2007) Standard Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength

ASTM A529 (2005) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality

ASTM A572 (2007) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A653 (2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A792a (2006) Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

ASTM A924 (2007) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM A992a (2006) Standard Specification for Steel for Structural Shapes

ASTM A1011 (2007) Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra High-Strength.

ASTM E84 (2008) Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM F1554a (2007) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

BHMA A156. Builders Hardware Manufacturers Association – Door and Window Hardware Standards

ANSI/SDI A250.8 (1998) Recommended Specifications for Standard Steel Doors and Frames

UL 580 (1994) Standard for Tests for Uplift Resistance of Roof Assemblies

UL 723 (1996) Standard for Test for Surface Burning Characteristics of Building Materials

1.05 DESIGN CRITERIA

A. The pre-engineered metal building structure shall be designed in accordance with the requirements of the section entitled, "Design

Practices" of the MBMA-02 Metal Building Systems Manual, building use category I, and with ASCE 7-05. The building shall conform to the latest edition of the International Bldg. Code.

B. Allowable stresses may be increased one-third for design-load combinations involving wind, for allowable stress design only.

C. Structural steel members shall be designed in accordance with AISC M021 (ASD, 1989), or AISC M020L (LRFD, 1995), and with AISI SG 973 (1996).

D. Standard frame type: Clear span, rigid frame, tapered column, and tapered beam.

E. Minimum Design Loads -

1. Roof Live Load: 20 PSF, with no tributary area reduction

2. Wind Load:
Basic Wind Velocity - 90 MPH
Importance Factor - 1

3. Seismic Load; Zone - 1
Importance Factor - 1

4. Roof Collateral Dead Load: 12 PSF – This comprises an additional dead load above the dead weight of the steel structure and building components (eg.:light fixtures, piping, ductwork, etc.).

5. Snow Load: 10 PSF ground snow load

F. Maximum Allowable Deflections

1. Live load: Roof Purlins - span/180

2. Wind load: Girts - span/240

G. Design of structural steel sections and welded plate members shall be based upon the applicable specifications of AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings, as determined by the manufacturer.

H. Light-gage, cold-formed structural members and exterior coverings shall be designed based upon the applicable sections of AISI

Specifications for the Design of Cold-Formed Steel Structural Members, as determined by the manufacturer.

I. Bracing in the plane of the roof and vertical wall bracing shall be round rods or angle bracing, as determined by the building manufacturer. Bracing shall be located such that it does not interfere with window or door openings. In walls where cross bracing would interface with openings, portal braces or portal frames may be used.

J. End bays shall be framed with the same rigid frame as the interior bays to facilitate future expansion.

PART 2 PRODUCTS

2.01 STRUCTURAL

A. Structural steel shall generally conform to ASTM A529, ASTM A572, ASTM A992, and/or ASTM A36.

B. Cold-formed structural steel shall generally conform to ASTM A1101 and shall have a minimum yield strength of 50 KSI.

C. Bolts. Bolts shall conform to ASTM A325 for high strength bolts, and ASTM A307 for common bolts (not to be used for primary framing connections).

D. Anchor Rods. Anchor rods shall be designed using allowable loads for ASTM F 1554-GR36 threaded parts per AISC. Anchor rods shall include a 1/8 inch corrosion allowance in their sizing.

2.02 METAL ROOFING

A. Roofing: Roof panels shall be 24 ga. standing seam roof panels with minimum 2" high rib and 16 inch minimum coverage. The clips shall allow for + or -1 in. of thermal movement (2 in. slot) Panels shall be furnished in full lengths without endlaps. Panels shall be 50 KSI minimum yield steel. Roof system shall have a class 90 UL uplift rating, per UL580. All standing seam roofs shall be installed by mechanically seaming along the ribs to produce rigid, watertight seams.

B. Roof panel shall be sheet steel hot dip coated with aluminum or 50% aluminum and 50% zinc (Galvalume) and finished with a PVDF fluorocarbon resin (“KYNAR-500”) oven baked over an epoxy

primer for a total thickness of one mil. Back surface shall have a wash coat of silicon polyester over an epoxy primer for a total thickness of one half mil. Panel finish shall be warranted for 20 years against chalking, fading, blistering, peeling, or cracking when exposed to normal atmospheric conditions. Base metal shall have a minimum yield strength of 50,000 psi, and shall conform to ASTM A792.

2.03 METAL SIDING

A. Wall panels shall be 24 ga. with profile as shown on the drawings.

B. Wall panels shall be galvanized steel conforming to ASTM A924 class G90. Base metal shall have a minimum yield strength of 50,000 psi, and shall conform to ASTM A653.

C. Wall panel finish shall have an oven baked epoxy primer on both surfaces. The exposed finish shall have a silicone polyester coating baked over the primer for a total dry film thickness of not less than one mil. The unexposed side of the panel shall have a silicone polyester coating baked over the primer for a total thickness of one half mil. The finish shall be warranted for a period of 10 years against chalking, fading or cracking when exposed to normal atmospheric conditions.

2.04 INTERIOR LINER PANELS

Interior liner panels shall be 26 ga. with profile as shown on the drawings. Finish shall be the same as wall panels except the minimum warranty period shall be 5 years.

2.05 TRIM AND ACCESSORIES

Exposed flashings and trim shall be a minimum of 26 gauge and shall be of the same finish as the walls. Color shall match the wall.

2.06 FASTENERS

Fasteners that meet or exceed warranty requirements for the building shall be furnished or approved by the metal building manufacturer. A concealed fastening system shall be standard for roof and wall panels; however, where exposed fasteners are unavoidable, the fasteners shall have colored heads to match the color of the material being fastened, unless otherwise approved by the COTR.

2.07 ROOF INSULATION

A. Thermal value: R-24, minimum.

B. Insulation system shall be as shown on the drawings or approved equal.

C. Facing material: polypropylene - scrim - kraft paper.

D. Flame spread: 25 or less; smoke developed: 50 or less per UL723 and ASTM E-84.

2.08 WALL INSULATION

A. Thermal value: R-19

B. Insulation system shall be as shown on the drawings or approved equal.

C. Facing material: polypropylene - scrim - kraft paper.

D. Flame spread: 25 or less; smoke developed: 50 or less per UL723 and ASTM E-84.

2.09 STEEL DOORS AND FRAMES

A. Door and frames shall conform to ANSI/SDI A250.8.

B. Doors and frames shall be galvanized in accordance with ASTM A924, G90.

C. Preparation for hardware shall be in accordance with ANSI A115 and the manufacturer's standards. Doors and frames shall be prepared for the specified locksets.

D. Doors shall be standard at 3' x 7' x 1-3/4", unless shown otherwise.

2.10 FINISH HARDWARE

A. Hardware shall be the manufacturer's standard except locksets, and conform to BHMA Standards: A156.1, A156.2, A156.3, A156.4, A156.6, and A156.8.

B. Finishes shall conform to BHMA A156.18.

C. Locksets shall be as shown on drawings.

2.11 WEATHERSTRIPPING

Weatherstripping for the heads, jambs, meeting stiles, and sills of exterior doors shall be the manufacturer's standard.

2.12 SHOP DRAWINGS

Submit shop drawings which accurately depict the final “as-built” conditions to the COTR for approval. These shop drawings shall be submitted in both electronic and paper (hard copy) formats, in accordance with the requirements listed in Section 01 33 00, “Submittals”.

PART 3 EXECUTION

3.01 FABRICATION

A. Steel fabricators shall have been engaged in steel fabrication for the past 10 years, and must be a member of the Metal Building Manufacturers Association, and shall be an AISC class “MB” certified fabricator. Fabricators shall also have on staff a qualified Professional Engineer registered in the State of Alabama in charge of engineering.

B. Fabrication shall be based on approved drawings in accordance with AISC Code of Standard Practice. (CSP-2000)

C. Light gage cold formed sections shall be manufactured by precision roll or brake forming.

D. Structural steel shall be detailed and fabricated in accordance with the MBMA Code of Standard Practice.

E. The detailing and fabrication of anchor bolt assemblies shall be in accordance with AISC.

F. All welders shall be AWS Certified in the positions and type of welding they will be performing during fabrication.

3.02 SHOP PAINTING

Shop prime primary members with a lead–free, rust inhibitive primer, compatible with the finish to be applied.

3.03 ASSEMBLY

A. Erection shall be done by a Contractor who has a minimum of 5 years experience in the erection of pre-engineered buildings. The building shall be erected in accordance with the MBMA Code of Standard Practice and the AISC Code of Standard Practice.

B. Side laps for siding shall be one full corrugation.

C. Accessories for roofing or siding, necessary for a complete installation, and as shown, shall be furnished and installed with the roofing and siding. Cutouts and flashing shall be provided for vents, ventilator ducts, roof hatches and all other penetrations as shown and required. Joints shall be caulked as shown and required for a weathertight installation. Field-cut edges of roofing and siding, including penetrations, shall be touched up with manufacturer's coating compatible with sheet finish.

D. Doors shall be installed in accordance with the manufacturer's reviewed specifications, reviewed engineering document submittals, and as shown. Doors shall operate freely and easily, shall be properly aligned and balanced and shall be true and square with the openings.

3.04 TOUCH-UP PAINTING

A. Structural steel connections and all areas damaged subsequent to shop painting shall be repaired, cleaned and touch-up painted, prior to roofing/siding installation.

B. Damaged or stained areas of roofing, siding, and accessories shall be touched up with the manufacturer's coating in accordance with manufacturer's current published instructions.

END OF SECTION

SECTION 13 34 24

PRE-ENGINEERED RETROFIT ROOF SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes Retrofit Roof Systems used only as full or partial replacement roof coverings for existing buildings. This Section assumes that, generally, the existing roof covering will be left in place, however, the construction documents will determine the actual construction methods. This Section does not pertain to new roofs for pre-engineered buildings: See Section 13 34 19: Fabricated Engineered Metal Building Structure, for those roofs. Roof coverings for small structures, whether new or replacement, are covered by Section 07 41 13: Metal Roof Panels.

1.02 RELATED SECTIONS

A. Section 05 12 00 Structural Steel Framing

B. Section 05 21 00 Steel Joist Framing

C. Section 05 40 00 Cold-Formed Metal Framing

D. Section 07 41 13 Metal Roof Panels

E. Section 13 34 19 Fabricated Engineered Metal Building Structure

1.03 SUBMITTALS

A. Submit for approval: Items listed in the Schedule for Submittals, in accordance with Section 01 33 00: Submittals.

B. Design Data: Design Analysis and Calculations for all components of the Retrofit Roof System shall be submitted for approval. Structural calculations shall be prepared and certified by a professional structural engineer, registered in the State of Alabama.

C. Design analysis and calculations for the fasteners required to attach the retrofit system to the existing roof structure. Structural calculations shall be prepared and certified by a professional structural engineer, registered in the State of Alabama.

D. Product Data: Manufacturer's Catalog Data shall be submitted for the following items, including accessories and installation materials: Structural Steel Members, Roofing, Coatings, Accessories, Insulating Materials, Weather-stripping, Ventilators and Louvers, Gutters and Downspouts, Fasteners, Sealants, and Snow Jacks.

E. Shop Drawings: Fabrication and Erection Drawings for all components of the Retrofit Roof System shall be submitted for approval.

F. Manufacturer’s Instructions: Manufacturer's Instructions for all components of the Retrofit Roof System shall be submitted for approval. The instructions shall indicate the recommended installation methods and sequence.

G. Certificates: Letter of Approval from Retrofit Roof Manufacturer for Installation Contractor. Manufacturer's experience. Installation Contractor's experience.

H. Test Reports: Submit Building Protection Plan for approval prior to beginning any work on the existing roof system. Submit Fastener Test Plan for review and approval by the Government prior to beginning any work on the existing roof system. Submit required pull-out values and uplift reactions for each type of retrofit member to existing roof/structural connection. Submit test results to the Government for review and approval for all fastener pull-out tests within 3 days after tests are performed.

I. Certificates: Certificates of Compliance shall be submitted for the following items showing conformance with the referenced standards contained in this section: Materials, Structural Steel, Fasteners, and Accessories. Submit quality control certification for manufacturer's engineering, procurement, and fabrication offices in accordance with paragraph "Quality Control." Submit UL-1-90 Certification. Submit certifications for gutter slope in accordance with paragraph "Gutters."

J. Samples: The Contractor shall provide the following samples: Metal Roofing: One piece, 8 inches by width of panel. Color Panels: Three pieces, 4 inches by 4 inches, to indicate maximum color range. Fasteners: One of each type. Special Flexible Flashings. Filler Strip: One piece, width of panel. Sealants: Three cured samples of each sealant and each color to be used. Downspout Turn Out. Downspout Connector Boots. Downspout Joints. Gutter Joints. Gutter End. Downspout/Gutter Connection. Gutter Strap. Gutter Space. Downspout Strap. Outlet Tubes. Downspout Strainer. Gutter. Downspout.

K. Samples: Manufacturer's Standard Color Charts shall be submitted for Architect’s color selection of Roof Panels and Accessories, and Trim.

1.04 QUALITY ASSURANCE

A. All components of the retrofit roof support system and covering are to be engineered and manufactured by a sole entity, hereafter referred to as "The Manufacturer." The manufacturer shall have a minimum of 5 years experience in design and fabrication of pre-engineered retrofit roof systems. The manufacturer shall meet the quality control requirements of paragraph "Quality Control."

B. The Contractor shall not provide a system that is made up of components (purlins, roof panels, structural steel, trim, etc.) designed and manufactured by different manufacturers.

C. The work shall be designed under the direct supervision of a registered structural engineer experienced in the design of this work. Structural calculations shall be prepared and certified by a registered structural engineer, registered in the State of Alabama.

D. Provide a roofing system which has been tested and listed by the Underwriters Laboratories, Inc., to have a wind uplift classification of Class 90. Copy of certification shall be submitted to the Government.

E. Erection of the roof structure and covering shall be performed by a contractor having specialized experience in the erection of pre-engineered retrofit roof framing systems, and metal building covering systems, for a period of at least 3 years. A brief list of similar projects by this contractor shall be submitted to the Government.

F. Installation Contractor of the Retrofit Roofing System shall be approved by the Manufacturer.

1.05 DESIGN CRITERIA

A. See Section 13 34 19-1.05 for minimum design loads for roofs. These design loads supercede the Code-defined lesser loads required below.

B. The Retrofit Roof System shall be designed to withstand the requirements included in The Standard Building Code, 1997 (SBC-99), and in ASCE 7-05. All loads shall be combined for determining maximum stress as required by the Codes.

C. The retrofit support framing system shall be designed to distribute the newly imposed loads, including live and dead, into the existing roof support system structure. Unless specified otherwise, the retrofit roof shall not be fastened directly to the existing roof's decking, or to any other existing secondary structural members.

D. Welded connections shall comply with current, applicable AWS structural welding codes.

E. The Contractor shall employ a professional structural engineer, registered in the State of Alabama, to design and select the fasteners for attachment of the retrofit roof framing system to the existing building's roof structure. The fasteners shall have pull-out and shear values equal to the reaction forces provided by the Manufacturer's Design Calculations, multiplied by a minimum safety factor of 3. The calculations for the fasteners shall be sealed by the structural engineer, and shall be submitted to the Government for review and approval. Calculations shall include a drawing showing the fastener locations and existing construction for all fasteners selected.

F. Deflection of metal roofing panels and supports shall not exceed 1/180 of the span for single-span loading under the total live and wind load.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store prefabricated components so they will not be damaged or deformed. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight ventilated covering will be allowed. Store metal sheets or panels so that water accumulations will drain freely. Do not store sheets or panels in contact with other materials which might cause staining.

B. Do not store panels, framing, or other materials on the existing roof.

1.07 WARRANTY

A. Steel roofing panels and trim shall be warranted in writing for a period of twenty years against failure of the finish, delamination or blisters. Warranty shall be non-prorated and shall require the manufacturer to replace, at no cost to the Government, any panels that fail. Warranty shall include the cost of both material and labor.

B. Roof system manufacturer's liability shall be established at 100 percent of the original contract amount for roof panel installation.

PART 2 - PRODUCTS

2.01 STRUCTURAL RETROFIT ROOF SUPPORT FRAMEWORK AND FASTENERS

A. Retrofit roof framing system shall be a structural package engineered and factory fabricated for field assembly using bolts and self-drilling fasteners.

B. Retrofit roof framing system structural materials used in fabrication shall be designed utilizing standard practices and procedures in compliance with the application sections of the AISC and AISI.

C. Cold-formed members shall be fabricated of material conforming to the physical requirements of ASTM A1011 and shall have a minimum yield strength of 55 ksi.

D. Structural shapes shall be of material conforming to the physical requirements of ASTM A36, A500, or A992, as applicable.

E. All framing members shall either be shop painted, or of pre-painted material with a shop coating. All prior mill steel preparation shall be in accordance with SSPC-SP2 minimum requirements.

F. All framing members shall carry an easily-visible, painted or stenciled identifying piece mark.

G. Structural field connections shall normally be by bolting of primary structural members using high strength bolts, of minimum ¾-inch size, and of secondary members by machine bolts, of minimum ½-inch size, in shop drilled, punched, or reamed holes, or self-drilling fasteners of minimum #12 size. Primary connections shall conform to ASTM A325, and secondary bolted connections to ASTM A307.

H. The fasteners for sub-framing to existing structurals shall be corrosion resistant or stainless steel. The length of the fastener(s) required may vary with the thickness of the existing roof system as indicated. The Contractor is to coordinate with the roof manufacturer and the Contractor's structural engineer as required to determine length and quantity of fasteners. These fasteners shall be furnished by the Contractor and installed in accordance with the fastener manufacturer's instructions.

2.02 ROOF COVERING

A. Roofing sheets and panels shall be roll formed to the specific profile and thickness indicated. Material shall be plumb and true, and within the tolerances listed in ASTM A653.

B. 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 sheets, and shall be not less than 0.0239 inches thick.

C. Roofing sheets shall be continuous from ridge to roof edge without joints and of sufficient length to bridge at least three spans plus the required end lap. However, where spans are greater than 40 feet, roofing sheets may be installed

with staggered end laps. Show all end lap conditions on the Fabrication and Erection Drawings.

D. Roofing material, before coating, shall be not less than 0.0239 inches thick, unless otherwise indicated.

E. Section properties, including yield point, section modulus, and moment of inertia per foot of width, shall equal or exceed the required values determined by design.

F. Panels shall be approximately 24 inches wide, with major corrugations occurring at side seam laps. Panels shall include minor corrugations as required for rigidity. Major corrugations shall include a standing seam, with the total height (corrugation plus seam) being not less than 2.5 inches or more than 3 inches. Panels shall be connected to supporting structure by concealed fasteners. Standing seams are to be rolled during installation by an electrically driven seaming machine.

G. Other roofing panel profiles submitted must be approved in writing by the Contracting Officer prior to receipt of bids.

H. Roofing sheets shall be coated on both sides with a layer of aluminum-zinc alloy (approximately 55 percent aluminum and 45 percent zinc) applied by a continuous hot dip method. Corrugation dimensions and profile shall be as specified. Sheets shall have a coating in accordance with ASTM A653, G90 or ASTM A792 aluminum-zinc. Provide sheets with a 70-percent “Kynar 500” (or equal) fluoropolymer finish.

I. Color of sheets shall be selected by the Government.

2.03 INSULATION

A. Insulation shall have a flame spread not in excess of 25, and a smoke-developed rating not in excess of 50, when tested in accordance with ASTM E84 and UL 723.

B. Insulating materials shall be flexible, resilient noncombustible blankets of glass fiber and resinous binders with polypropylene-scrim-kraft paper. Minimum density shall 1.5 pcf and minimum R-value shall be 19 for walls and 24 for roofs.

2.04 VENTILATORS AND LOUVERS

A. Ventilators and louvers shall be the manufacturer's standard of galvanized steel conforming to ASTM A653, G90. Factory painted to match roofing color unless shown otherwise on drawings. Field painting will not be allowed.

B. Bird screen shall be ½ inch by ½ inch mesh of 20 gage minimum-diameter galvanized wire.

2.05 GUTTERS AND DOWNSPOUTS

A. Gutters and downspouts shall be galvanized steel and conform to ASTM A653, G90. Material shall be not less than 24 gauge. Factory paint is to match siding unless otherwise noted on drawings. Gutters shall slope to downspouts. Provide strainers at downspouts.

2.06 CLOSURE MATERIALS

A. Mastic Closure Strips: Mastic closure strips shall be closed-cell, expanded cellular rubber conforming to ASTM D1056, Type S, Class SCE-41 CMP. Closure strips shall be cut or pre-molded to the exact configuration of the specified roofing material. Closure strips shall be uniform in appearance, free of weak sections, bubbles, cracks, and defects.

B. Adhesives for Closure Strips: Adhesive for use with closure strips shall be the type recommended and furnished by the closure strip manufacturer.

C. Metal Closure Strips: Metal closure strips shall be factory-fabricated accessories matching the type, gauge, and corrugation profile of the specified roofing. Steel closure strips shall be the same gage and finish as the exterior roofing panels.

2.07 JOINT SEALANTS

A. Sealants shall be an approved gunnable type for use in hand-or air-pressure caulking guns at temperatures above 40 degrees F (or frost-free application at temperatures above 10 degrees F). They shall be used wherever required to achieve a weathertight enclosure. The solids content shall be a minimum of 85 percent of the total volume. The 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.

B. Joints shall be primed with a compatible one-component or two-component primer as recommended by the sealant manufacturer.

C. Sealant for shop-applied caulking shall be an approved gun grade, non-sag, one-component polysulfide or silicone, conforming to FS TT-S-00230, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

D. Sealant for field-applied caulking shall be an approved gun grade, composed of non-sag one-component polysulfide, or two-component polyurethane, with an

initial maximum Shore A durometer hardness of 25, and shall conform to FS TT-S-00227, Type II. Color shall match panel colors.

2.08 REPAIR OF FINISH-PROTECTED MATERIALS

A. Galvanizing Repair Paint: Galvanizing repair paint shall be a high-zinc-dust content paint, compatible with the specified galvanized finish roofing materials.

B. Finish Repair Paint: Repair paint for paint finish roofing shall be compatible with and of the same color as the approved finish furnished by the roofing manufacturer. It shall be replaced at no cost to the Government if it weathers differently in any way from the surrounding paint. Inspect at 1-year intervals after substantial completion for a period of 5 years.

2.09 REFABRICATED PIPE FLASHING UNITS

A. Prefabricated pipe flashing units shall be ethylene propylenediene monomer (EPDM) rubber with a ductile-steel or aluminum reinforcing ring bonded to a rubber flange on the base of the flashing unit. Pipe flashing shall be approved by the preformed roofing manufacturer.

2.10 EQUIPMENT CURBS

A. Equipment curbs (8-inch high, minimum) shall be provided by the roofing manufacturer at all roof equipment locations. (Verify locations.)

2.11 SHOP DRAWINGS

Submit shop drawings which accurately depict the final “as-built” conditions to the COTR for approval. These shop drawings shall be submitted in both electronic and paper (hard copy) formats, in accordance with the requirements listed in Section 01 33 00, “Submittals”.

PART 3 - EXECUTION

3.01 BUILDING PROTECTION PLAN

A. The buildings at the Marshall Space Flight Center house extremely expensive, and often one-of-a-kind research and development equipment and space flight hardware, that must not be damaged during installation of this roof. The

Contractor shall submit a building protection plan for Contracting Officer's Technical Representative (COTR) approval that defines, in detail, all construction methods, materials, and procedures that the Contractor will use to protect the building's contents during the duration of the project. Items that must be addressed include, but are not limited to:

1. Weather protection (patch) at all roof fastener penetrations. The roof fastener penetrations must be sealed so that water does not get into the building.
2. How to allow for roof drainage during retrofit roof construction, i.e., if the structural system includes continuous base members installed perpendicular to the roof slope, what will be done at these members to allow for drainage (shim, cut)?
3. Protection at the roof edges when existing flashing and gutters are removed.
4. What will be done to protect the building contents from dust and debris that is created by the drilling, cutting, etc. on the roof? This includes interior finishes, equipment, files, etc.
5. Method(s) to be used to field demonstrate that protection methods outlined will work as planned.

B. The construction methods included in the plan shall minimize disruptions to building occupants and operations, and to access/egress routes.

C. Prior to any roof penetrations, the Contractor shall have an approved building protection plan and shall field demonstrate, using a small test area(s), that the proposed methods of protection will work. The field demonstration shall be witnessed and approved by the Government.

3.02 ASSEMBLY AND ERECTION

A. Verify site conditions.

B. Verify conditions of the existing roof system and structural supports before starting installation of the new re-roof framework system. Notify the COTR of conditions detrimental to the successful installation before erecting the framework. This system is intended to be installed over the existing roof system with minimum penetrations to the existing roof system. Notify the COTR prior to any work if this system cannot be installed as intended or as designed.

C. Remove existing roof mounted equipment and penetrations as scheduled.

D. Remove all loose roof ballast/membrane materials (gravel, etc.). Provide a clean, even contact surface between new framework base members and support elements at existing roof.

E. Provide blocking and shimming for secure and rigid attachment of base members as required.

F. Contact COTR if deteriorated roof insulation and roof deck are discovered.

G. Work shall be designed and installed to allow for thermal movement of the roof system, and to provide permanent freedom from noise due to wind pressure.

3.03 INSTALLATION

A. Framing Systems: Install framing system as directed by manufacturer's instructions, erection procedures, and/or shop drawings. Coordinate with installation of roofing and other adjacent work including heating, ventilation, and air conditioning equipment work. Establish constant elevation of base attachment members as directed unless otherwise required by job conditions shall be determined by accurate elevation control instruments. Vertical framework members shall be plumb with an out of plumb tolerance not exceeding 3 millimeter plus or minus. Provide and install temporary bracing and end closure as required during the installation process to prevent damage due to inclement weather conditions and other lateral force entities. End laps when required shall be at least 6 inches, sealed with manufacturer's recommended sealants, fasteners, and/or clamping plates as required for UL Class 90 Wind Uplift Classification. Properly flash and seal roof covering at ridges, hips, valleys, walls, penetrations, and eaves to assure water tightness. Repair or replace any work which has been stained, marred, or otherwise damaged during the work under this section. Remove damaged materials from site.

B. Metal Flashing: Metal flashing shall be fabricated and installed in accordance with the roof manufacturer’s instructions to provide a complete water-tight system subject to approval the approval by the COTR of the required shop drawings.

C. Open valley flashing shall be at least 4 inches wide at the top, and width shall increase 1/8 inch for each foot of length. Flashing shall be fastened at edges only. Open ends of the metal corrugations shall be sealed with the specified mastic closure strips. Drips shall be formed to the profile indicated, with the edge folded back ½ inch to form a reinforced drip edge.

D. Closures: Metal closure strips shall be installed at the following locations: At open ends of metal ridge rolls; Open ends of corrugated or ribbed pattern roofs, and at intersection of wall and roof unless open ends are concealed with formed eave flashing; At rake of metal roof unless open end has a formed flashing member; and At other areas, as indicated, or needed. Mastic closure strips shall be installed at the following locations: At intersection or ridge roll with metal roofing, when indicated; At other locations, as indicated, or needed.

E. Prefabricated Pipe Flashing Units: Prefabricated pipe flashing units shall be installed as per the preformed metal roofing manufacturer's installation drawings.

F. Joint Sealants: Joints shall be made weathertight. Joints of metal roofing shall be sealed. Flashing at ridges, eaves, rakes, curbs, and openings in roofs shall be sealed with the specified joint sealant. Sealing beads shall be continuous, not less than ½-inch in diameter, and applied to ensure a weathertight joint. Joints in gutters are to be inside the gutter, never outside. Sealants shall match the color of the surface to which they are applied.

3.04 GUTTERS AND DOWNSPOUTS

A. Metal gutters and downspouts shall be installed where indicated on the drawings. Gutters, downspouts, and hangers are to be the same finish material as roofing. Thickness shall be as shown or, if not shown, shall be same or greater thickness as roofing.

B. Gutters: Gutters shall be Fabricated and installed in accordance with the manufacturer's instructions to provide a complete system subject to the approval of the shop drawings by the COTR. Gutters shall provide positive drainage and shall be sloped towards downspouts with no exceptions. Outside lip of gutters shall be a minimum of 1 inch below edge of roof. If manufacturer's standard gutter configuration does not conform to this requirement, then a special shape gutter must be manufactured to achieve this conformance. Test all gutters for proper water drainage in the presence of NASA construction inspector.

C. Gutter Expansion Joints: The Contractor shall provide gutter expansion joints at a spacing of not more than 32 feet on center. Allowances for gutter expansion shall be in accordance with SMACNA-02, Plate 6, but in no case shall less than a 1-inch space be provided between gutter ends. Expansion spaces shall be completely closed with perimeter cover plates and caps having loose-lock slip joints.

D. Downspouts: Downspouts shall be provided on outside walls from gutters, conductor heads, and scuppers, as indicated. Downspouts shall be spaced as indicated or, if not indicated, each downspout shall drain less than 50 feet of gutter. Downspouts shall be non-corrugated and rectangular, of sizes as required per SMACNA drainage system design guidelines. Downspouts shall be joined to the gutters at outlet tubes and joined to each other by telescoping and joints 2.5 inches into the lower section. Downspouts shall be erected plumb unless indicated otherwise and installed not less than 1 inch nor more than 3 inches from walls. Downspout hangers shall be fabricated of the same material as downspouts. One hanger shall be provided at the top of each downspout section with an additional hanger at the bottom of each section. Edges of hangers shall be hemmed. Hangers shall be two-piece flat-stock assembly conforming to SMACNA-02, Plate 34, Figure C. Connection holes shall be slotted to permit field adjustment. 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 with shop fabricated transitions where downspouts

terminate in drainage lines. Joints shall be filled to the full height of the bell with Portland-cement mortar caps. Submit sample of elbow and transitions for review and approval.

3.05 ACCEPTANCE PROVISIONS

A. Erection Tolerances: Metal roofing shall be erected straight and true with plumb lines correctly lapped and secured in accordance with the manufacturer's written instructions. Horizontal lines shall not vary more than 2.5 inches in 40 feet.

B. Fastener Testing: The fasteners to be used to attach the retrofit roof system to the existing building roof structures shall be selected by the Contractor's Structural Engineer. Fasteners shall meet the requirements set forth by paragraph, Design Criteria. A "Fastener Test Plan" shall be submitted to and approved by the Government prior to any work on the existing roof system. The Fastener Test Plan shall include:

1. The qualifications of persons performing the tests.
2. A description of the procedure performing and recording the tests.
3. A sketch or drawing showing the location of all tests, type of fastener to be tested, allowable pull-out valves for fasteners, and test force for each fastener.
4. A description of the test fixture and documentation showing the date the fixture was last calibrated.

C. The Fastener Test Plan must define a test method that clearly demonstrates that the retrofit roof system installed will be adequate for the anticipated loads. Once the Plan is approved, the fasteners proposed for connecting the retrofit roof framing system to the existing building roof structures shall be tested in place prior to and after the installation of the retrofit roof system. Testing shall be done by Contractor and witnessed by the Government. A minimum of 10 fasteners for each connection condition shall be tested prior to the installation of the retrofit roof system to verify the design and the lab pull-out values for each fastener. A minimum of 10 fasteners shall be tested for every 2000 square feet of roof area after the installation is complete to verify proper installation methods. The testing done on the completed roof installation areas shall be done as the work progresses. The Contractor shall not wait until the entire project is complete and then start the tests. All test results shall be submitted to the Government for review and approval within 3 days after the tests are performed. Test results must meet the pull-out values specified by the Contractor's Structural Engineer. Any fastener that does not meet the specified pull-out values will be replaced by the Contractor at no additional expense to the Government. The Government reserves the right to increase the rate of the testing if a fastener fails to meet the specified pull-out values. At locations where the fasteners fail, the Contractor's Structural Engineer will determine the alternative method of attachment and

further testing will be done as needed until the fasteners meet or exceed the specified values.

D. 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 Government shall be immediately removed and replaced with new material.

E. Paint-Finish On Metal Roofing and Trim: Paint-finish on metal roofing may be tested for color stability by the Government during the manufacturer's specified guarantee period. Tests will be performed by means of groups on 2-inch metal disks, fastened in exposed areas of the building. 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.

3.06 QUALITY CONTROL

A. The Contractor shall certify that the manufacturer's Engineering, Procurement, and Fabrication Offices currently meet the following quality control requirements. Certification shall be submitted to the Government for review and approval.

B. Design and Engineering Practices: The manufacturer's design and engineering practices are conducted using sound engineering practices to assure the translation of the intent of the design criteria into detail drawings, specification instructions, and procedures which meet the specified quality levels and the following codes as applicable. AISC: American Institute of Steel Construction, Inc. - National organization which writes specifications for the "Design Manual of Steel Construction." AISI: American Iron and Steel Institute - National organization which writes specifications for the "Design of Cold-Formed Steel Structural Members." ANSI: American National Standard Institute - National organization which specifies minimum design loads for buildings. ASTM: American Society for Testing and Materials - National organization for the development of standards on characteristics and performance of materials, products, systems, and services. AWS: American Welding Society - National organization which writes codes requiring welding requirements applicable to all types of welded structures. IBC: International Building Code.

C. Procurement, Material Receipt, and Storage: The manufacturer's materials and services conform to the Engineering Department's documents, specifications, and design requirements. Actual materials conform to the specifications during both receipt of materials and during the transfer of materials to the manufacturing processes.

D. Fabrication: The manufacturer fabricates and ships, from approved drawings and procedures supplied by the Engineering Department, quality roof systems consistent with the design documents and specifications.

E. Organization, Personnel, Quality Control: The manufacturer demonstrates the existence and use of a written statement affirming that the manufacturer's policy is to direct all activities of the organization in such a manner that the retrofit roof system meets the quality requirements specified. The manufacturer has and exhibits an organization chart clearly showing lines of authority and lines of responsibility down to principal departmental supervisors. Principal departmental supervisors include: Engineering, Manufacturing, Procurement, and Quality Control. All stages of manufacturing are performed in accordance with the design documents and specifications.

F. Compliance: At the option of the Government, a nationally recognized organization, selected by the Government, will perform a quality control audit at no cost to the Contractor. The audit will verify conformance with the quality control requirements of this section.

END OF SECTION

SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SUMMARY

This section applies to, and is a component part of, each section in Division 21, Fire Suppression.

1.02 SCOPE OF WORK

Furnish all labor, material, equipment, and services to construct, install, and test the complete fire suppression systems and related work as indicated and specified.

1.03 INTERPRETATION OF DRAWINGS AND SPECIFICATONS

A. It is the intent of these specifications and the contract drawings to provide a complete and workable Fire Suppression System.

B. The provisions of specifications in Division 01 (those beginning with the number 01xxxx) shall apply to and form a part of each section of the specifications.

C. Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements which may be required for proper installation of the work. Such work shall be verified at the site.

D. Except where shown in dimensional detail, the locations of structural, architectural, plumbing, mechanical equipment, ducts, piping, and fittings are only approximate; the exact locations shall be field determined, subject to A/E approval.

E. Piping sizes and fire suppression equipment & accessories shall not be changed without approval of the A/E.

1.04 CODES AND STANDARDS

A. Fire suppression equipment design, fabrication, testing, installation and system performance shall, unless shown or specified

otherwise, comply with the referenced publications to the extent indicated by the references thereto.

B. References to codes and standards shall be understood to mean the latest revision in force at the time of contract award or most recent contract modification.

1.05 COORDINATION AND INTERFERENCES

A. Coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work is avoided.

B. All necessary offsets in piping and all fittings, etc., required to properly install the work shall be furnished complete in place without additional cost to the Government.

C. If interference develops, the COTR will decide which equipment/ piping shall be relocated, regardless of which was installed first.

1.06 APPROVAL REQUIREMENTS

A. Except as otherwise specified, approval of materials and equipment will be based on Part 2 “PRODUCTS.” The Contractor shall submit for approval, proof that the items furnished conform to the specified requirements as indicated below and in
Section 01 33 00, SUBMITTALS.

1.07 STORAGE AND PROTECTION OF EQUIPMENT AND MATERIALS

All equipment and materials stored at the site shall be fully protected from damage, dirt, debris, and weather per Section 01 60 00, PRODUCT REQUIREMENTS.

1.08 PREVENTION OF CORROSION

A. All metallic materials shall be corrosion resistant, or shall be protected against corrosion.

B. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by approved fittings and treatment.

C. All ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers,

and miscellaneous parts not of stainless steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A123 or ASTM A153.

1.09 WELDING FOR FIRE SUPPRESSION PIPING

A. This section specifies the requirements for welding of carbon steel pipe for fire suppression.

B. Qualified welders and welding procedures are required for all work, unless otherwise noted on the drawings, or in other sections of these specifications. The contractor shall be responsible for the quality of the welding.

C. WELDING PERMIT

Prior to performing any welding, the Contractor shall obtain a welding permit from the MSFC Safety Office.

D. PROCEDURE QUALIFICATION

1. Except as noted in paragraph 1.09.E below, Welding Procedures shall be submitted for approval prior to procedure qualification testing.

2. Procedures shall conform to applicable regulatory codes including AWS D1.1, ASTM A423, ASTM A370, and The ASME Boiler and Pressure Vessel Code, Section IX.

3. Welding procedure qualification testing shall be performed by the Contractor at no cost to the Government. The procedure testing shall include all types of welding to be used by the Contractor. Procedure Qualification Records and radiographs shall be submitted for approval.

4. Copies of the approved procedures shall be retained by the Contractor, and shall be available for examination by the Government Inspector and other authorized personnel. Deviation from the approved procedure will not be permitted without resubmittal of the procedure for approval, as specified above.

5. No welding shall be accepted by MSFC / NASA / Inspector until the Contractor has received the approved procedures.

6. Approval of the procedures does not relieve the Contractor of responsibility to meet the required quality of the welding.

E. WELDER AND WELDING OPERATOR QUALIFICATION

1. Before a welder or welding operator is assigned to do any work he shall pass qualification tests using the same base metals, equipment, positions, and procedures that will be encountered in his work.

2. All welders and welding operators employed shall be qualified for each project, except that a prior qualification may be submitted for approval if it meets the following three conditions:

   a. The qualifications submitted comply with requirements specified herein.

   b. Qualification tests have been taken within 6 months.

   c. The welder or welding operator has been employed as a certified welder on work for MSFC within the past 60 days.

3. Qualification tests to weld piping shall conform to the requirements of ASME Boiler and Pressure Vessel Code, Section IX. All welds shall be full penetration welds. Backing rings are not permitted.

4. Materials for pipe joint test coupons shall be as follows:

   a. Wall thickness less than .25 inches- fabricate from sections of 6 inch or larger pipe of the material, wall thickness, and end preparation to be used on the job.

   b. Wall thickness .25 inch and greater -fabricate from 6 to 8 inch long sections of pipe, .760 inch minimum wall thickness, of the material to be used on the job.

5. For each type of welding to be performed, the welder or welding operator shall fabricate test coupons as follows:

   a. Steel stencil stamp the numbers 1-4 at 90- degree intervals around the test sections. Begin welds at #1.

   b. Weld one coupon each in the "2-G" and "5-G" positions, or weld a single coupon in the "6-G" position.

- For the "2-G" test, the pipe axis shall be fixed in the vertical position.

- For the "5-G" test, the pipe axis shall be fixed in the horizontal position, with the #1 weld position on the bottom.

- For the "6-G" test, the pipe axis shall be fixed at 45-degrees from vertical, with the #1 weld position on the bottom.

6. The Government Inspector and COTR reserve the right to witness all qualification tests. The Contractor shall notify the Government Inspector in advance, and shall not proceed with testing until the witnesses are present, or until the right to witness testing has been waived.

7. All test coupons shall be inspected and evaluated by an independent testing agency. Testing and reporting requirements are specified in Section 01 33 00, SUBMITTALS, under submittal descriptions SD-13 and SD-14.

8. Welder Qualification Reports and radiographs shall be submitted on each welder and welding operator per schedule of submittals for approval.

F. WELDER'S CERTIFICATES

1. Upon successful completion of the applicable qualification tests, each welder shall be provided with a certificate by the Contractor, certifying to the type of welding for which he is qualified, the code under which he is qualified, and the firm or individual certifying the qualification tests.

2. The certificate and a copy of the approved Welder Qualification Report shall be kept on file at the job site by the Contractor, and shall be presented for examination upon request of the Government Inspector or Contracting Officer’s Representative. The certificate will remain in effect for the duration of the job, except when cancellation is required due to questionable workmanship.

G. WELDER'S IDENTIFICATION

1. The Contractor shall assign each welder an identifying number, letter, or symbol which shall be used by the welder to identify all welds made by him. For identification, the welder shall lightly stamp his symbol adjacent to the weld by means of a metal stamp.

2. When more than one welder is employed to complete a weld, the stamp for the stringer pass welder shall be located on the left side of vertical welds, and on the bottom side of horizontal welds.

3. In the case of seam welds, the stamp shall be adjacent to the weld at 3 ft. intervals.

H. RECERTIFICATION OF WELDERS

1. The Contracting Officer may, at any time after initial qualification, require the requalification of any welder doing questionable work, and identifying stenciled tests specimens shall be submitted.

2. Recertification of the welder shall be made only after the required tests have been passed.

3. Testing required for requalification shall be conducted at no additional expense to the Government.

4. If the welder fails the requalification test, he shall be removed from the project.

I. WELDING PROCESS ABBREVIATIONS

1. SMAW = Shielded Metal Arc Welding

2. GTAW = Gas Tungsten Arc Welding, also known as "TIG"

3. GMAW = Gas Metal Arc Welding , also known as "MIG"

J. PIPING UNDER LOAD

1. No welding shall be performed on any piping while it is supporting a load.

1.10 RADIOGRAPHIC INSPECTION OF WELDED FIRE SUPPRSSION PIPING

A. The degree of radiographic inspection for each service will be identified on the drawings, or in other sections of these specifications.

PART 2 PRODUCTS

2.01 STANDARD PRODUCTS

Mechanical materials and equipment to be provided under this contract shall be standard catalog products of manufacturers regularly engaged in the manufacture of the products, except as herein modified, and shall duplicate material and equipment that have been in satisfactory use for at least 2 years.

2.02 MATERIAL AND EQUIPMENT

Mechanical material and equipment shall meet the requirements indicated and specified, and shall be suitable for the installation shown. Where two or more units of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable. All materials and equipment shall be new and free from defects.

2.03 WELDING PRODUCTS

A BASE MATERIALS

Base (pipe) materials for fire suppression service shall be as specified in NFPA 24.

B. ELECTRODES AND FILLER METALS

Electrodes and filler metals for each process shall be selected in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

C. SHIELD AND PURGE GAS

Shield and purge gas for GMAW and GTAW processes shall be high purity welding grade argon.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install all materials, equipment, & accessories in accordance with the requirements of the contract drawings, approved recommendations of the manufacturers & NFPA National Fire Codes.. If there is a conflict, request direction from the COTR by filing a Request for Information (RFI).

B. The installation shall be so made that there is no degradation of fire ratings of walls, floors, or ceilings.

C. Install emergency switches and alarms in conspicuous and accessible locations.

D. Install equipment with manufacturer's recommended clearances so that all parts requiring service are accessible.

3.02 CUTTING AND PATCHING

A. Install work in such a manner, and at such time as will require a minimum of cutting and patching of the building structure.

B. All holes in or through existing masonry walls and floors in exposed locations shall be drilled or sawed. The use of a jack hammer will be permitted only where specifically approved. The edges of trenches in concrete floors shall be sawcut. Material between cuts may be broken up with a jackhammer to facilitate removal.

C. Do not cut, or weld to, building structural members unless indicated on the drawings, or approved in advance by the COTR.

3.03 CLEANING

A. Before final acceptance, all fire suppression equipment including piping & accessories, shall be clean and free from dirt, debris, oil, grease, and finger marks.

3.04 WELDING

A. GENERAL

1. Unless otherwise noted, all pipe welds shall be full penetration.

2. The use of backing rings will not be permitted.

3. Safety Precautions:

   a. All necessary precautions shall be taken and maintained to minimize the possibility of injury to personnel and existing facilities.

   b. Confined areas shall be ventilated where required. Shields and drapes shall be provided as eye protection, and to control air currents and drafts.

   c. All items in areas where welding is performed shall be protected from damage by weld spatter.

B. MOISTURE CONTROL

1. Electrode moisture control shall conform to the applicable requirements of AWS D1.1, except that the dry and baking period for low-hydrogen type electrodes shall be for two hours at 450 to 500 degrees F.

2. At the time of removal from sealed container, low-hydrogen electrodes shall contain not more than 0.8% moisture by weight.

3. The Contractor has the option of storing the electrodes in a holding oven at 250 degrees F in lieu of the specified requirements.

4. The electrode manufacturer shall furnish moisture control recommendations. If these recommendations are more stringent than those specified above, the Contractor shall conform to the manufacturer's recommendations at no additional cost to the Government.

5 All filler metals shall be properly identified, and stored in dry areas or containers.

C. JOINT PREPARATION

1. The work to be welded shall be accurately cut to size and shape by mechanical methods.

2. Flame cutting will be permitted, provided that the cut is ground back to remove oxidation before welding.

3. Machine-beveled pipe ends shall be protected with sheet metal caps, or other approved means, during transit and storage.

4. Joint preparation and fit-up for all piping shall be in accordance with ANSI/ASME B31.1.

5. Pipe ends shall be securely held in alignment during welding, but shall not be forced into alignment.

D. PRE-WELD CLEANING

1. Prior to fit-up, the surfaces to be joined shall be thoroughly cleaned to remove all foreign material, and degreased to remove all oil or other hydrocarbons.

2. Scale or surface oxides shall be removed by grinding, wire brushing, or by rubbing with an abrasive cloth.

3. After welding operations are completed, the Contractor shall clean all pipes, vessels, containers, etc., of all pieces of welding rods, trimmings, filings, and other pieces of metal and trash.

4. Final passes of all welds shall be thoroughly cleaned.

E. WORKMANSHIP

1. Deposited metal shall be thoroughly fused with the base metal at all sections of the weld & full penetration shall be obtained.

2. Remove all slag, flux, spatter, cracks, blow-holes, inclusions, surface oxides, and foreign matter from each bead before depositing additional weld metal. Flame cleaning will not be

permitted. Remove craters and cracks by grinding the full width of the puddle.

3. Heat-sink (suck-back) or burn-through in the root pass shall be controlled to avoid concavity and excessive metal beyond the root side of the weld joint. The deposited metal shall not project more than 3/32 inch beyond the inside wall of the pipe.

4. Mechanical peening of welds will not be permitted.

5. The finished weld shall have an even and regular overlay, free from undercuts, and merging smoothly into the base metal.

6. All items in the area where welding is carried on shall be protected from damage by weld spatter.

F. INERT GAS SHIELD AND PURGE

1. Shield GTAW and GMAW welding with argon gas at flow rates sufficient to create an inert envelope around the molten metal.

2. Take care to avoid drafts and air movements which may disrupt the protective atmosphere around the arc and cause porosity in the weld.

3. Provide an argon gas purge inside piping when GTAW or GMAW root passes are being welded.

G. APPLICATION OF WELDING PROCESSES

1. Welding for carbon steel piping may be accomplished by either SMAW, GTAW, or GMAW processes, except as specified below.

2. Piping with wall thickness .250 inch and greater shall be welded by one of the following processes.

a. GTAW root and filler passes.

b. GMAW root and filler passes.

c. GTAW or GMAW root pass with SMAW filler passes.

H. EXAMINATION AND ACCEPTANCE

1. When noted on the drawings, the Contractor shall provide radiographic inspection services.

2. In addition, the Government reserves the right to inspect welding, at its own expense, by any or all of the following methods.

    1. Dye Penetrant Inspection

    2. Radiographic Inspection

    3. Magnetic Particle Inspection

    4. Ultrasonic Inspection

        - The Contractor shall supervise the preparation of reference blocks from material and labor furnished by the Government. The blocks will be of the same material, thickness, and joint design, and shall be fabricated by the same procedure as the weldments to be inspected.

        - The reference blocks shall be used to adjust the sensitivity level of the equipment, and shall be compatible with the degree of weld discontinuity established by mutual agreement at the outset of each inspection job.

        - At the completion of the work the test blocks will become the property of the Government, and shall be delivered to the Contracting Officer or his representative.

3. Final decisions about the acceptance or rejection of welds will rest with the Contracting Officer, based on the requirements of the contract documents and applicable industry standards.

3.06 RADIOGRAPHIC INSPECTION

A. GENERAL NOTES AND REQUIREMENTS

1. The Contractor shall notify, schedule, and coordinate all X-ray work with the Government Inspector and the MSFC Radiation Safety Officer.

2. The Contractor shall maintain all the necessary precautions and safeguards to minimize the possibility of radiation injury to personnel.

3. When required, the Contractor shall, at no additional cost to the Government, make test shots to prove that the technique to be used will be satisfactory.

B. RADIOGRAPHIC INSPECTION TECHNIQUES

1. The welds to be inspected shall be radiographed by an X-ray or gamma ray technique which has sufficient sensitivity to indicate the features of the penetrameter.

2. The dimensions of the film shall conform to standard industry practice, and be suitable for the size of the weld and the diameter of the fabrication to be inspected.

3. Radiographic inspection shall be performed in accordance with ANSI B31.1 and the references therein (namely, Section V of the ASME Boiler and Pressure Vessel Code). In addition to the standards for weld acceptability, all radiographic requirements of Article 2, Section V, shall be strictly adhered to.

4. Welds in pipe up to 2-1/2 inch diameter shall be X-rayed vertically and horizontally at angles that are sufficient to show the entire weld area. The minimum number of radiographs shall be two at 90 degrees for elliptical radiographs or three at 120 degrees for superimposed radiographs.

5. Welds in material larger than 2-1/2 inch diameter shall be X-rayed in sequence around the circumference of the fabrication.

C. IDENTIFICATION OF WELDS

All welds that require radiographic inspection shall be permanently identified with the prefix "X" and the assigned number from the weld map. The Contractor shall assign weld numbers beginning with the number 1, and continuing in a numerical sequence that includes all welds for the subject contract. The piping shall be marked with the weld identification numbers as follows:

1. Material having a wall thickness of 3/16 inch and up shall be steel stencil stamped adjacent to the weld. Weld identifying stamps shall not be sharp edged (V-tool), but shall be rounded edge, non-stress-inducing type.

2. Material having a wall thickness of 1/8 inch and less shall be temporarily identified with a non-soluble ink. After completion of all radiographic inspection, the Contractor shall permanently identify the approved welds with a stainless steel tag (3/8" x 1" x 1/16"). The tag shall be steel stencil stamped with the assigned weld number, and tack welded adjacent to the weld.

3. All sectional film views of welds shall be marked in non-soluble ink around the circumference of the weld joint alphabetically (i.e., "A-B", "B-C", "C-D", "D-E", etc., returning to view "A").

D. EVALUATION

1. Developed film is to be submitted to the Government Inspector for disposition to the Independent Test Agency.

2. Developed film showing water marks, blemishes, distortion, darkness, or any other condition that interferes with the interpretation of the weld will not be accepted.

3. Acceptability of welding shall be determined in accordance with the standards referenced in this section.

4. Production and evaluation of radiographs shall be performed by an independent testing agency regularly engaged in such work. The testing agency’s report shall include all pertinent information regarding welds that have been judged unacceptable.

5. All radiographs, including those that show weld defects, shall be submitted to the Government. Films shall be marked to identify the inspection agency's name, the date, the weld and view numbers, and the piece or part number (if more than one requires inspection).

6. Final acceptance of all radiographs will be determined by the Government.

E. PROGRESSIVE EXAMINATION

When random radiography (i.e. less than 100% inspection) reveals defective welds, the progressive examination criteria of ANSI B31.3 shall be followed.

F. DEFECTIVE WELDS

1. Repair or replace defective welds and provide additional radiographic inspection at no additional cost to the Government.

2. Identify X-ray film for such welds with the prefix "R" added to the weld number.

END OF SECTION

SECTION 21 05 29

HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

Work specified in this section includes the following:

A. Hangers, supports, supporting elements, and structural attachments for fire suppression piping and equipment.

B. Pipe sleeves, seals, and escutcheons.

C. See Section 03 30 00 for fire suppression equipment support pads.

PART 2 PRODUCTS

2.01 STANDARDS

A. Type numbers specified below refer to those identified in Manufacturers Standardization Society (MSSP) Standard SP-69.

B. Hangers, supports, and attachments shall be Factory Mutual approved or UL listed.

2.02 HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPE

A. Pipe Hangers: Malleable iron or carbon steel, adjustable, Type 1 (Clevis) or Type 6 (Split ring); Anvil Figures 104, 260,and 300, or equal.

B. Vertical pipe supports: Riser clamp, Type 8, black carbon steel; Anvil Figure 261 or equal.

C. Trapeze hangers: For multiple parallel piping - carbon steel channel, properly sized to support the intended load; Anvil Figure 46 or equal.

D. Roller supports: Adjustable, cast iron roll and sockets, steel roll rod, Type 41; Anvil Figures 175 and 177, or equal.

.E. Other types of hangers and supports may be submitted for approval.

2.03 SUPPORTING ELEMENTS

A. Threaded rod: Carbon steel, threaded one end, both ends, or continuous; Anvil Figures 140 and 146 or equal.

B. Turnbuckle: Forged steel, Type 13; Anvil Figure 230 or equal.

C. Clevis: Forged steel, Type 14; Anvil Figure 299 or equal.

D. Angle brackets: Carbon steel, welded construction, type selected according to the supported load; Anvil Figures 194, 195, and 199 or equal.

2.04 STRUCTURAL ATTACHMENTS

A. Welded attachments: Carbon steel, Type 22 (Anvil Figure 66), Type 57 (Anvil Figure 55), or equal.

B. Beam Attachments

1. C-Clamps: For piping 1 1/2" and smaller, black malleable iron body with hardened steel set screw; Type 23, with retaining clip for I-beams or locknut for channel; Anvil Figures 86 and 87 or equal.

2. Beam Clamps: Malleable iron, center loading, Type 21, 28, 29, or 30; Anvil Figures 131, 228, 229, and 292 or equal.

C. Masonry Attachments

1. Concrete inserts: Cast-in-place, single point, carbon steel, Type 18, Anvil Figure 285 or equal.

2. Concrete inserts: Cast-in-place, continuous, carbon steel; Unistrut Series P-3200 or equal.

3. Anchor bolts: Cast-in-place, carbon steel, with steel pipe sleeve; B-Line Figure B3022 or equal.

4. Concrete anchors: For cast concrete; self-drilling, wedge or expansion sleeve type; Phillips "Red-head" or equal.

5. Masonry anchors: For brick and concrete block, full length expansion sleeve type; ITW Ramset "Dynabolt" or equal.

2.05 SUGGESTED MANUFACTURERS

A. Pipe hangers, supports, supporting elements and attachments shall be as manufactured by Anvil, Michigan Hanger Co., Elcen, B-line, Unistrut, or approved equal.

B. Masonry attachments shall be as manufactured by Phillips, ITW Ramset, HILTI, Molly Fastening Systems, Rawl-Plug Co., or approved equal.

2.06 SUPPLEMENTARY STEEL

Supplementary steel for pipe and equipment supports shall be ASTM A36 structural shapes or commercial strut systems (Unistrut or equal).

2.07 PIPE SLEEVES AND RELATED PRODUCTS

A. Sleeves for masonry walls and floors: Standard weight PVC or galvanized steel pipe.

B. Escutcheons, interior, up to 4" NPS: One or two-piece, chromed steel, sized to conceal the pipe penetration.

C. Escutcheons, exterior, and interior above 4" NPS: Cast iron, black (interior) or galvanized (exterior) with set screws; Grinnell Figure 395 or equal.

D. Wall sleeve seals: Watertight mechanical compression seal consisting of EPDM rubber links with glass reinforced plastic pressure plates and galvanized steel bolting; MetraFlex “MetraSeal” or equal.

PART 3 EXECUTION

3.01 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping within one foot of each elbow, and at maximum intervals specified below.

1. Steel Pipe

Nominal Pipe Size	Maximum Spacing, Ft.	Hanger rod Diam., In.
1/2	6	3/8
3/4 to1-1/2	8	3/8
2 & 2 -1/2	10	3/8 & 1/2
3	12	1/2
4	14	5/8
6	18	3/4
8	20	7/8
10 & 12	22	7/8

B. Support piping so that connected equipment does not bear piping loads.

C. Provide additional supports near heavy components (valves, filters, in-line pumps, etc.) to minimize load on pipe.

D. Install hangers to provide minimum 1/2-inch clear space between finished covering and adjacent work.

E. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.

F. Where possible, support riser piping independent of connected horizontal piping. In multi-story buildings, support risers at each floor.

3.02 CONCRETE INSERTS

Provide a 1-foot (minimum) length of 1/2-inch rebar to anchor each single point insert.

3.03 SUPPLEMENTARY STEEL

Welding of supplementary steel shall be in accordance with the procedures described in AWS D1.1. Welder qualification testing is not required unless noted on the drawings or Schedule of Submittals.

3.04 PIPE SLEEVES

A. Provide sleeves where piping penetrates walls or floors with the following exceptions.

1. Sleeves are not required where penetrations are core drilled through cast concrete.

2. Sleeves are not required for interior partition (frame) walls unless indicated on the drawings to preserve fire rating.

3. Where piping passes through new concrete slab floors, 1/2 inch thick closed cell foam insulation, extending two inches above and below slab, may be used in lieu of a sleeve.

B. Fill voids in pipe sleeves as follows:

1. Interior fire rated walls and floors - provide a fire barrier system per the drawing details and Section 07 84 00, “Firestopping.”

2. Exterior walls above grade - pack with fiberglass insulation and seal ends with a minimum 1/2 inch depth of silicone sealant.

3. Exterior walls below grade - provide a mechanical seal per paragraph 2.08.D.

C. Provide escutcheons where piping penetrates ceilings, walls, or floors into finished areas, or to visible areas of the building exterior.

3.05 MECHANICAL SUPPORT PADS

Concrete support pads for mechanical equipment shall be constructed per Section 03 30 00, “Cast-In-Place” Concrete.

END OF SECTION

SECTION 21 05 53

IDENTIFICATION FOR SUPPRESSION PIPING & EQUIPMENT

PART 1. GENERAL

1.01 This section specifies the products and methods for identification of fire suppression systems.

1.02 Fire Suppression identification systems shall be in accordance with ANSI A13.1.

PART 2. PRODUCTS

2.01 All materials used in Fire Suppression identification shall be waterproof and corrosion resistant.

2.02 IDENTIFICATION PRODUCTS

A. Pipe markers - Vinyl, self-adhering; Seton, Emed, or equal.

B. Pipe markers - Snap-on type, preformed, acrylic plastic with clear overlaminate; Seton "Setmark", Emed "Kwik-koil", or equal.

C. Valve tags - Brass or aluminum, 1-1/2 inch minimum diameter, stamped or engraved, attached to the valve with #12 AWG wire (galvanized or stainless steel) or with chain (galvanized or brass).

D. Equipment tags - Engraved laminated plastic, white letters on black, minimum 3 inch x 1 inch tag with 1/4-inch lettering, unless otherwise noted.

E. Equipment Nameplate Data Sheet - To be submitted per Section 01330. Data sheets shall be provided in the following format for each piece of powered equipment and shall contain appropriate data for each item:

Submittal Information for Every Piece of Operable Equipment					
Contractor		Ref Drawing #			
Work Order #		Equip ID shown on drawing		MAXIMO # (if known)	
Name Plate Data					
Manufacturer		Motor		Max Temp.	
Model #		Drive		Max Pressure	
Serial #		Size		Sheave Size (motor)	
Cat. # / Part #		Motor rpm		Sheave Size (equip.)	
Mfg. Date		Horsepower		Capacity (gpm, cfm, ton, etc.)	
Voltage		Frame		Equipment rpm	
Phase		Duty		Filter Size	
Amps		Service Factor		Filter Qty.	
KVA Rating		NEMA Rating		Belt Size	
Equipment Type (fan, pump, AHU, CRU, etc.)		Motor % Efficiency		Belt Qty.	

F. Underground Warning Tapes:

1. For metallic piping - color coded polyethylene film, 6 inches wide, with legend identifying the utility below; Seton, Emed, or equal.

2. For non-metallic piping - color coded metallic foil tape, 6 inches wide, with legend identifying the utility below; Seton, Emed, or equal.

PART 3. EXECUTION

3.01 PIPING IDENTIFICATION SYSTEMS

A. Identify contents and flow direction of all new piping unless otherwise indicated. Acceptable methods of identification are as follows:

1. Pipe and covering less than 3/4-inch O.D.

   a. Vinyl pipe markers adhered to non-ferrous plates. Suspend the plates from the piping with galvanized or stainless steel wire.

   b. Paint color bands on the pipe. At each band, provide a non-ferrous plate with a stenciled identifying legend. Suspend plate from piping with galvanized or stainless steel wire.

2. Pipe and covering 3/4-inch O.D. and larger.

   a. Snap-on pipe markers.

   b. Vinyl pipe markers secured at each end with pressure sensitive tape wrapped completely around the pipe and overlapped.

   c. Painted color band with stenciled legend.

B. Minimum dimensions of identification markings shall be as follows.

O.D. of Pipe and Covering	Band Length	Letter Height
3/4" to1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2"to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"

C. Color coding of identification markings shall be as follows.

Service	Legend	Band Color	Legend Color
Industrial water	Industrial Water	Green	White
Fire protection water	Fire Protection Water Sprinkler Water	Red	White
Drain	Drain	Green	White
Shop air (<100 psi)	Shop Air or	Blue	White
(100+psi)	Compressed Air	Yellow	Black

		Band	Legend

D. Pipe identification markings shall be located as follows.

1. Adjacent to each valve or group of valves.

2. At each side of wall or floor penetrations.

3. At each equipment connection.

4. On long piping runs, at 20-foot maximum intervals.

E. Provide flow direction markings at each identification point.

F. Where pipelines are located more than nine feet above floor level, place the lettering below the horizontal centerline of the pipe.

G. Mark piping which presents a bumping or tripping hazard with black and yellow stripes at the point of hazard.

H. Clean and degrease surfaces to receive adhesive markers. Prior to painting on steel pipe, remove rust and provide one coat of primer.

3.02 VALVE AND EQUIPMENT TAGS

Identification requirements and tag numbers for valves and equipment will be indicated on the drawings, if required.

3.03 WARNING TAPE

A. Place warning tape directly above all buried piping. Note that different warning tapes are required for metallic and non-metallic utilities.

B. Burial depth for polyethylene tape shall be approximately one foot below grade.

C. Burial depth for metallic foil tape shall be 4 to 6 inches below grade.

END OF SECTION

SECTION 21 10 00

WATER BASED FIRE-SUPPRESSION SYSTEMS

PART 1 GENERAL

1.01 GENERAL

A. The type, extent, and hazard classification of each fire protection system will be indicated on the drawings.

B. Fire protection systems shall be designed and installed by a contractor who is licensed by the State of Alabama for the type of system specified.

C. Fire protection systems shall be designed and installed in accordance with all applicable sections of the NFPA National Fire Codes.

D. Hydraulic calculations shall be based on available flow and pressure data provided by the Government.

E. At the completion of installation, the Contractor shall submit shop drawings to the COTR which accurately depict the final “as-built” conditions. These drawings will be incorporated into the record facility drawing files. The “as-built” shop drawings shall be submitted in both electronic and paper (hard copy) formats and shall comply with the format requirements described below.

1. Electronic files shall be submitted in either Tiff (tg4) or Jpg (JPEG) image format. Drawings prepared using Computer Aided Design (CAD) software are acceptable substitutes and shall be delivered in dxf, dwg or dgn format only. All Computer Aided Design (CAD) files shall be self-contained and stand-alone. All cross-referenced or reference files shall be electronically merged into the contract drawing such that each drawing file shall be a completely stand-alone document. All levels and/or layers shall be turned on.

   All electronic files of drawings shall be delivered on a CD-ROM. All media shall be formatted so that it is compatible with Microsoft Windows XP (or above) operating system.

2. For paper (hard copy) drawings, the required drawing size shall be “E” size (40” x 28”) and shall be drawn and lettered to permit

reproduction at half size. Lettering shall not be less than 1/8” in height. The AE will properly identify, size, detail, and dimension all the items and conditions on the drawings.

1.02 RELATED SECTIONS

A. Section 09 90 00 Painting & Coating

B. Section 23 05 53 Identification for HVAC Piping & Equipment

C. Section 31 23 00 Excavation and Fill

D. Section 33 61 13 Underground Hydronic Energy Distribution

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. All products and materials for fire protection systems shall comply with applicable requirements of the NFPA National Fire Codes. In addition, all components other than pipe and fittings shall be Factory Mutual approved or UL listed for fire protection applications.

B. Metal Tags – All piping equipment, valves, and accessories shall be provided with a 2” dia., brass or aluminum, ID tag indicating the equipment designation number, function of the control, etc. (this must match the drawing or control diagram designations). Also include project drawing number. Tags shall be wired to valve or equipment w/#12 AWG (.0808 inch dia.) galvanized wire. All information is to be stamped.

2.02 EXTERIOR PIPING

A. Exterior water supply piping and valves shall be selected in accordance with NFPA 24.

B. Valve boxes shall be cast iron, 3-piece, adjustable, with drop cover marked "Water".

C. Exterior valves, boxes, and indicator posts shall be Stockham, Kennedy, Mueller, or equal.

D. Fire hydrants shall be in accordance with AWWA C502, dry barrell-type fire hydrant. Hydrant 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. Working parts shall be bronze. Hydrants shall be connected to the mains with 6-inch diameter pipes. Hydrants shall be painted with one coast of zinc-chromate alkyd paint primer and two finish coats of paint, color as indicated below.

1. Top of hydrant and hose caps shall be painted to designate rated capacity of hydrant:

RED- 0 to 500 gpm
ORANGE- 500 to 1000 gpm
GREEN- 1000 to 1500 gpm
LT. BLUE- over 1500 gpm

2. The main body of the hydrant shall be yellow.

2.03 INTERIOR PIPING

A. Interior valves, pipe, fittings, and associated components shall be selected in accordance with NFPA 13.

B. Manufacturers shall be Simplex Grinnell, Viking, Central, or equal.

C. Butterfly valves shall not be used.

PART 3 EXECUTION

3.01 EXTERIOR PIPING

A. Provide all trenching, excavation, shoring, pumping, and backfilling required for this installation.

B. Provide valves and indicator posts where shown on the drawings.

C. Provide a valve box for each buried valve, except post indicator valves.

D. Provide thrust blocks, clamps, and tie rods in accordance with NFPA 24 to prevent pipe movement and fitting separation. Protect clamps and tie rods with an asphaltic coating.

E. Hydrostatically test piping per NFPA 24 (as of Fall 2007, this is 200 psi, +/- 5 psi, over a 2 hour period). The Government Inspector shall witness testing.

F. Paint exposed piping and supports per Section 09 90 00. Color shall be red unless otherwise noted.

G. Provide concrete splash blocks where drains, water motor gong outlets, and inspector's test stations are drained to grade in unpaved areas.

3.02 INTERIOR PIPING

A. Provide pipe hangers and supports per NFPA 13.

B. Flush and test the system per NFPA 13. Testing shall be witnessed by the Government Inspector.

C. Where piping is exposed to view in finished areas, and where otherwise noted on the drawings, paint piping and supports per Section 09 90 00. Color shall be red unless otherwise noted.

D. Furnish to the Government a stock of spare sprinkler heads with appropriate wrenches and storage cabinet, in accordance with NFPA 13.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

This section applies to, and is a component part of, each section in Division 22, Plumbing.

1.02 SCOPE OF WORK

Furnish all labor, material, equipment, and services to construct, install, and test the complete mechanical systems and related work as indicated and specified.

1.03 INTERPRETATION OF DRAWINGS AND SPECIFICATONS

A. It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

B. The provisions of specifications in Division 01 (those beginning with the number 01 xx xx) shall apply to and form a part of each section of the specifications.

C. Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements which may be required for proper installation of the work. Such work shall be verified at the site.

D. Except where shown in dimensional detail, the locations of plumbing, mechanical equipment, ducts, piping, and fittings are only approximate; the exact locations shall be field determined, subject to A/E approval.

E. The physical dimensions of equipment indicated are approximate. Before installing any equipment, obtain the exact requirements for the items furnished and install plumbing, piping, fittings, supports, and other items of the correct size and type for the equipment to be installed.

F. Plumbing and piping sizes and equipment ratings shall not be changed without approval of the A/E.

1.04 CODES AND STANDARDS

A. Equipment design, fabrication, testing, installation and system performance shall, unless shown or specified otherwise, comply with the referenced publications to the extent indicated by the references thereto.

B. References to codes and standards shall be understood to mean the latest revision in force at the time of contract award or most recent contract modification.

1.05 COORDINATION AND INTERFERENCES

A. Coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work is avoided.

B. All necessary offsets in piping and all fittings, etc., required to properly install the work shall be furnished complete in place without additional cost to the Government.

C. If interference develops, the COTR will decide which equipment shall be relocated, regardless of which was installed first.

1.06 APPROVAL REQUIREMENTS

A. Except as otherwise specified, approval of materials and equipment will be based on manufacturer's published data. The Contractor shall submit for approval, proof that the items furnished conform to the specified requirements as indicated below and in Section 01 33 00, SUBMITTALS.

B. UL Compliance Requirements

1. Where materials and equipment are specified to conform to the standards of the Underwriter's Laboratories, the label of, or listing with re-examination in, UL PUB. REF. NO. 2, and UL PUB. REF. No. 3 will be acceptable as sufficient evidence of conformance with UL requirements.

2. 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 conform to the specified requirements. Certificate shall include a description of the methods of testing used.

C. Where materials or equipment are specified to be constructed and/or tested in accordance with specific industry or government standards, a manufacturer's certificate of compliance for each item will be acceptable as proof of compliance.

D. Conformance with specified standards does not free the item from being in compliance with any other requirements of these specifications.

1.07 STORAGE AND PROTECTION OF EQUIPMENT AND MATERIALS

All equipment and materials stored at the site shall be fully protected from damage, dirt, debris, and weather per Section 01 60 00, PRODUCT REQUIREMENTS.

1.08 PREVENTION OF CORROSION

A. All metallic materials shall be corrosion resistant, or shall be protected against corrosion.

B. Equipment enclosures shall be given rust-inhibiting treatment and standard finish by the manufacturer.

C. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by approved fittings and treatment.

D. All ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of stainless steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A123 or ASTM A153.

1.09 GENERAL WELDING FOR PLUMBING PIPING

A. This section specifies the requirements for welding of carbon steel and corrosion resistant (stainless) steel pipe for plumbing utility services.

B. Qualified welders and welding procedures are required for all work, unless otherwise noted on the drawings, or in other sections of these specifications. The contractor shall be responsible for the quality of the welding.

C. WELDING PERMIT

Prior to performing any welding, the Contractor shall obtain a welding permit from the MSFC Safety Office.

D. PROCEDURE QUALIFICATION

1. Except as noted in paragraph 1.09.E below, Welding Procedures shall be submitted for approval prior to procedure qualification testing.

2. Procedures shall conform to applicable regulatory codes including AWS D1.1, ASTM A423, ASTM A370, and The ASME Boiler and Pressure Vessel Code, Section IX.

3. Welding procedure qualification testing shall be performed by the Contractor at no cost to the Government. The procedure testing shall include all types of welding to be used by the Contractor. Procedure Qualification Records and radiographs shall be submitted for approval.

4. Copies of the approved procedures shall be retained by the Contractor, and shall be available for examination by the Government Inspector and other authorized personnel. Deviation from the approved procedure will not be permitted without resubmittal of the procedure for approval, as specified above.

5. No welding shall be accepted by MSFC / NASA/ Inspector until the Contractor has received the approved procedures.

6. Approval of the procedures does not relieve the Contractor of responsibility to meet the required quality of the welding.

E. WELDER AND WELDING OPERATOR QUALIFICATION

1. Before a welder or welding operator is assigned to do any work he shall pass qualification tests using the same base

metals, equipment, positions, and procedures that will be encountered in his work.

2. All welders and welding operators employed shall be qualified for each project, except that a prior qualification may be submitted for approval if it meets the following three conditions:

   a. The qualifications submitted comply with requirements specified herein.

   b. Qualification tests have been taken within 6 months.

   c. The welder or welding operator has been employed as a certified welder on work for MSFC within the past 60 days.

3. Qualification tests to weld piping shall conform to the requirements of ASME Boiler and Pressure Vessel Code, Section IX. All welds shall be full penetration welds. Backing rings are not permitted.

4. Materials for pipe joint test coupons shall be as follows:

   a. Wall thickness less than .25 inches- fabricate from sections of 6 inch or larger pipe of the material, wall thickness, and end preparation to be used on the job.

   b. Wall thickness .25 inch and greater -fabricate from 6 to 8 inch long sections of pipe, .760 inch minimum wall thickness, of the material to be used on the job.

5. For each type of welding to be performed, the welder or welding operator shall fabricate test coupons as follows:

   a. Steel stencil stamp the numbers 1-4 at 90- degree intervals around the test sections. Begin welds at #1.

   b. Weld one coupon each in the "2-G" and "5-G" positions, or weld a single coupon in the "6-G" position.

      - For the "2-G" test, the pipe axis shall be fixed in the vertical position.

- For the "5-G" test, the pipe axis shall be fixed in the horizontal position, with the #1 weld position on the bottom.

- For the "6-G" test, the pipe axis shall be fixed at 45-degrees from vertical, with the #1 weld position on the bottom.

6. The Government Inspector and COTR reserve the right to witness all qualification tests. The Contractor shall notify the Government Inspector in advance, and shall not proceed with testing until the witnesses are present, or until the right to witness testing has been waived.

7. All test coupons shall be inspected and evaluated by an independent testing agency. Testing and reporting requirements are specified in Section 01 33 00, SUBMITTALS, under submittal descriptions SD-13 and SD-14.

8. Welder Qualification Reports and radiographs shall be submitted on each welder and welding operator per schedule of submittals for approval.

F. WELDER'S CERTIFICATES

1. Upon successful completion of the applicable qualification tests, each welder shall be provided with a certificate by the Contractor, certifying to the type of welding for which he is qualified, the code under which he is qualified, and the firm or individual certifying the qualification tests.

2. The certificate and a copy of the approved Welder Qualification Report shall be kept on file at the job site by the Contractor, and shall be presented for examination upon request of the Government Inspector or Contracting Officer’s Representative. The certificate will remain in effect for the duration of the job, except when cancellation is required due to questionable workmanship.

G. WELDER'S IDENTIFICATION

1. The Contractor shall assign each welder an identifying number, letter, or symbol which shall be used by the welder

to identify all welds made by him. For identification, the welder shall lightly stamp his symbol adjacent to the weld by means of a metal stamp.

2. When more than one welder is employed to complete a weld, the stamp for the stringer pass welder shall be located on the left side of vertical welds, and on the bottom side of horizontal welds.

H. RECERTIFICATION OF WELDERS

1. The Contracting Officer may, at any time after initial qualification, require the requalification of any welder doing questionable work, and identifying stenciled tests specimens shall be submitted.

2. Recertification of the welder shall be made only after the required tests have been passed.

3. Testing required for requalification shall be conducted at no additional expense to the Government.

4. If the welder fails the requalification test, he shall be removed from the project.

I. WELDING PROCESS ABBREVIATIONS

1. SMAW = Shielded Metal Arc Welding

2. GTAW = Gas Tungsten Arc Welding, also known as "TIG"

3. GMAW = Gas Metal Arc Welding , also known as "MIG"

J. MEMBERS UNDER LOAD

A. No welding shall be performed on any plumbing component while it is supporting a load.

1.10 GENERAL RADIOGRAPHIC INSPECTION OF WELDED PIPING

A. SUMMARY

The degree of radiographic inspection for each service will be identified on the drawings, or in other sections of these specifications.

PART 2 PRODUCTS

2.01 STANDARD PRODUCTS

Plumbing materials and equipment to be provided under this contract shall be standard catalog products of manufacturers regularly engaged in the manufacture of the products, except as herein modified, and shall duplicate material and equipment that have been in satisfactory use for at least 2 years.

2.02 MATERIAL AND EQUIPMENT

Plumbing material and equipment shall meet the requirements indicated and specified, and shall be suitable for the installation shown. Where two or more units of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable. All materials and equipment shall be new and free from defects.

2.03 WELDING PRODUCTS

A. BASE MATERIALS

Base (pipe) materials for plumbing service shall be as specified on the drawings, or in the applicable sections of these specifications.

B. ELECTRODES AND FILLER METALS

Electrodes and filler metals for each process shall be selected in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

C. SHIELD AND PURGE GAS

Shield and purge gas for GMAW and GTAW processes shall be high purity welding grade argon.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install all materials and equipment in accordance with the requirements of the contract drawings and approved recommendations of the manufacturers. If the two conflict, request direction from the COTR by filing a Request for Information (RFI).

B. The installation shall be so made that there is no degradation of fire ratings of walls, floors, or ceilings.

C. Install emergency switches and alarms in conspicuous and accessible locations.

D. Install equipment with manufacturer's recommended clearances so that all parts requiring service are accessible.

3.02 CUTTING AND PATCHING

A. Install work in such a manner, and at such time as will require a minimum of cutting and patching of the building structure.

B. All holes in or through existing masonry walls and floors in exposed locations shall be drilled or sawed. The use of a jack hammer will be permitted only where specifically approved. The edges of trenches in concrete floors shall be sawcut. Material between cuts may be broken up with a jackhammer to facilitate removal.

C. Do not cut, or weld to, building structural members unless indicated on the drawings, or approved in advance by the COTR.

3.03 CLEANING

A. Exposed surfaces of piping and equipment which 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.

B. Before final acceptance, all plumbing equipment including piping and fixtures shall be clean and free from dirt, debris, oil, grease, and finger marks.

3.04 DEMOLITION

A. The extent of piping removal shall be as shown on drawings. Remove piping, duct, hangers, and attachments to points shown and cap or blank off.

B. Where removed piping passed through a wall, floor, or ceiling, patch holes, refinish, and repaint to match existing construction.

C. Remove equipment as shown on drawings, including all associated anchor bolts, pads, hangers, etc.

D. All removed materials and equipment not designated to be salvaged by the Government shall be disposed of at no additional cost to the Government.

E. Removed materials and equipment designated for salvage shall be turned over to the Government at the location specified by the Government Inspector. All piping, electrical, and ductwork connections on salvaged equipment shall be capped or sealed prior to turn-over. Salvaged equipment shall be protected from the weather.

3.05 WELDING

A. GENERAL

1. Unless otherwise noted, all pipe welds shall be full penetration.

2. The use of backing rings will not be permitted.

3. Safety Precautions:

a. All necessary precautions shall be taken and maintained to minimize the possibility of injury to personnel and existing facilities.

b. Confined areas shall be ventilated where required. Shields and drapes shall be provided as eye protection, and to control air currents and drafts.

c. All items in areas where welding is performed shall be protected from damage by weld spatter.

B. MOISTURE CONTROL

1. Electrode moisture control shall conform to the applicable requirements of AWS D1.1, except that the dry and baking period for low-hydrogen type electrodes shall be for two hours at 450 to 500 degrees F.

2. At the time of removal from sealed container, low-hydrogen electrodes shall contain not more than 0.8% moisture by weight.

3. The Contractor has the option of storing the electrodes in a holding oven at 250 degrees F in lieu of the specified requirements.

4. The electrode manufacturer shall furnish moisture control recommendations. If these recommendations are more stringent than those specified above, the Contractor shall conform to the manufacturer's recommendations at no additional cost to the Government.

5. All filler metals shall be properly identified, and stored in dry areas or containers.

C . JOINT PREPARATION

1. The work to be welded shall be accurately cut to size and shape by mechanical methods.

2. Flame cutting will be permitted, provided that the cut is ground back to remove oxidation before welding.

3. Machine-beveled pipe ends shall be protected with sheet metal caps, or other approved means, during transit and storage.

4. Joint preparation and fit-up for all piping shall be in accordance with ANSI/ASME B31.1.

5. Pipe ends shall be securely held in alignment during welding, but shall not be forced into alignment.

D. CLEANING

1. Prior to fit-up, the surfaces to be joined shall be thoroughly cleaned to remove all foreign material, and degreased to remove all oil or other hydrocarbons.

2. Scale or surface oxides shall be removed by grinding, wire brushing, or by rubbing with an abrasive cloth.

3. After welding operations are completed, the Contractor shall clean all pipes, vessels, containers, etc., of all pieces of welding rods, trimmings, filings, and other pieces of metal and trash.

4. Final passes of all welds shall be thoroughly cleaned.

E. WORKMANSHIP

1. Deposited metal shall be thoroughly fused with the base metal at all sections of the weld & full penetration shall be obtained.

2. Remove all slag, flux, spatter, cracks, blow-holes, inclusions, surface oxides, and foreign matter from each bead before depositing additional weld metal. Flame cleaning will not be permitted. Remove craters and cracks by grinding the full width of the puddle.

3. Heat-sink (suck-back) or burn-through in the root pass shall be controlled to avoid concavity and excessive metal beyond the root side of the weld joint. The deposited metal shall not project more than 3/32 inch beyond the inside wall of the pipe.

4. Mechanical peening of welds will not be permitted.

5. The finished weld shall have an even and regular overlay, free from undercuts, and merging smoothly into the base metal.

6. All items in the area where welding is carried on shall be protected from damage by weld spatter.

F. INERT GAS SHIELD AND PURGE

1. Shield GTAW and GMAW welding with argon gas at flow rates sufficient to create an inert envelope around the molten metal.

2. Take care to avoid drafts and air movements which may disrupt the protective atmosphere around the arc and cause porosity in the weld.

3. Provide an argon gas purge inside piping when GTAW or GMAW root passes are being welded.

G. APPLICATION OF WELDING PROCESSES

1. Welding for carbon and stainless steel piping may be accomplished by either SMAW, GTAW, or GMAW processes, except as specified below.

2. Piping with wall thickness .250 inch and greater, and piping to be cleaned to Class I, II, or III, shall be welded by one of the following processes.

a. GTAW root and filler passes.

b. GMAW root and filler passes.

c. GTAW or GMAW root pass with SMAW filler passes.

H. EXAMINATION AND ACCEPTANCE

1. The Government reserves the right to inspect welding, at its own expense, by any or all of the following methods.

a. Dye Penetrant Inspection

b. Radiographic Inspection

c. Magnetic Particle Inspection

d. Ultrasonic Inspection

- The Contractor shall supervise the preparation of reference blocks from material and labor furnished by the

Government. The blocks will be of the same material, thickness, and joint design, and shall be fabricated by the same procedure as the weldments to be inspected.

- The reference blocks shall be used to adjust the sensitivity level of the equipment, and shall be compatible with the degree of weld discontinuity established by mutual agreement at the outset of each inspection job.

- At the completion of the work the test blocks will become the property of the Government, and shall be delivered to the Contracting Officer or his representative.

2. Final decisions about the acceptance or rejection of welds will rest with the Contracting Officer, based on the requirements of the contract documents and applicable industry standards.

3.06 RADIOGRAPHIC INSPECTION

A. GENERAL NOTES AND REQUIREMENTS

1. The Contractor shall notify, schedule, and coordinate all X-ray work with the Government Inspector and the MSFC Radiation Safety Officer.

2. The Contractor shall maintain all the necessary precautions and safeguards to minimize the possibility of radiation injury to personnel.

3. When required, the Contractor shall, at no additional cost to the Government, make test shots to prove that the technique to be used will be satisfactory.

B. RADIOGRAPHIC INSPECTION TECHNIQUES

1. The welds to be inspected shall be radiographed by an X-ray or gamma ray technique which has sufficient sensitivity to indicate the features of the penetrameter.

2. The dimensions of the film shall conform to standard industry practice, and be suitable for the size of the weld and the diameter of the fabrication to be inspected.

3. Radiographic inspection shall be performed in accordance with ANSI B31.1 and the references therein (namely, Section V of the ASME Boiler and Pressure Vessel Code). In addition to the standards for weld acceptability, all radiographic requirements of Article 2, Section V, shall be strictly adhered to.

4. Welds in pipe or tubing up to 2-1/2 inch diameter shall be X-rayed vertically and horizontally at angles that are sufficient to show the entire weld area. The minimum number of radiographs shall be two at 90 degrees for elliptical radiographs or three at 120 degrees for superimposed radiographs.

5. Welds in material larger than 2-1/2 inch diameter shall be X-rayed in sequence around the circumference of the fabrication.

C. IDENTIFICATION OF WELDS

All welds that require radiographic inspection shall be permanently identified with the prefix "X" and the assigned number from the weld map. The Contractor shall assign weld numbers beginning with the number 1, and continuing in a numerical sequence that includes all welds for the subject contract. The piping shall be marked with the weld identification numbers as follows:

A. Material having a wall thickness of 3/16 inch and up shall be steel stencil stamped adjacent to the weld. Weld identifying stamps shall not be sharp edged (V-tool), but shall be rounded edge, non-stress-inducing type.

B. Material having a wall thickness of 1/8 inch and less shall be temporarily identified with a non-soluble ink. After completion of all radiographic inspection, the Contractor shall permanently identify the approved welds with a stainless steel tag (3/8" x 1" x 1/16"). The tag shall be steel stencil stamped with the assigned weld number, and tack welded adjacent to the weld.

C. All sectional film views of welds shall be marked in non-soluble ink around the circumference of the weld joint alphabetically (i.e., "A-B", "B-C", "C-D", "D-E", etc., returning to view "A").

D. EVALUATION

1. Developed film is to be submitted to the Government Inspector for disposition to the Independent Test Agency.

2. Developed film showing water marks, blemishes, distortion, darkness, or any other condition that interferes with the interpretation of the weld will not be accepted.

3. Acceptability of welding shall be determined in accordance with the standards referenced in Section 15051, “Welding for Mechanical Utility Piping.”

4. Production and evaluation of radiographs shall be performed by an independent testing agency regularly engaged in such work. The testing agency’s report shall include all pertinent information regarding welds that have been judged unacceptable.

5. All radiographs, including those that show weld defects, shall be submitted to the Government. Films shall be marked to identify the inspection agency’s name, the date, the weld and view numbers, and the piece or part number (if more than one requires inspection).

6. Final acceptance of all radiographs will be determined by the Government.

E. PROGRESSIVE EXAMINATION

When random radiography (i.e. less than 100% inspection) reveals defective welds, the progressive examination criteria of ANSI B31.3 shall be followed.

F. DEFECTIVE WELDS

1. Repair or replace defective welds and provide additional radiographic inspection at no additional cost to the Government.

2. Identify X-ray film for such welds with the prefix "R" added to the weld number.

END OF SECTION

SECTION 22 05 00.01

LASER ALIGNMENT FOR PLUMBING PUMPS & ROTATING EQUIPMENT

PART 1 GENERAL

MSFC requires laser alignment on all shaft coupled machines in keeping with its implementation of Reliability Centered Maintenance. Laser alignment designed into the machine will:

- Minimize machine installation and set-up time.
- Allow verification of pump, fan, and compressor equipment.
- Allow identification of unique errors in machine motions and structure.

Provides engineering performance guidelines for use by maintenance and design personnel as well as pump, fan, and equipment builders during the design and building of new equipment and the rebuild of existing equipment.

1.01 LASER ALIGNMENT SUPPORT SYSTEMS

NOTE: Nominal English/Metric dimensioning is used for Laser/Target Holding Adapter I.D. and Bushings I.D., therefore English to Metric I.D. conversions will not be exact, however the tolerancing integrity must be maintained.

1.01.1 LASER/TARGET HOLDING ADAPTERS shall be

a. Practical to install and use while Plumbing Pump/Fan/Equipment is in a production environment.

b. Shall mount to represent the spindle's axis of rotation.

c. Standard inside diameter of each Laser holding adapter shall be ground to .7500 inch +.0010/-.0000 inch I.D. (20mm +.0250/-.0000 mm I.D.). If spacing or center distance constraints do not allow for a .7500 inch (20mm) inside diameter, then the inside diameter may be reduced to the next appropriate nominal size (+.0010/-.0000 inch) + (.0250/.0000 mm). Laser holding adapters shall be of a length that is as long as

is practical and conditions allow, and run out of the inside diameter to the mounting journal shall not exceed .001 inch (0.0254 mm).

d. Standard inside diameter of each target holding adapter shall be ground to .7500 inch +.0002/-.0000 inch I.D. (20 mm +.0051/0000 mm I.D.) If spacing or center distance constraints do not allow for a .7500 inch (20 mm) inside diameter, then the inside diameter shall be reduced to the next appropriate nominal size +.0002/-.0000 inch (+.0051/-.0000 mm).

1.01.2 Adapters are required for each line-up application to secure the laser or target.

1.01.3 Each adapter shall be black oxide coated and have the inside bore diameter clearly stamped and filled with yellow paint on the body of the adapter.

2.0 COUPLED SHAFTS LASER ALIGNMENT

2.01 MSFC COUPLED SHAFT ALIGNMENT REQUIREMENT

MSFC operations require laser alignment on all shaft coupled machines to maximize part quality and productivity, and to eliminate premature machine failure due to misalignment.

2.02 COUPLED SHAFTS ALIGNMENT

Coupled shaft alignment is the positioning of two or more machines so that the rotational centerlines of their shafts are co-linear at the coupling center under operating conditions.

2.03 LASER SHAFT ALIGNMENT SYSTEM REQUIREMENTS

The Laser Alignment System used for coupled shaft alignment shall use either a combined laser emitter and laser target detector unit or separate units for its laser emitter and laser target detector.

2.04 SHAFT ALIGNMENT TOLERANCES

2.04.1 All shaft-to-shaft centerline alignments shall be within the tolerances specified in Table 1 unless more precise tolerances are specified by the Plumbing Pump/Fan/Equipment manufacturer or by the design engineer for special applications.

*TABLE 1 COUPLED SHAFT ALIGNMENT TOLERANCE VALUES

	RPM	TOLERANCE SPECIFICATION
SOFT FOOT	ALL	<.002 inch (.0508 mm) at each foot

	RPM	HORIZONTAL & VERTICAL PARALLEL OFFSET	ANGULARITY/GAP Inch/10 inch (mm/254 mm) Coupling Diameter
SHORT COUPLINGS			
	600	.005 in (0.1270mm)	.010 in (0.2540 mm)
	900	.003 in (0.0762 mm)	.007 in (0.1778 mm)
	1200	.0025 in (0.0635 mm)	.005 in (0.1270 mm)
	1800	.002 in (0.0508 mm)	.003 in (0.0762 mm)
	3600	.001 in (0.0254 mm)	.002 in (0.0508 mm)
	7200	.0005 in (0.0127 mm)	.001 in (0.0254 mm)

		HORIZONTAL & VERTICAL PARALLEL OFFSET PER INCH (25.4 mm) OF SPACER LENGTH	
COUPLINGS			
WITH	600	.0018 in (0.0457 mm)	
SPACERS	900	.0012 in (0.0305 mm)	
	1200	.0009 in (0.0229 mm)	
	1800	.0006 in (0.0152 mm)	
	3600	.0003 in (0.0076 mm)	
	7200	.00015 in (0.0038 mm)	

JACKSHAFTS Below “critical speed” of Jackshaft
Short coupling tolerances apply to each coupling of the jackshaft.
Above “critical speed” of Jackshaft
Short coupling tolerances apply relative to the centerlines of the two machines.

*References: “The Optalign Training Book.” 1990, Ludeca Inc., Miami, FL.

2.04.2 The tolerances specified in the Table 1 are the maximum allowable deviations from Zero-Zero Specifications or ALIGNMENT TARGET SPECIFICATIONS (i.e. an intentional targeted offset and/or angularity).

2.04.3 Acknowledging that machines often move after start-up due to THERMAL GROWTH, dynamic load shifts, etc., the alignment parameters shall be measured and adjusted for operating conditions.

2.05 COUPLED SHAFTS ALIGNMENT VERIFICATION

2.05.1 Laser alignment shall be performed on the Plumbing pump/fan/equipment supplier's floor on all shaft coupled equipment.

2.05.2 When verifying the alignment of coupled shafts the Plumbing pump/fan/equipment supplier must document and provide the following data for each set of coupled shafts:

a. Alignment tolerances used.
b. SOFTFOOT
c. Vertical ANGULARITY (Pitch) at the COUPLING POINT.
d. Vertical OFFSET at the coupling point.
e. Horizontal angularity (Yaw) at the coupling point.
f. Horizontal offset at the coupling point.

This information shall be provided in the submittal (Section 01 33 00).

2.05.3 Verification of alignment and re-alignment shall be conducted at the MSFC facility during installation of the equipment.

2.06 PUMP/EQUIPMENT BASES

2.06.1 PUMP/EQUIPMENT BASE CONSTRUCTION

2.06.1.1 A solid and rigid base is required to achieve and maintain shaft alignment.

2.06.1.2 Where bases are constructed using concrete or grouts, final shaft alignment shall not be conducted until ample curing time has taken place. (A minimum of thirty days is recommended).

2.06.1.3 Where the plumbing pump/fan/equipment foundation installation specification does not require a concrete or grout base or the installation schedule does not permit the proper cure time for the concrete/grout, base construction shall be a structurally rigid steel fabrication or machined casting as determined by the Government.

2.06.1.4 Where corrosion is or may be a problem the base must be fabricated of corrosive resistant materials.

2.07 HOLD-DOWN BOLTS

The use of hold down bolts is the preferred method of fastening components to the base. Hold-down bolts shall meet the following specifications:

a. Hold-down bolts for both the driver and the driven machine(s) (in pairs or in trains) shall be positioned (spotted) after the machine's shafts have been aligned.
b. Hold-down bolts shall be centered in the hole of the machine foot.
c. Hold-down bolts shall not be undercut ("Chicagoed") to achieve HORIZONTAL adjustment.

2.08 PIPING

Piping must be fitted, supported, and sufficiently flexible such that softfoot due to movement caused by tightening pipe flanges doesn't exceed .002" (.051 mm). Piping must not restrict the minimum 180 degree rotation requirement of the laser alignment system.

2.09 SHIMS

Shims shall meet the following specifications:

a. Commercially die-cut.
b. Made of corrosion and crush resistant stainless steel, which is dimensionally stable when subjected to high compression over long periods of time.
c. Consistent over the whole shim area, without seams or folds from bending.
d. Clean, free from burrs, bumps, nicks and dents of any kind.
e. Size, numbers, or trademarks etched into the shim, not printed or stamped.
f. The smallest commercial shim which will fit around the hold down bolts without binding shall be used.
g. The overall shim pack shall not exceed a total of three (3) shims.
h. Shims must rest on bare metal, not paint or other coatings.

2.10 MACHINE VERTICAL MOBILITY

All machines shall be installed with a minimum of .125 inch (3.0 mm) dimensionally stable shims under each surface mounting point for vertical mobility.

2.11 COUPLING PLAY/BACKLASH

OEM's shall use only Lovejoy or Woods Couplings unless otherwise agreed upon by the purchaser. During the alignment process coupling play or backlash shall be eliminated to accomplish a precision shaft alignment.

2.12 AXIAL SHAFT PLAY

Axial shaft play or end play shall be no greater than .025 inch (3.175 mm). Accommodation of end movement must be accomplished without inducing abnormal loads in the connecting equipment.

GLOSSARY

1) ACCESSIBLE: The ability to reach and adjust the aligning feature. Consideration should be given to confined space restrictions, removing guards, bushing plates, hydraulic lines, lubrication lines, electric lines, etc.

2) ALIGNMENT TARGET SPECIFICATIONS: Desired intentional offset and angularity at coupling center to compensate for thermal growth and/or dynamic loads. Most properly specified as an OFFSET, and an angle in two perpendicular planes, horizontal and vertical.

3) ANGULAR ERROR: A misalignment condition characterized by the angular error between the desired centerline and the actual centerline. This misalignment condition may exist in planes both horizontal and vertical to the axis of rotation.

4) ANGULARITY: The angle between the rotational centerlines of two shafts. Angularity is a “slope” expressed in terms of a rise (millimeters or thousandths of an inch) over a run (meter or inches).

5) AXIAL PLAY, AXIAL FLOAT, END FLOAT: Shaft axial movement along its centerline caused by axial forces, thermal expansion or contraction, and permitted by journal bearings, sleeve bearings and/or looseness.

6) BASE PLATE: The surface, often made of steel plate or cast iron, to which the feet of a pump/motor are attached.

7) Co-linear: Co-linear means two lines that are positioned as if they were one line. Co-linear as used in alignment means two or more centerlines of rotation with no offset or angularity between them. Two or more lines are co-linear when there is no offset or angularity between them (i.e. they follow the same path).

8) COPLANAR: The condition of two or more surfaces having all elements in one plane.

9) COUPLING POINT: The phrase “COUPLING POINT” in the definition of SHAFT ALIGNMENT is an acknowledgment that vibration due to misalignment originates at the point of power transmission, the coupling. The shafts are being aligned and the coupling center is just the measuring point.

10) FLATNESS: The condition of a surface having all elements in one plane.

Note: As used in these specifications, a flat is a small surface flush with or cut into a BASE PLATE, machined flat, and co-planar with the other flats in the base plate. The flats support the shims and/or feet of the machine to be installed. A pad is a small block of metal that serves to elevate the feet of the machine above the surface of the base plate. Pads are commonly used to compensate for differences in machine center line any possible standing fluids. Pads and flats have holes drilled and tapped in their centers to accept hold down bolts.

11) HORIZONTAL: Parallel to the mounting surface.

12) JACKBOLTS, JACKSCREWS, PUSH/PULL BLOCKS: Positioning bolts on the machine base which are located at each foot of the machine and are used to adjust the position of the machines.

13) LASER/TARGET ADAPTER: A laser/target adapter is and adapter which allows the laser/target to be mounted into the spindle or master part.

14) LEVEL: Parallel to a reference plane or a reference line established by a laser.

15) MACHINE: The total entity made up of individual machine components such as motors, pumps, spindles, fixtures, etc. Also reference MACHINE COMPONENT.

16) MACHINE BASE: The structure that supports the machine or machine components under consideration.

17) MACHINE COMPONENT: An individual unit such as a motor, pump, spindle, fixture, etc. often referred to as a machine in its own context.

18) OFFSET: The distance (in thousands of an inch or in millimeters) between two reference centerlines such as a spindle center line and a part characteristic centerline or the rotational centerlines of two parallel shafts.

19) PITCH: An angular misalignment in the vertical plane.

20) POSITION ERROR (CENTERLINE/OFFSET MISALIGNMENT): A misalignment condition that exists when the spindle/shaft centerline is parallel but not in line with (not coincidental) with the desired alignment centerline.

21) PUSH-PULL BLOCKS: Side push-pull adjustment blocks used for aligning machine tool in the horizontal plane.

22) REPEATABILITY: The consistency of readings and results between consecutive sets of measurements.

23) SHAFT ALIGNMENT: Positioning two or more machines components (e.g. a motor driving a centrifugal pump(s). etc.) so that the rotational centerlines of their shafts are co-linear at the coupling center under operating conditions.

24) SPINDLE ALIGNMENT: The geometric relationship between the spindle axis of rotation and a reference datum.

25) SOFT FOOT: A condition that exists when the bottom of all of the feet of the machinery components are not on the same plane (can be compared to a chair with one short leg.) Soft foot is present if the machine frame distorts when a foot bolt is loosened or tightened. It must be corrected before the machine is actually aligned.

PARALLEL SOFT FOOT:	A parallel gap between the machine foot and its support surface.
ANGULAR SOFT FOOT:	An angled gap between the machine foot and its support surface.
INDUCED SOFT FOOT:	A type of soft foot that is caused by external forces, (pipe strain, coupling strain, etc.,) acting on a machine independent of the foot to base plate connection.
“SQUISHY” SOFT FOOT:	A type of soft foot characterized by material, (could be shims, paint, rust, grease, oil, dirt, etc.) acting like a spring between the underside of the machine foot and the base plate contact area.

26) STRESS FREE CONDITION: The condition that exists when there are no forces acting on the structure of a machine, machine component, or machine base that would cause distortion in the structure such as bending, twist, etc.

27) THERMAL EFFECTS (GROWTH OR SHRINKAGE): This term is used to describe displacement of the shaft axis due to machinery temperature changes (or dynamic loading effects) during start-up.

28) TOLERANCE VALUES: Maximum allowable deviation from the desired values, whether such values are zero or non-zero.

29) VERTICAL: Perpendicular to the horizontal plane.

30) YAW MISALIGNMENT: An angular misalignment in the horizontal plane.

END OF SECTION

SECTION 22 05 19

GAGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

This section specifies pressure gages and thermometers for plumbing systems. Gage requirements and locations are indicated on the drawings.

PART 2 PRODUCTS

2.01 SUGGESTED MANUFACTURERS

Gages and thermometers shall be Ashcroft, Marshalltown, Weiss, Trerice, U.S. Gauge, Helicoid, Weksler, or equal.

2.02 PRESSURE GAGES

A. Gages shall be selected so that the normal operating pressures are between 25 and 75 percent of full scale unless noted otherwise on the drawings.

B. Gages for services requiring Class I, II or III cleaning per Section 15215 shall have capillary bleeds for flushing and cleaning.

C. Type PG-1: Industrial quality pressure gauge, pressure ranges up to 1,000 psig, phosphor bronze bourdon tube, brass socket, bottom connection unless noted otherwise, 300 series stainless steel movement, Grade 1A (1%) accuracy per ASME B40.1, adjustable pointer, fiberglass reinforced polypropylene case with solid front and blow out back, shatter proof lens, 4-1/2 inch aluminum dial with white face, black graduations and numerals with 270 degree arc, PSIG/kPa dual scale. Weksler Type BA14-2 or equal.

D. Type PG-2: Process quality pressure gauge, pressure ranges up to 20,000 psig, 316 stainless steel bourdon tube and socket, bottom connection unless noted otherwise, 300 series stainless steel movement, Grade 2A (0.5%) accuracy per ASME B40.1, adjustable pointer, fiberglass reinforced polypropylene case with solid front and blow-out back, shatter proof lens, 4-1/2 inch aluminum dial with white face, black graduations and numerals with 270 degree arc, PSIG/kPa dual scale. Weksler Type AA44-2 or equal.

E. Type PG-3: Same as Type PG-1 except as follows: 316 stainless steel bourdon tube and socket, dual scale of 0-100 psig/0-231 feet of water. Weksler Type BN44-2 or equal.

F. Type PG-4: Same as PG-1 except as follows: 316 stainless steel bourdon tube and socket, liquid-filled case, Grade 2A (0.5%) accuracy per ASME B40.1. Weksler Type AY44-2 or equal. Provide piston type pressure snubber.

G. Type PG-5: Steam Service - Process quality pressure gauge, pressure ranges up to 400 psig, 316 stainless steel bourdon tube and socket, bottom connection unless noted otherwise, 300 series stainless steel movement, Grade 2A (0.5%) accuracy per ASME B40.1, adjustable pointer, aluminum case with solid front and blow-out back, black epoxy finish, shatter proof lens, 4-1/2 inch aluminum dial with white face, black graduations and numerals with 270 degree arc, PSIG/kPa dual scale. Weksler Type AA44-4 or equal. Provide stainless steel siphon tube for steam service.

H. Type PG-6: Differential Pressure Gage, Low Pressure Service – Cast aluminum case and bezel, silicone rubber blowout plug, acrylic lens, o-ring seal, silicone rubber diaphragm, magnetically actuated linkage with jeweled bearings, red tipped pointer, zero adjustment screw, accuracy 2% of full scale, 4 inch white dial with black graduations and numerals, Inches of Water scale, duplicate 1/8 inch female NPT connections on back and side, surface or flush mounting with included hardware. Dwyer Series 2000 Magnehelic or equal.

I. Type PG-7: Steam Service – Pressure range up to 400 psi, cast aluminum case, adjustable pointer (recalibratable), 4 ½” face, black lettering on white dial face, phorphor bronze bourdon tube, brass movement, 1% accuracy over middle half of range, bottom ¼” NPT connection. Specify “For Steam Service”. Trerice Series 600C w/siphon and Series 735 gagecock.

2.03 THERMOMETERS

A. Thermometers shall be selected so that the normal operating temperatures are between 25 and 75 percent of full scale unless noted otherwise on the drawings.

B. Dial Type Thermometers: Bimetallic coil element, minimum 3 inch diameter dial, 1% accuracy, external adjustment, stainless steel case, adjustable angle pivoting dial.

C. Liquid Filled Thermometers: Liquid Filled Thermometers: Industrial type, adjustable angle, aluminum case, plastic or safety glass window, six inch minimum scale length, liquid filled glass, mercury free, bronze or brass sensing element, 1% accuracy.

2.04 GAGE COCKS AND VALVES

A. Gage Cocks: For water and gaseous services in carbon steel or copper piping - Brass body, tee handle, 1/4" FPT connections; suggested make and model as follows:

1. Working pressure up to 125 psig - Weksler Type A10 or equal.

2. Working pressure 125 to 250 psig - Weksler Type A10E, Ernst Gage Co. Figure 123, or equal.

B. Gage Cocks: For steam and steam condensate service.

1. Working pressure up to 75 psig - Brass body, tee handle, 1/4" FPT connections; Weksler Type A-10 or equal.

2. Working pressure 75 to 300 psig - Bronze body, tee handle, 1/4" FPT connections; Ernst Gage Co. Figure 3 or equal.

C. Gage Valves: For gaseous services in stainless steel pipe or tubing - Stainless steel needle valve, 1/4" FPT connections, Type NV-2 (up to 3000 psig) or Type NV-3 (3000 to 5000 psig) per Section 22 05 23, "GENERAL –DUTY VALVES FOR PLUMBING PIPING."

D. Trumpet Valves: Brass manifold with push-button valves for multiple point pressure readings with a single gage (number of connections per drawing); complete with spring-return push-buttons, 1/4" o.d. compression connections, mounting bracket, and gage equal to Type PG-3 (unless otherwise noted); 200 psig working pressure; Flow Conditioning Corp. TV Series or equal.

2.05 SIPHON TUBES

Brass or black iron, 1/4" MPT ends, minimum rating of 250 psig at 400°F; Weksler type A03B or A03I, Ernst Gage figure 750, or equal.

2.06 THERMOWELLS

Separable well, nonferrous, sized to accommodate thermal sensing element; Weksler, Trerice, Ernst Gage, or equal.

PART 3 EXECUTION

3.01 Install all gages and thermometers where they are readily accessible for reading and maintenance.

3.02 Provide gage cocks or needle valves for all pressure gages. In addition, provide siphon tubes for all steam pressure gages.

3.03 Provide thermowells for all thermometers.

3.04 On insulated piping, provide lagging extensions or other stand-off fittings for all gages and thermometers.

END OF SECTION

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies valves for plumbing, air and gas piping systems.

B. Metal Tags - all piping equipment, control valves, header branch valves & accessories shall be provided with a 2" dia, brass or aluminum, ID tag indicating the equipment designation number, function of the control, etc. (This must match the drawing or control diagram designations). Also include project drawing number. Tags shall be wired to valve or equipment w/#12 AWG (0.0808 inch dia.) galvanized wire. All information is to be stamped.

PART 2 PRODUCTS

2.01 GENERAL VALVE SELECTION CRITERIA

A. Valve patterns for each installation shall be as indicated symbolically on the drawings (i.e. ball valve, gate valve, etc.).

B. Valves shall be selected from the tables in paragraph 2.02 unless the drawings indicate a specific type designation, or a valve is specified by manufacturer and model number.

C. The working pressure ratings for valves submitted may differ from those specified herein, provided they are adequate for the actual system operating pressures and temperatures.

D. Flow factors and orifice sizes specified are minimums, unless otherwise noted on the drawings.

E. Valves shall be full line size, except where a smaller valve equals or exceeds the flow capacity required herein.

2.02 VALVE TYPE SELECTIONS

A. WATER SERVICE - POTABLE, AND INDUSTRIAL WATER UP TO 150 PSIG.

		VALVE TYPE DESIGNATIONS							
LINE SIZE	LOCATION	GATE	GLOBE	CHECK	BALL	BUTTERFLY	NEEDLE	SOLENOID	RELIEF
UP TO 2"	BELOW GRADE	GTV-1							
	ABOVE GRADE	GTV-2	GLV-1**	CHV-1	BLV-1, BLV-2	BFV-1	NV-1*	SOV-1	SRV-1
2 1/2" AND LARGER	BELOW GRADE	GTV-1				BFV-3			
	ABOVE GRADE	GTV-3	GLV-2	CHV-2	BLV-3, BLV-4	BFV-2			SRV-1

* AVAILABLE UP TO 3/4" NPT ONLY. ** "SEE 2.04A FOR HOSE BIBB SPECIFICATIONS"

B. STEAM AND STEAM CONDENSATE (VALVES MUST HAVE ID TAG & PSI RATING ON VALVE BOX COVER)

			VALVE TYPE DESIGNATIONS							
MEDIUM	MAX. PSIG	LINE SIZE	GATE	GLOBE	CHECK	BALL	BUTTERFLY	NEEDLE	SOLENOID	RELIEF
STEAM ***	125	UP TO 2"	GTV-2**	GLV-3	CHV-1	BLV-1, BLV-2		NV-1*	SOV-2	
		2 1/2" AND LARGER	GTV-3**	GLV-2	CHV-2	BLV-3, BLV-4	BFV-4			SRV-2
	150	UP TO 2"	GTV-4**	GLV-3	CHV-3	BLV-1, BLV-2		NV-1*	SOV-3	
		2 1/2" AND LARGER	GTV-5**	GLV-4	CHV-4	BLV-3	BFV-4			
	250	UP TO 2"	GTV-6**	GLV-5	CHV-5	BLV-5, BLV-6		NV-1*	SOV-4	
		2 1/2" TO 12"	GTV-5**	GLV-4	CHV-4	BLV-7, BLV-8	BFV-5			
STEAM COND.	125	UP TO 2"	GTV-2**	GLV-1	CHV-1	BLV-1, BLV-2		NV-1*	SOV-2	
		2 1/2" AND LARGER	GTV-3**	GLV-2	CHV-2	BLV-3, BLV-4				

* AVAILABLE UP TO 3/4" NPT ONLY
** MAY BE USED FOR STEAM WHERE POSITIVE SHUTOFF IS NOT REQ'D IF POSITIVE SHUT OFF IS REQ'D EQUIPMENT VALUE IS TO BE CAST STEEL CONSTRUCTION
*** IF POSITIVE SHUT-OFF IS REQUIRED, VALVE SHALL BE CARBON STEEL BALL VALVE WITH FULL PORT, 2-PIECE DESIGN, ANSI 300# FLANGE CONNECTIONS, AND STAINLESS STEEL TFE SEATS DESIGNED FOR BUBBLE-TIGHT SHUT-OFF. PBM #ANE L1M H---8- OR APPROVED EQUAL.

C. AIR AND INERT GASES (NITROGEN, HELIUM, ARGON)

			VALVE TYPE DESIGNATIONS					
PIPING MTL	LINE SIZE	MAX PSIG	GLOBE	CHECK	BALL	NEEDLE	SOLENOID	RELIEF
COPPER, TYP L	UP TO 2"	200						
CARBON STEEL PIPE	UP TO 2"	200	GLV-6	CHV-6, CHV-7	BLV-1, BLV-2	NV-1*	SOV-5	SRV-1
	2 1/2" & LARGER	200	GLV-7	CHV-8	BLV-3, BLV-4			SRV-2
STAINLESS STEEL TUBING	UP TO 1/2"	500	GLV-9	CHV-9	BLV-9	NV-2	SOV-6	SRV-3
		1500			BLV-9		SOV-7	
		2000			BLV-10			
		3000			BLV-11		SOV-8	
		5000		CHV-10	BLV-11	NV-3	SOV-9	
	3/4" TO 1"	500	GLV-9	CHV-9	BLV-9	NV-4	SOV-6	
		1500			BLV-9		SOV-7	
		2000			BLV-10			
		3000			BLV-11		SOV-8	
		5000		CHV-11	BLV-11			

* AVAILABLE UP TO 3/4" NPT ONLY

2.03 VALVE TYPE SPECIFICATIONS

A. GATE VALVE

1. TYPE GTV-1: AWWA approved, iron body, bronze mounted, non-rising stem, double disc, parallel seat, 200 psi water working pressure, square operator nut, end connections as required; Stockham G-700 Series or approved equal.

2. TYPE GTV-2: Bronze body, rising stem, Class 125, solid disc, Stockham Fig. B-100 (threaded), Hammond #IB640 (threaded), Stockham Fig. B-108 (soldered), Hammond #IB635 (soldered), or approved equal.

3. TYPE GTV-3: Iron body, bronze mounted, rising stem, Class 125, flanged, solid wedge disc, OS&Y type; Stockham Fig. G-623, Hammond #IR1140, or approved equal.

4. TYPE GTV-4: Bronze body, rising stem, Class 150, solid disc; Stockham Fig. B-120 (threaded), Hammond #IB629 (threaded), Stockham Fig. B-122 (soldered), Hammond #IB641 (soldered), or approved equal.

5. TYPE GTV-5: Iron body, bronze mounted, rising stem, Class 250, flanged, solid wedge disc, OS&Y type; Stockham Fig. F-667, Hammond #IR330, or approved equal.

6. TYPE GTV-6: Bronze body, rising stem, Class 200, threaded, solid disc; Stockham Fig. B-135, or approved equal.

7. Suggested Manufacturers:

   a. GTV-1: Stockham, Mueller, Kennedy, or approved equal.

   b. GTV-2 thru GTV-6: Stockham, Crane, Nibco, Powell, Milwaukee, Hammond, or approved equal.

B. GLOBE VALVES

1. TYPE GLV-1: Bronze body and disc, Class 125; Stockham Fig. B16 (threaded), Hammond #IB440 (threaded), Stockham Fig. B17 (soldered), Hammond #IB418 (soldered), or approved equal.

2. TYPE GLV-2: Iron body, bronze mounted, Class 125, flanged, OS&Y type, renewable seat and disc; Stockham Fig. G-512, Hammond #IR116, or approved equal.

3. TYPE GLV-3: Bronze body, Class 150, threaded, plug type, renewable stainless steel seat and disc; Crane No. 14-1/2 P or approved equal.

4. TYPE GLV-4: Iron body, bronze mounted, Class 250, flanged, OS&Y type, renewable seat and disc; Stockham Fig. F-532, Hammond #IR313, or approved equal.

5. TYPE GLV-5: Bronze body, Class 200, threaded, plug type, renewable stainless steel seat and disc; Stockham Fig. B-62, Hammond #IB434, or approved equal.

6. TYPE GLV-6: Bronze body, Class 125, Teflon disc; Stockham Fig. B13-T (threaded), Fig. B-14T (soldered) or approved equal.

7. TYPE GLV-7: Iron body, bronze mounted, Class 125, flanged, OS&Y type, renewable bronze trim; Stockham Figure G-512, Hammond #IR116, or approved equal.

8. TYPE GLV-8: Not used.

9. TYPE GLV-9: 6000 PSIG working pressure, 300 series stainless steel body and stem, soft seated, Teflon or KEL-F stem tip; NPT, MS, or AN connections; minimum Cv as shown below (unless otherwise indicated); Circle Seal MV60 Series or approved equal.

LINE SIZE	1/8"	1/4"	3/8"	1/2"	3/4"	1"
Min. Cv	0.22	0.34	1.40	1.40	5.00	5.00

10. SUGGESTED MANUFACTURERS:

    a. GLV-1 thru GLV-7: Stockham, Crane, Nibco, Powell, Milwaukee, Hammond, or approved equal.

    b. GLV-9: Circle Seal, Tescom, Whitey, Robbins, Anderson-Greenwood, Teledyne Republic, or approved equal.

C. CHECK VALVES

1. TYPE CHV-1: Bronze body and disc, swing type, Class 125; Stockham Fig. B319 (threaded), Hammond #IB904 (threaded), Stockham Fig. B-309 (soldered), Hammond #IB912 (soldered), or approved equal.

2. TYPE CHV-2: Iron body, bronze mounted, swing type, Class 125, flanged; Stockham Fig. G-931, Hammond #IR1124, or approved equal.

3. TYPE CHV-3: Bronze body and disc, swing type, Y-Pattern, Class 150, threaded; Stockham Fig. B-321, Hammond #IB944, or approved equal.

4. TYPE CHV-4: Iron body, bronze mounted, swing type, Class 250, flanged; Stockham Fig. F947, Hammond #IR322, or approved equal.

5. TYPE CHV-5: Bronze body and disc, swing type, Y-pattern, Class 200, threaded; Stockham Fig. B-345, or approved equal.

6. TYPE CHV-6: Bronze body, swing type, Class 125, BUNA-N disc; Stockham Fig. B-320B (threaded), Fig. B-310B (soldered), or approved equal.

7. TYPE CHV-7: Bronze body, poppet type, minimum 200 PSIG operating pressure,bubble - tight shutoff, elastomer seat, threaded; Apollo 61-500 series, or approved equal.

8. TYPE CHV-8: Iron body, bronze mounted, swing type, Class 125, flanged, iron/vulcanized rubber disc; Stockham Fig. G-932B, or approved equal.

9. TYPE CHV-9: Poppet type, 3000 PSIG operating pressure, bubble - tight shutoff, 316 stainless steel body, Buna-N or Viton O-ring seals; NPT, MS, or AN connections; minimum flow capacities as shown below (unless otherwise noted); Circle Seal 200 Series, NUPRO C and CP Series, Check -All Style TCVF, or approved equal. (Do not submit CHV-9 for pre-approval per Section 01339 paragraph 1.13).

LINE SIZE	1/8"	1/4"	3/8"	1/2"	3/4"	1"
Min. Cv	0.15	0.35	1.20	1.20	4.00	4.50

10. TYPE CHV-10: Same specification as CHV-9 except 5000 PSIG working pressure; Parker Hannifin, Check All Style TCVF, or approved equal.

11. TYPE CHV-11: Same specification as CHV-9 except 5000 PSIG working pressure; Circle Seal H200 Series Check - All Style TCVF, or approved equal.

12. SUGGESTED MANUFACTURERS:

    a. CHV-1 thru CHV-8: Stockham, Crane, Nibco, Powell, Milwaukee, Apollo, Hammond, or approved equal.

    b. CHV-9 thru CHV-11: Circle Seal, Parker, Nupro, Teledyne Republic, Check - All Valves, or approved equal.

D. BALL VALVES

1. TYPE BLV-1: Standard port, bronze body, chromium plated ball, TFE seats, manual lever, minimum 200 psi w.o.g. and 150 PSI w.s.p., threaded or soldered ends; Apollo 70-100 series, Watts B-6000 Series, PBM, or approved equal.

2. TYPE BLV-2: Same specification as BLV-1 except full port; Apollo 77-100 series, Watts B-6080 Series, PBM,or approved equal. Note: Watts valve has a maximum steam pressure of 125 PSIG.

3. TYPE BLV-3: Standard port, cast iron or carbon steel body, reinforced TFE seats and seals, ANSI Class 150 flanged ends, manual lever; Apollo 88-100 Series, Watts CF-1500 Series, PBM, or approved equal.

4. TYPE BLV-4: Full port, cast iron body, reinforced TFE seats and seals, ANSI Class 125 flanged ends, manual lever; Watts G-4000 Series or PBM, approved equal.

5. TYPE BLV-5: Standard port, 250 PSIG steam service, bronze body, 316 stainless steel ball and stem, vented ball, multi-filled Teflon seats, manual lever, threaded ends; Apollo 70-140-64, Watts B-6400-SS-04, PBM, or approved equal.

6. TYPE BLV-6: Same specification as BLV-5 except full port; Watts B-6400-SS-04, or approved equal.

7. TYPE BLV-7: Standard port, 250 PSIG steam service, carbon steel body, 316 stainless steel trim, bronze filled TFE seats, ANSI

Class 300 flanges, manual lever; Velan SB-300 Standard Bore PBM, or approved equal.

8. TYPE BLV-8: Same specification as BLV-7, except full port; Velan SB-300 Full Bore, PBM, or approved equal.

9. TYPE BLV-9: 1500 PSIG w.o.g., 316 stainless steel body and trim, NPT ends, Teflon seats, manual lever; Parker B Series, Whitey 83 Series, or approved equal.

10. TYPE BLV-10: Standard port, 2000 PSIG w.o.g., 316 stainless steel body and trim, NPT ends, reinforced TFE seats and seals, manual lever; Apollo 76-100 Series, Watts S-8000 Series, or approved equal.

11. TYPE BLV-11: 6000 PSIG w.o.g., 316 stainless steel body and trim, NPT ends, KEL-F seats, manual lever; Parker B Series, Whitey 83 Series, or approved equal. Also, HI-GEAR valves, MS series, w/Vespel SP-21 or Delrin guide bushings, US. Paraplate Series MS-KV_ _ P or approved equal.

12. Suggested Manufacturers for BLV-1 through BLV-11: Stockham, Apollo, Watts, Worcester, Velan, Parker, Whitey, or approved equal.

13. TYPE BLV-12: Not used.

14. TYPE BLV-13: 600 PS1G W.O.G., bronze full port ball valve w/ stainless steel ball, stem, & latch lock handle, threaded ends. Typically used as a secondary containment block/release valve. Apollo Series # 77-140-27 or approved equal.

E. BUTTERFLY VALVES

1. Except where otherwise indicated, provide manual detent levers for valves up to 8-inch NPS, and manual gear operators for larger sizes.

2. TYPE BFV-1: 350 PSI w.o.g., 29" Hg vacuum, bronze body, stainless steel disc and stem, Viton seals; Milwaukee "Butterball" Series BB2-100 (threaded), Series BB2-350 (soldered) or approved equal.

3. TYPE BFV-2: 200 PSI CWP, lug or wafer pattern (as noted on drawings), cast iron body, aluminum bronze disc, phenolic-backed elastomer seat; Stockham LG Series or approved equal.

4. TYPE BFV-3: Same as BFV-2, with extension stem to raise actuator to a minimum of twelve inches above grade, unless otherwise indicated.

5. TYPE BFV-4: ANSI Class 150, lug or wafer pattern, nickel aluminum bronze body and disc, monel shaft and thrust bearing, filled TFE seats and seals; Jamesbury Type 815 or approved equal.

6. TYPE BFV-5: Same as BFV-4, except ANSI Class 300; Jamesbury Type 830 or approved equal.

7. Suggested manufacturers: Crane, Stockham, Jamesbury, Keystone, Milwaukee, Grinnell, or approved equal.

F. NEEDLE VALVES

1. TYPE NV-1: Class 200, bronze body, threaded ends, globe pattern; Stockham Fig. B-64 or approved equal.

2. TYPE NV-2: 3000 PSIG, 316 stainless steel body and trim, regulating stem; NPT, MS, or AN connections; flow capacity as shown below (unless otherwise specified); Whitey Forged Body Series and Screwed Body Series or approved equal.

LINE SIZE	1/8"	¼"	3/8"	1/2"
Min. Cv	0.15	0.35	0.70	1.00

3. TYPE NV-3: Same specification as NV-2 except 5000 PSIG working pressure; minimum flow capacity as shown below (unless otherwise indicated); Whitey Union Bonnet Series, Parker V Series, or approved equal.

LINE SIZE	1/8"	1/4"	3/8"	1/2"
Min. Cv	0.35	0.50	1.00	1.20

4. TYPE NV-4: 6000 PSIG, 316 stainless steel body and trim, regulating stem, reinforced TFE packing, flow capacities shown below (unless otherwise specified on the drawings); NPT, MS, or AN connections; Whitey 20 Series, Apollo 60-600 Series, or approved equal.

LINE SIZE	1/8"	1/4"	3/8"	1/2"	3/4"	1"
Min. Cv	0.15	0.30	0.60	1.00	2.00	2.50

5. Suggested manufacturers:

   a. Type NV-1: Stockham, Crane, Milwaukee, or approved equal.

   b. Type NV-2 thru NV-4: Apollo, Parker, Whitey, Teledyne Republic, Robbins, Anderson-Greenwood, Deltrol, or approved equal.

G. SOLENOID VALVES

1. Valve configurations, electrical requirements, and normal position shall be as shown on the drawings.

2. Valves specified by model number below are 2-way valves. 3-way and 4-way valves for the same applications shall meet the same specifications.

3. Unless otherwise indicated, the orifice diameters of all solenoid valves shall equal or exceed the I.D. of the associated pipe or tubing.

4. TYPE SOV-1: 150 PSI w.o.g., slow closing, pilot operated, brass or bronze body, NPT connections, Buna-N disc; ASCO 8221 Series or approved equal.

   Water hammer characteristics of type SOV-1 valves shall meet the requirements of Fluid Controls Institute Standard FCI-82-1, class CC (up to 3/4") or class BB (1" to 2 1/2").

5. TYPE SOV-2: 125 PSI steam working pressure, brass or bronze body, NPT connections, Teflon disc; ASCO Hot Water/Steam Series or approved equal.

6. TYPE SOV-3: Same as SOV-2, except minimum 200 PSI steam working pressure; Atkomatic Series 4000 (up to 1- 1/2"), or approved equal.

7. TYPE SOV-4: 250 PSI steam working pressure, stainless steel body, NPT connections; Atkomatic Series 8000 or approved equal.

8. TYPE SOV-5: 200 PSI w.o.g., brass or bronze body, NPT connections, Viton or Buna-N disc; Atkomatic "Shorty" Series or approved equal.

9. TYPE SOV-6: 500 PSI w.o.g., 300 series stainless steel body and trim; NPT, MS, or AN connections, Viton or Buna-N disc; J.D. Gould Type KS or approved equal.

10. TYPE SOV-7: Same spec as SOV-6, except 1500 PSI w.o.g. rating; Atkomatic "Dymo" Series 15,000 or approved equal.

11. TYPE SOV-8: Same spec as SOV-6, except 3000 PSI w.o.g. rating; Atkomatic "Uramic" Series 30,000 or approved equal.

12. TYPE SOV-9: Same spec as SOV-6, except a minimum 5000 PSI w.o.g. rating; Atkomatic Series 7004 or approved equal.

13. Suggested manufacturers:

    a. SOV-1 thru SOV-9: Asco, Atkomatic, J.D. Gould, Magnatrol, Skinner, Parker, or approved equal.

H. SAFETY/RELIEF VALVES (SRV'S)

1. SRV capacities and set pressures shall be as specified on the drawings.

2. SRV capacities shall be A.S.M.E. National Board certified.

3. SRV's shall provide the specified relief capacity with a maximum overpressure of 10% for steam and inert gases, and 25% for water service.

4. Inlet connection sizes shall be determined by required flow capacity,not by service line size. Discharge piping shall be the full size of the SRV discharge connection, unless the drawings indicate larger.

5. TYPE SRV-1: Water and low-pressure inert gas services.

    a. Body materials - brass, bronze, iron, or carbon steel.

    b. Trim materials - brass, bronze, or stainless steel.

c. Seat materials - Neoprene, Buna-N, Viton, EPR, or Teflon soft seats.

d. Connections - NPT or ANSI 150# flanges.

6. TYPE SRV-2: Steam service

a. Body materials - brass, bronze, iron, or carbon steel.

b. Trim materials - brass, bronze, or stainless steel.

c. Seat materials - nonferrous metal seats or Viton, EPR, Teflon, or KEL-F soft seats.

d. Provide manual lift lever for all steam service SRV's.

e. Connections - NPT or ANSI flanges appropriate for the maximum line pressure.

7. TYPE SRV-3: Air and inert gas services

a. Body materials - 304 or 316 stainless steel.

b. Trim materials - 300 series stainless steel.

c. Seat materials - Buna-N, Neoprene, EPR, or Viton soft seats.

d. Connections - NPT, MS, or AN.

8. Suggested manufacturers:

a. Types SRV-1 and SRV-2: Anderson-Greenwood, Kunkle, Conbraco, Watts, Cash/Acme, Crosby, Spirax/Sarco, Armstrong, or approved equal.

b. Type SRV-3: Anderson - Greenwood, NUPRO, Circle Seal, Teledyne Republic, or approved equal.

2.04 MISCELLANEOUS VALVES AND ACCESSORIES

A. Hose Bibbs: Water service, 125 PSI w.o.g., bronze body, NPT or solder inlet connection, 3/4-inch hose thread outlet; Nibco Figure #46 or approved equal.

B. Valve Boxes: Roadway extension box, cast iron, two- or three-piece, adjustable, with tee handle valve wrench and drop lid with service identification; Kennedy, Mueller, or approved equal.

C. Chainwheel Operators: Cast iron construction, stem- or handwheel-mounted type, with chain guide, galvanized chain, and all required mounting hardware; as manufactured by Babbitt Steam Speciality Company or approved equal.

D. Hammer-Blow Chainwheel Operators: Ductile or malleable iron construction, handwheel-mounted, with sprocket rim, hammer-blow mechanism, chain guide, galvanized steel chain, and all required mounting hardware; as manufactured by Babbitt Steam Speciality Company or approved equal.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Provide valves where indicated on the drawings, and as otherwise required for proper system operation.

B. Provide shut-off valves (Ball, Butterfly, or Gate) in all branch connections to mains, and at each piece of equipment.

C. Install all valves to be accessible for maintenance. Where valves are unavoidably concealed in furred spaces, provide maintenance access panels.

D. Install valves with stems vertical if possible. Otherwise, mount with stems horizontal.

E. Remove internal parts of valves, or otherwise protect them from excessive heat during soldering, unless manufacturer’s literature indicates otherwise.

3.02 SAFETY/RELIEF VALVES (SRV'S)

SRV relief pressure settings shall be certified in one of the following ways.

A. Submit a manufacturer's Factory Test Report verifying factory testing and adjustment.

B. Submit an independent agency's Test Report.

C. Perform a bench test in the presence of the Government Inspector.

1. Use a test media that is identical to the contents of the system where the valve will be installed.

2. Use a calibrated test gage to verify the relief pressure setting.

3. Test and adjust the SRV until it consistently relieves at the indicated pressure +/- 5 percent up to 1000 PSIG, and +/- 1 percent above 1000 PSIG.

4. Submit a Field Test Report signed by the witnessing Government Inspector.

3.03 VALVE ACCESSORIES

A. Provide valve boxes and tee handles for all type GTV-1 gate valves.

1. In paved areas, the top of the valve box shall be flush with the pavement. Repair surrounding pavement to match existing.

2. In unpaved areas, provide a 24 inch square or 24 inch diameter round x 4 inch thick reinforced concrete slab around the top of the valve box. The top of the valve box and slab shall be approximately one inch above finished grade. The slab shall taper down to grade at the edges.

B. Chain Operators

1. Provide chain operators for valves as indicated on the drawings.

2. Provide hammer-blow type chainwheel operators for gate valves.

3. When chainwheels are required for butterfly valves, provide valves with manual gear drive operators instead of detent levers.

4. When chain operators are required for ball valves, provide valves with chain levers and dual pull chains.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

Work specified in this section includes the following:

A. Hangers, supports, supporting elements, and structural attachments for plumbing piping and tubing.

B. Pipe sleeves, seals, and escutcheons.

C. See Section 03 33 00 for plumbing equipment support pads.

PART 2 PRODUCTS

2.01 STANDARDS

A. Type numbers specified below refer to those identified in Manufacturers Standardization Society (MSSP) Standard SP-69.

B. Hangers, supports, and attachments shall be Factory Mutual approved or UL listed.

2.02 HANGERS AND SUPPORTS FOR PIPE AND TUBING

A. Pipe Hangers: Malleable iron or carbon steel, adjustable, Type 1 (Clevis) or Type 6 (Split ring); Anvil Figures 104, 260,and 300, or equal.

B. Vertical pipe supports: Riser clamp, Type 8, black carbon steel; Anvil Figure 261 or equal.

C. Trapeze hangers: For multiple parallel piping - carbon steel channel, properly sized to support the intended load; Anvil Figure 46 or equal.

D. Roller supports: Adjustable, cast iron roll and sockets, steel roll rod, Type 41; Anvil Figures 175 and 177, or equal.

E. Tubing supports: 12 gage steel channel, 1-5/8" square, factory applied finish, with compatible tubing clamps; Unistrut or equal.

F. Tubing cushion: Elastomeric tubing wrap for vibration and temperature isolation, for use with tubing clamps; Unistrut "Unicushion" P-2600 or equal.

G. High-pressure tubing clamps: Interlocking split-block type, aluminum alloy body; as manufactured by the V-G Interlocking Tube Clamp Company or equal.

H. Hydraulic tubing clamps: Galvanized steel clamps with molded resilient elastomer inserts; as manufactured by Hydrazorb, ZSI “Cush-a-Clamp,” Hydro-craft, or equal.

I. Insulation protection shields: Type 40, galvanized carbon steel, minimum 18 gage, minimum 12 inch length, for use with pipe hangers; Anvil Figure 167 or equal.

J. Insulation protection saddles: Type 39A or 39B, steel, minimum 12 inch length, for use on hot pipes with roller supports; Anvil Figures 160 thru 166A, or equal.

K. Pipe & Tubing Roof Mounted Supports: To be "Pipe Pier Pipe Supports" as manufactured by ERICO, Inc.

L. Other types of hangers and supports may be submitted for approval.

2.03 SUPPORTING ELEMENTS

A. Threaded rod: Carbon steel, threaded one end, both ends, or continuous; Anvil Figures 140 and 146 or equal.

B. Turnbuckle: Forged steel, Type 13; Anvil Figure 230 or equal.

C. Clevis: Forged steel, Type 14; Anvil Figure 299 or equal.

D. Angle brackets: Carbon steel, welded construction, type selected according to the supported load; Anvil Figures 194, 195, and 199 or equal.

2.04 STRUCTURAL ATTACHMENTS

A. Welded attachments: Carbon steel, Type 22 (Anvil Figure 66), Type 57 (Anvil Figure 55), or equal.

B. Beam Attachments

1. C-Clamps: For piping 1 1/2" and smaller, black malleable iron body with hardened steel set screw; Type 23, with retaining clip for I-beams or locknut for channel; Anvil Figures 86 and 87 or equal.

2. Beam Clamps: Malleable iron, center loading, Type 21, 28, 29, or 30; Anvil Figures 131, 228, 229, and 292 or equal.

C. Masonry Attachments

1. Concrete inserts: Cast-in-place, single point, carbon steel, Type 18, Anvil Figure 285 or equal.

2. Concrete inserts: Cast-in-place, continuous, carbon steel; Unistrut Series P-3200 or equal.

3. Anchor bolts: Cast-in-place, carbon steel, with steel pipe sleeve; B-Line Figure B3022 or equal.

4. Concrete anchors: For cast concrete; self-drilling, wedge or expansion sleeve type; Phillips "Red-head" or equal.

5. Masonry anchors: For brick and concrete block, full length expansion sleeve type; ITW Ramset "Dynabolt" or equal.

2.05 SUGGESTED MANUFACTURERS

A. Pipe hangers, supports, supporting elements and attachments shall be as manufactured by Anvil, Michigan Hanger Co., Elcen, B-line, Unistrut, or approved equal.

B. Masonry attachments shall be as manufactured by Phillips, ITW Ramset, HILTI, Molly Fastening Systems, Rawl-Plug Co., or approved equal.

2.06 SUPPLEMENTARY STEEL

Supplementary steel for pipe and equipment supports shall be ASTM A36 structural shapes or commercial strut systems (Unistrut or equal).

2.07 VIBRATION ISOLATORS

A. Vibration isolators for mechanical equipment shall be rubber-in-shear or spring type as manufactured by Vibration Mounting and Controls Inc. or equal.

B. Unless otherwise specified, vibration isolators for mechanical equipment shall be selected and provided by the equipment manufacturer for the specific type of installation indicated.

2.08 PIPE SLEEVES AND RELATED PRODUCTS

A. Sleeves for masonry walls and floors: Standard weight PVC or galvanized steel pipe.

B. Escutcheons, interior, up to 4" NPS: One or two-piece, chromed steel, sized to conceal the pipe penetration.

C. Escutcheons, exterior, and interior above 4" NPS: Cast iron, black (interior) or galvanized (exterior) with set screws; Grinnell Figure 395 or equal.

D. Wall sleeve seals: Watertight mechanical compression seal consisting of EPDM rubber links with glass reinforced plastic pressure plates and galvanized steel bolting; MetraFlex “MetraSeal” or equal.

PART 3 EXECUTION

3.01 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping within one foot of each elbow, and at maximum intervals specified below.

1. Steel Pipe

Nominal Pipe Size	Maximum Spacing, Ft.	Hanger rod Diam., In.
1/2	6	3/8
3/4 to1-1/2	8	3/8
2 & 2 -1/2	10	3/8 & 1/2
3	12	1/2
4	14	5/8
6	18	3/4
8	20	7/8
10 & 12	22	7/8

2. Copper Pipe (Water Tube)

Nominal Size, In.	Maximum Spacing, Ft.	Hanger rod Diam., In.
1/2-1	6	3/8
1 1/4-2 1/2	8	3/8
3	10	1/2
4	12	1/2

3. PVC Pipe - Support spacing shall be as shown below. For temperatures other than those listed, use spacing for the next highest listed temperature. Spacing is shown in feet.

FLUID TEMPERATURE, ^{o}F

PIPE SIZE	40	60	80	100	120	140	160
1/2 & 3/4	5.5	5.5	5	4.5	4	3	1.5
1 & 1-1/4	6.5	6	5.5	5.5	4.5	3.5	2
1-1/2 & 2	7	6.5	6	5.5	5	3.5	2
2-1/2 & 3	8	7.5	7	6.5	5.5	4.5	2.5
4	8.5	8	7.5	7	6	4.5	2.5
6	9	8.5	8	7.5	6.5	5	3
8 & 10	10.5	10	9	8.5	7	5.5	3
12	11	10.5	10	9	8	6	3.5

4. HDPE PIPE

a. Support spacing as shown is based on SDR-11 HDPE pipe .

b. Support spacing as shown below is based on 70F ambient & fluid temperature and shall be considered as maximum spacing allowed.

c. For warmer temperatures, refer to www.plasticpipe.org, “HDPE Handbook”.

d. Support spacing below allows 1” sag between supports, at above conditions, per HDPE Handbook calculations.

e. HDPE exposed to sunlight shall be, as a minimum, insulated and wrapped with aluminum reflective tape.

f. Support hanger contact shall not be a “point” contract, but a minimum of 4D long either side of the hanger centerline.

g. If no sag is allowable, place HDPE pipe on cable tray or place HDPE pipe in the “V” of an approximately like-sized angle iron. Secure HDPE to angle iron with plastic wire ties every 12”cc.

D (DIAMETER)	HORIZONTAL SPACING*	HORIZONTAL SPACING**	VERTICAL SPACING**
½”	43 3/4”	24” t	48”
¾”	48 1/2”	26 1/2” t	48”
1”	54 3/4”	30” t	48”
1 1/4”	61 3/4”	34” t	48”
1 1/2”	66”	36 1/4” t	48”
2”	73 3/4”	41”	54”tt
3”	89 1/2”	51”	67”tt
4”	101 1/2”	56”	74”tt

*Calculated from HDPE Handbook
**Recommended in 2006 International Building Code
t Interpolated comparing 2006 IBC to Hdpe Handbook Calcs
tt Interpolated

B. Support piping so that connected equipment does not bear piping loads.

C. Provide additional supports near heavy components (valves, filters, in-line pumps, etc.) to minimize load on pipe.

D. Install hangers to provide minimum 1/2-inch clear space between finished covering and adjacent work.

E. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.

F. Size hangers on insulated piping to accommodate insulation. Use galvanized steel shields to protect the insulation. Where the insulation is soft and will not support the piping without being crushed, install wood blocking or rigid insulation in the shield.

G. Where several pipes can be installed parallel and at the same elevation, trapeze hangers may be used.

H. Where possible, support riser piping independent of connected horizontal piping. In multi-story buildings, support risers at each floor.

I. Hangers for uninsulated copper piping shall be copper plated or plastic coated.

3.02 TUBING SUPPORTS

A. Support stainless steel tubing (except hydraulics) within one foot of bends, elbows, and tees, and at maximum intervals specified below.

Nominal Tube O.D.	Horizontal Tubing Runs	Vertical Tubing Runs
Up to 3/8”	4 Ft	5 Ft
1/2”-3/4”	6 Ft	7 Ft
1”	9 Ft	10 Ft

B. Where multiple tubing runs are supported together on common supports, the spacing shall be as specified for the smallest tubing size supported.

C. “V-G” clamps are required only if specified on the drawings. However, they may be used at the Contractor‘s discretion for supporting all tubing except hydraulics.

D. Support hydraulic tubing with steel strut and hydraulic clamps. Support spacing shall be as follows.

1. Spacing shall not exceed 60 tubing diameters.

2. On straight runs of tubing exceeding 20 feet, vary the spacing between supports by approximately 15% to break up and change vibration frequency.

3. Support tubing as close as possible to each side of bends.

4. Support tubing within one foot of connections to flexible hoses.

5. Support tubing adjacent to all in-line valves.

3.03 CONCRETE INSERTS

Provide a 1-foot (minimum) length of 1/2-inch rebar to anchor each single point insert.

3.04 SUPPLEMENTARY STEEL

Welding of supplementary steel shall be in accordance with the procedures described in AWS D1.1. Welder qualification testing is not required unless noted on the drawings or Schedule of Submittals.

3.05 PIPE SLEEVES

A. Provide sleeves where piping penetrates walls or floors with the following exceptions.

1. Sleeves are not required where penetrations are core drilled through cast concrete.

2. Sleeves are not required for interior partition (frame) walls unless indicated on the drawings to preserve fire rating.

3. Where piping passes through new concrete slab floors, 1/2 inch thick closed cell foam insulation, extending two inches above and below slab, may be used in lieu of a sleeve.

B. Fill voids in pipe sleeves as follows:

1. Interior fire rated walls and floors - provide a fire barrier system per the drawing details and Section 07 84 00, “Firestopping.”

2. Exterior walls above grade - pack with fiberglass insulation and seal ends with a minimum 1/2 inch depth of silicone sealant.

3. Exterior walls below grade - provide a mechanical seal per paragraph 2.08.D.

C. Provide escutcheons where piping penetrates ceilings, walls, or floors into finished areas, or to visible areas of the building exterior.

3.06 MECHANICAL SUPPORT PADS

Concrete support pads for mechanical equipment shall be constructed per Section 03 33 00, ”Cast-In-Place” concrete.”

END OF SECTION

SECTION 22 05 33

ELECTRICAL HEAT TRACING FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SUMMARY

This section of the specification applies to supply and installation of electrical heat tracing system for freeze protection as indicated on the drawing and specified herein.

1.02 REFERENCES

The electrical heat tracing system shall conform to this specification. It shall be manufactured, installed, and tested accordance with the applicable requirements of the latest edition of the following codes and standards:

A. Factory Mutual (FM)
B. Institute of Electrical and Electronics Engineers (IEEE 515)
C. National Electrical Code (NFPA 70)
D. National Electrical Manufacturers Association (NEMA)
E. National Electrical Safety Code (NESC)
F. Underwriters' Laboratories, Inc (UL 746B)
G. American National Standards Institute (ANSI 844 and 202)
H. Occupational Safety and Health Association (OSHA)

1.03 SUBMITTALS

The following shall be submitted along with the electrical heat tracing system as per Schedule of Submittals:

A. Product Data (SD -03)

1. Catalog information for heating cable.
2. Catalog information for control panel.
3. Catalog information for thermostat included in the system.
4. Catalog information for accessories included in the system.

B. Test Report (SD-06)

1 Factory Test Report.
2 Site Acceptance Test Report.

PART 2 PRODUCTS

2.01 SELF-REGULATING HEATING CABLES

A. Self-regulating heating cable shall vary its power output relative to the temperature of the surface of pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.

B. Cable must be of parallel construction so that it can be cut to length without changing its power output per unit length.

C. Long term stability shall be established by the service life performance test per IEEE 515 Std.

D. Self-regulating heating cable shall be designed for a useful life of 20 years or more with “power on” continuously, based on the following useful life criteria:

1. Retention of at least 75 percent of power after 20 years of operation at the maximum continuous exposure (maintain) temperature.
2. Retention of at least 90 percent of rated power after 1000 hours operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 746B.

E. A warranty against manufacturing defect for a period of 10 years shall be available.

F. All cables shall be capable of passing a 2.5 KV dielectric test for one minute after undergoing a 0.5 kg-m impact.

G. The cable shall be capable of maintaining process temperatures up to 150°F while energized, and a continuous exposure to pipeline temperature of 185°F while de-energized.

H. The heating cable assembly shall be a monolithic construction consisting of two parallel 16 AWG or larger nickel-plated copper bus conductors and a semi-conductive PTC polymer heating element. A poly-ethylene dielectric jacket shall be co-extruded over the heating core and be integrally bonded to the heating core.

J. The basic cable will be covered by means of a metallic braid of tinned copper. The braid will provide a nominal coverage of eighty percent (80%) and will exhibit a resistance not exceeding 0.0.0045 ohm/ft.

K. The cable shall be covered with a corrosion resistant over-jacket.

L. For longer circuit lengths and higher heat loss requirements greater than 10 W/ft @ 50°F, the heating cable shall have 14AWG nickel-plated copper bus conductors.

2.02 TERMINATION OF SELF-REGULATING CABLES

A. All connection components used to terminate heating cables, including power connectors, splices, and tees shall be approved for the respective area classification and approved as a system with the particular type heating cable in use.

B. In order to keep connections dry and corrosion resistant, components shall be constructed of non-metallic, electrostatic charge-resistant, glass-filled, engineered polymer enclosure rated NEMA 4X. The components shall be suitable for use with thermal insulation on pipes or vessel up to 4 inches.

C. Terminals shall be spring clamp wire connection type to provide reliable connection, maintenance free operation and ease of re-entry.

D. Heating cable terminations shall use cold-applied materials and shall not require the use of heat gun, torch or hot work permit for installation.

E. Components shall be rated to minimum of -10°F and maximum of 185°F.

2.03 CONTROL PANEL

Unless specified otherwise in the drawing, the control panel for heat tracing cables shall include the following:

A. Thermal magnetic circuit breaker.

B. Ground fault trip (set at 30mA) and alarm.

C. Continuity alarm.

D. Ambient sensing controller.

PART 3 EXECUTION

3.01 The installation of electrical heat tracing system shall be as per the installation standard of the manufacturer of the heat tracing cables, and must comply with the requirements of Article 427 of NFPA 70.

3.02 The cable shall be tested at the factory as per IEE Std 515 prior to shipment. A Factory Test Report shall be furnished for approval as per Schedule of Submittals.

3.03 The installation shall be tested after the installation for acceptance. Site acceptance shall include insulation test of each heating cable using 1000 Volt megger. The megger reading shall be greater than 20 meg-ohms for each heating cable. A Site Acceptance Test Report shall be furnished for approval as per Schedule of Submittals.

END OF SECTION

SECTION 22 05 48

VIBRATION CONTROLS FOR PUMPS AND ROTATING EQUIPMENT

PART 1 GENERAL

1.01 PURPOSE

The purpose of this specification is to:

A. Reduce operating costs at Marshall Space Flight Center by establishing acceptable vibration levels for new and rebuilt pumps and rotating equipment.
B. Improve the life and performance of rotating machines and Equipment purchased by Marshall Space Flight Center.
C. Provide a uniform procedure for evaluating the vibration characteristics of a machine for certification and acceptance.

1.02 SCOPE

This specification establishes:

A. Acceptable limits for vibration levels generated by new and rebuilt pumps and rotating equipment purchased by Marshall Space Flight Center.
B. Measurement procedures—including standardized measurement axis directions and locations, calibration and performance requirements of instrumentation, and procedures for reporting vibration data for machine certification and acceptance.

1.03 INSTRUMENTATION REQUIREMENTS

Vibration measurements shall be made with an FFT analyzer. The type, model, serial numbers(s) and latest certified calibration date of all equipment used in the measurement of vibration levels for machine certification, shall be recorded and made available upon request.

A. The FFT Analyzer shall be capable of a line resolution bandwidth of delta-f = 300 CPM for the frequency range specified for machine certification unless this restriction would result in less than 400 lines of resolution, in which case the requirement defaults to 400 lines of resolution. (Higher resolution may be required to resolve “Side Bands”, or in Band 1 to resolve machine vibration between 0.3X and 0.8X Running Speed.)
B. The Dynamic Range shall be a minimum of 72 dB.
C. The FFT analyzer shall be capable of applying a Hanning window.

D. The FFT analyzer shall be capable of linear non-overlap averaging.
E. The FFT analyzer shall have anti-aliasing filters.

1.04 MEASUREMENT SYSTEM ACCURACY

The measurement system (FFT analyzer, cables, transducer and mounting) used to take vibration measurements for machine certification and acceptance shall have a measurement system Amplitude accuracy over the selected frequency range as follows:

A. For displacement and velocity measurements +/- 10% or +/- 1 dB.
B. For acceleration measurements +/- 20% or +/- 1.5 dB.

1.05 MEASUREMENT SYSTEM CALIBRATION

A. Vibration equipment (transducer, preamplifier, FFT analyzer, recorder and connecting cable) used to take vibration measurements for machine certification and acceptance must be calibrated by a qualified instrumentation laboratory in accordance with Sections 5.1 and 5.2 of ASNSI S2.17-1980 “Technique of Machinery Vibration Measurement” within one (1) year prior to the date of machine certification.
B. Calibration shall be traceable to the National Institute of Standards and Technology (NIST) in accordance with MIL-STD45662 “Military Standard Calibration Systems Requirements” (June 10, 1980) or latest revision.

1.06 VIBRATION TRANSDUCERS

A. An accelerometer shall be used in the collection of data for machine certification and acceptance. The accelerometer must be selected and attached to the machine in such a way that the minimum frequency (F_{min}) and maximum frequency (F_{max}) as specified in Section 3.1 or specified otherwise by the purchaser, are within the useable frequency range of the transducer and can be accurately measured (reference recommendations of pickup manufacturer and /or Section 6.3, ANSI S2.17-1980).
B. The mass of the accelerometer ands its mounting shall have minimal influence on the frequency response of the system over the selected measurement range. (Typical mass of accelerometer and mounting should not exceed 10% of the dynamic mass of the structure upon which the accelerometer is mounted.) Reference Appendix for Dynamic Mass definition and Procedure to Determine Mass Effect.

measurements to velocity or displacement, or for converting velocity measurements to displacement.

1.07 MEASUREMENT LOCATION DOCUMENTATION CONVENTION

EQUIPMENT ID #	COMPONENT	POSITION	ORIENTATION
AHU-001	MTR	O	V

Figure 1.

EQUIPMENT ID # - MAXIMO # or other identifying tag#
COMPONENT ---- MTR – motor
GBX – gearbox
FAN – fan
PMP – pump
Others as required

POSITION – as noted on sketch which is to be attached to the report
ORIENTATION – H – horizontal
V – vertical
A – axial

1.08 TRANSDUCER & MACHINE MOUNTING CONDITIONS

A. VIBRATION TRANSDUCER MOUNTING

At the designated measurement positions, suitable surfaces shall be provided such that the mounted transducer will attach securely.

1. Hand-held pickups are not acceptable for measurement by this specification.
2. For a magnetic based mounted transducer the location on a machine's surface at which vibration measurements are to be taken shall be machined, if necessary, such that the magnet base can be attached firmly without "rocking".
3. For a stud mounted transducer the machine's surface at which vibration measurements are to be taken shall be in accordance with that specified by the transducer manufacturer (torque, grease, etc.) Designated transducer type to be specified by the purchaser.
4. If an adhesive is used to attach either the transducer or a magnetic mounting pad, the upper frequency limit of the transducer shall be reduced by 20% of the manufacturer's stated resonance for "hard" adhesives and 50% of the manufacturer's stated resonance for "soft" adhesives. Transducer manufacturer's specifications should be consulted.

5. The vibration transducer as mounted must be such that the measurement system Amplitude accuracy over the selected frequency range equals or exceeds the requirements specified in Section 1.03.

B. MACHINE MOUNTING

1. Where a machine can be tested as an individual unit (motor, spindle, etc.) the machine must be mounted as specified in Section 3.21
2. Where an individual machine can be tested only as an assembled unit (eg: motor/pump, motor/fan, etc.) the machine mounting conditions shall be as equivalent as possible/feasible to those to be encountered upon installation at the Government's site.

1.09 TECHNICAL REQUIREMENTS

A. VIBRATION MEASUREMENT UNITS

1. Vibration data for machine certification and acceptance shall be expressed in the following measurement units:

TABLE 1 VIBRATION MEASUREMENT UNITS

Frequency	Hertz (cycles/sec) or cycles per minute (CPM)
Rotation Speed	Revolutions/sec (RPS) or revolutions per minute (RPM)

Amplitude	METRIC	ENGLISH
-Displacement (peak-to-peak)*	Micrometers	Inch (also mil in U.S.)**
-Velocity (Peak)*	Millimeter/sec	Inch/sec
-Acceleration (Peak)*	Meter/sec^2	g's

*Can also use Root-Mean-Square (RMS) **1 "Mil" = 0.001 inch

2. The "Peak" and "Peak-to-Peak" Vibration Amplitude Measurements will be a Calculated Peak not a True Peak. The Calculated Peak will be derived form the RMS level based on the following equations:

   Peak (P) = 1.414 x RMS

   Peak-to-Peak (P-to-P) = 2 x (P) = 2 x 1.414 x RMS

3. If a "True Peak" is required, the units of vibration measurement will be designated by the words "True Peak".

B. FREQUENCY BANDS

The frequency range of measurement shall be divided into sub-groups called bands. The F_{min} and F_{max} for each band will be defined in units of frequency or orders of running speed of the machine. (ref.. Figure 1)

1. Mandatory Bands – Band 1 shall be (0.3 – 0.8) X Running Order, Band 2 shall be (0.8 – 1.2) X Running Order, Band 3 shall be (1.2 – 3.5) X Running Order.
2. Other Bands – Bands 4 through N shall be defined by the specific equipment application.

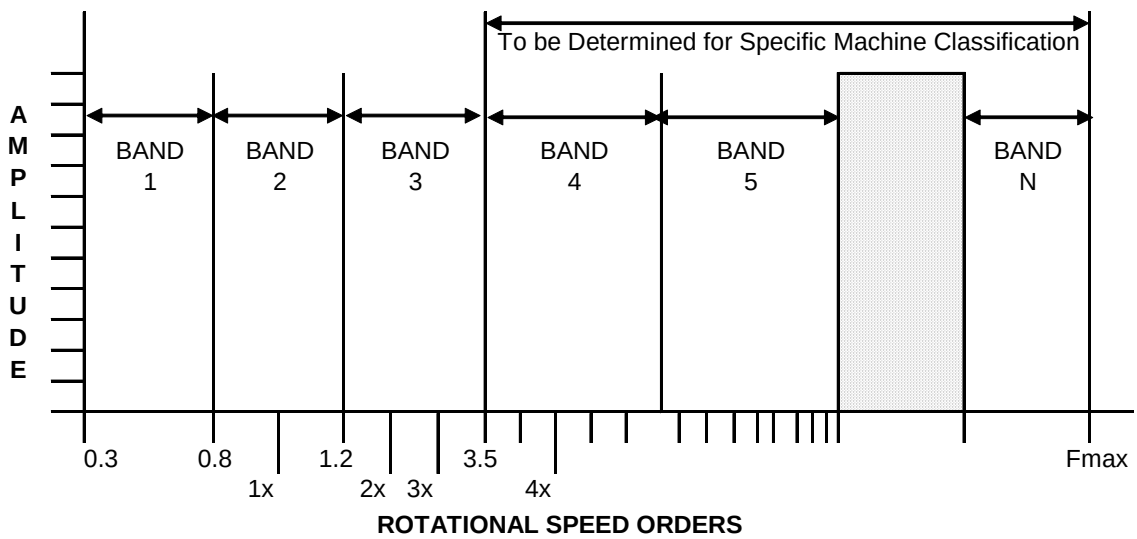


Figure 1 Frequency Bands

C. LINE AMPLITUDE ACCEPTANCE LIMITS

For vibration level limits specified in terms of “LINE AMPLITUDE ACCEPTANCE LIMITS”:

1. A line of resolution will have a band width delta-f = 300 CPM unless specified otherwise (Reference Section 1.09.D.1) requirement for total energy in a peak), or unless the delta-f = 300 CPM restriction would result in less than 400 lines of resolution over the frequency range specified for certification, in which case the resolution requirement will default to 400 lines. (Greater resolution may be required to resolve “Side Bands”, or in Band 1 to

resolve machine vibration between 0.3X and 0.8X Running Speed.)

2. The maximum amplitude of any line of resolution contained within a band shall not exceed the Line Amplitude Acceptance Limit for the Band.

D. BAND-LIMITED OVERALL AMPLITUDE ACCEPTANCE LIMITS

1. For vibration level limits specified in terms of "BAND-LIMITED OVERALL AMPLITUDE ACCEPTANCE LIMITS" the Total vibration level "A" in a band, as defined by the following equation, shall not exceed the Overall Amplitude Acceptance Limit specified for the Band

$$A = \sqrt{\frac{\sum_{i=1}^{N} A_i}{1.5}}$$

sq.root of (sum divided by 1.5)

A = Overall vibration level in the Band

A_i = Amplitude in the ith line of resolution in the Band

(I=1) = The first line of resolution in the Band

(i=N) = The last line of resolution in the Band

N = The number of lines of resolution in the Band. If the total energy in a peak is to be measured, a minimum of 5 lines of resolution must be used and the peak must be centered in the band.

E. If a line of resolution is coincidental with the F_{min}/F_{max} of two adjacent bands, the line of resolution will be included in the band having the lowest acceptance level limit.

F. The amplitude range sensitivity of the FFT Analyzer shall be set to the maximum input sensitivity possible without overloading such that the actual measurement uses at least 60 dB of the Dynamic Range.

G. Certification shall be based on:

1. Hanning Window
2. Four (4) averages (Linear non-overlapping)

H. The transducer mounting shall be such that the measurement system Amplitude accuracy over the selected frequency range equals or exceeds the requirements specified in Section1.03. This may require the use of more than one accelerometer where potentially high frequencies might occur (such as gear

mesh, or harmonics of gear mesh) along with lower frequencies (such as due to unbalance, misalignment, looseness, etc.)

I. ALIGNMENT

1. All coupled rotating machines consisting of consecutive shafts connected through a coupling (whether rigid or flexible) shall be aligned within the tolerances specified in TSRC-8, Section 23 05 00.01 “LASER ALIGNMENT FOR HVAC PUMPS AND ROTATING EQUIPMENT.”
2. Consideration shall be given to any ‘thermal growth” that may occur during the normal operation of the machine the would cause the machine to “grow out of alignment” to the extent that the alignment tolerances of this specification would not be met.

J. BALANCING

1. STANDARD KEY – For rotating machines and machine components with a keyed shaft, balancing will be achieved using a standard one-half key in the key seat in accordance with ISO 8821-1989. If a “full key”, corresponding to the half key used for balancing, is not provided with the rotating machine, a tag will be attached to the machine indicating the dimension of the key used to perform the balance test.
2. The use of solder or similar deposits to achieve rotor balance is not acceptable. Any parent metal removed to achieve dynamic balance or static balance shall be drilled out in a manner which will maintain the structural integrity of the rotor.

1.10 MACHINE QUOTATION, CERTIFICATION, AND ACCEPTANCE

A. SUBMITTALS

1. The submittal shall specify that the equipment meets the applicable vibration limits in Section 3.1 of this Specification or the vibration level limits (if different from Section 23 05 48) as noted on the drawings.
2. The submittal shall indicate the applicable specification vibration level limits being provided.

B. MEASUREMENT REQUIREMENTS FOR MACHINE CERTIFICATION

Vibration measurements shall:

1. Be the responsibility of the supplier unless specified otherwise on the drawings.
2. Be performed by technically qualified person who is trained and experienced in vibration measurement. The technical qualifications of the person doing the vibration certification shall be submitted as a part of the machine vibration certification data.

3. Be taken with the machine operating as specified in Section 3.1 where “no load” is specified, no actual work is taking place during the collection of machine vibration data. Where “rated load” is specified, rated operating load—either actual or simulated—will be applied during collection of machine vibration data.
4. Prior to taking vibration measurements, the machine will be “run in” until it reaches speed and thermal stability.
5. Vibration Signatures as required by Section 3.1 of this specification shall be submitted to the MSFC Maintenance Engineering Department (AS-24) or other authorized representative before acceptance of the machinery or equipment being purchased will be authorized.
6. Vibration data for machine certification shall be measured during “run-off” at the vendor’s facility. Where it is impractical to set-up and test a complete machine at the vendor’s facility, arrangements shall be made to perform the test at the Government’s facility. Under this circumstance, shipment of the equipment does not relieve the vendor of the responsibility for meeting the specified vibration level limits. The Government shall have the option to verify vibration data of equipment during machine “run-off” at the vendor’s test site prior to shipment – or at the Government’s site per Section 1.10.B.6 - prior to final acceptance authorization.
7. The machine layout drawing shall be submitted as part of the Machine Vibration Certification. Vibration measurement locations on the machine’s surface at which vibration measurements are taken shall be designated on the drawing per Section1.07 requirements. At the option of the purchaser, shaft speeds (RPM), gear type and number of teeth, gear mesh frequencies (CPM), bearing manufacturer’s name, bearing type number and class, shall be identified on the machine layout drawing.

C. ACCEPTANCE
Authorization for machine/equipment acceptance based on the vibration limits of this specification requires signature by the Government's authorized representative. A copy of the acceptance must be sent to the purchaser's Purchasing department before final acceptance is authorized.

PART 2 PRODUCTS (none)

PART 3 EXECUTION

3.1 VIBRATION LEVEL LIMITS

A. Electric Motors -- Refer to Section 3.2 "Vibration Standards for Electric Motors"
B. Fans – Refer to Section 3.3 "Vibration Standards for Fans"
C. Pumps – Refer to Section 3.4 "Vibration Standards for Pumps"

3.2 VIBRATION STANDARDS FOR ELECTRIC MOTORS

3.21 ELECTRIC MOTOR REQUIREMENTS

A. Motors will be defined for the purposes of this specification as: "Standard Motor—Utility".
B. The frequency range for motor certification will be F_{min} = 0.3 X Running Speed (synchronous speed) to F_{max} = 120,000 CPM (2000Hertz).
C. Alternating current motors will be tested at rated voltage and frequency, and no load. Single speed alternating current motors will be tested at synchronous speed. A multi-speed alternating current motor will be tested at all its rated synchronous speeds. Direct current motors will be tested at their highest rated speed. Series and universal motors will be tested at operating speed.
D. MOTOR ISOLATION
    1. Place the motor on an elastic mounting so proportioned that the up and down natural frequency shall be at least as low as 25 percent of the test speed of the motor. To accomplish this it is required that the elastic mounting be deflected downwards at least by the amounts shown in the following table due to the weight of the motor. When a flexible pad is used the compression shall in no case

be more than 50 percent of the original thickness of the flexible pad; otherwise the supports may be too stiff.

MOTOR SYNCHRONOUS SPEED (RPM)	ISOLATION PAD COMPRESSION (INCHES)
900	1
1200	9/16
1800	1/4
3600	1/16
7200	1/64

Note: The required deflection is inversely proportional to the speed squared

2. All new and rebuilt motors shall conform to the vibration limits specified in Table 3.2A when tested in accordance with this specification.

E. CRITICAL SPEED

Completely assembled motors shall have a percentage separation between the rotor shaft first actual critical speed and rated motor speed as specified:

ROTOR DESIGN	FIRST ACTUAL CRITICAL SPEED LOCATION
Rigid Shaft	At least 25% Above Rated Motor Speed
Flexible Shaft	Maximum of 85% of Motor Speed

3.22 LIMITS

A. All electric motors defined by NEMA Standard MG-1-1993 Section I “Classification According to Size”, Small (fractional), Medium (integral) and Large Machines, shall meet the following requirements:

1. The Velocity Amplitude (inch/sec-Peak) of any line of resolution, measured at bearing locations in any direction shall not exceed the Line-Amplitude Band Limit values specified in the Table 3.2A and graphed in Figure 3.2 when determined in accordance with Section 1.09.B using the frequency range defined in Section 3.21.B.
2. The Acceleration Overall Amplitude (g’s Peak) at bearing locations in any direction shall not exceed the Band-Limited Overall Amplitude Acceptance Limit values specified in Table 3.2A and graphed in Figure 3.2, when determined in accordance with Section 1.09.B using the frequency range defined in Section 3.21.B.

VELOCITY LINE-AMPLITUDE BAND LIMITS		
BAND	**FREQUENCY RANGE (CPM)**	**STANDARD (INCH/SEC – PEAK)**
1	0.3 x RPM – 0.8 x RPM	0.04
2	0.8 x RPM – 1.2 x RPM	0.075
3	1.2 x RPM – 3.5 x RPM	0.04
4	3.5 x RPM – 8.5 x RPM	0.03
5	8.5 x RPM – 60,000 CPM	0.03
6	60,000 CPM – 120,000 CPM	0.03

ACCELERATION BAND-LIMITED OVERALL AMPLITUDE LIMITS		
BAND	**FREQUENCY RANGE (CPM)**	**STANDARD (g's peak)**
1	0.3 x RPM – 120,000 CPM	0.5

TABLE 3.2A MAXIMUM ALLOWABLE VIBRATION LEVELS FOR ELECTRIC MOTORS (FRACTIONAL AND INTEGRAL HORSEPOWER AC/DC MOTORS

3.23 ELECTRIC MOTOR CERTIFICATION

A. The amplitude of vibration at bearing locations in any direction (radialand axial shall not exceed the values listed in Table 3.2.A.
B. Vibration signatures of velocity and acceleration, and a listing of the maximum peak velocity in each band for vibration measurements taken at position 1 horizontal, position 2 vertical, and position 3 axial shall be submitted as part of the motor certification. The data shall be identified with the Motor Serial Number, Frame Number, Model Number, Horsepower and Synchronous speed.
C. The motor nameplate shall carry the following designation: "0.075 IN/S MAX VIB 1X"
D. Vibration data and signatures must be submitted with the motor to the MSFC Maintenance Department (AS-24) or other authorized representative before acceptance of the motor will be authorized.
E. Motor not meeting the certification shall be rejected.

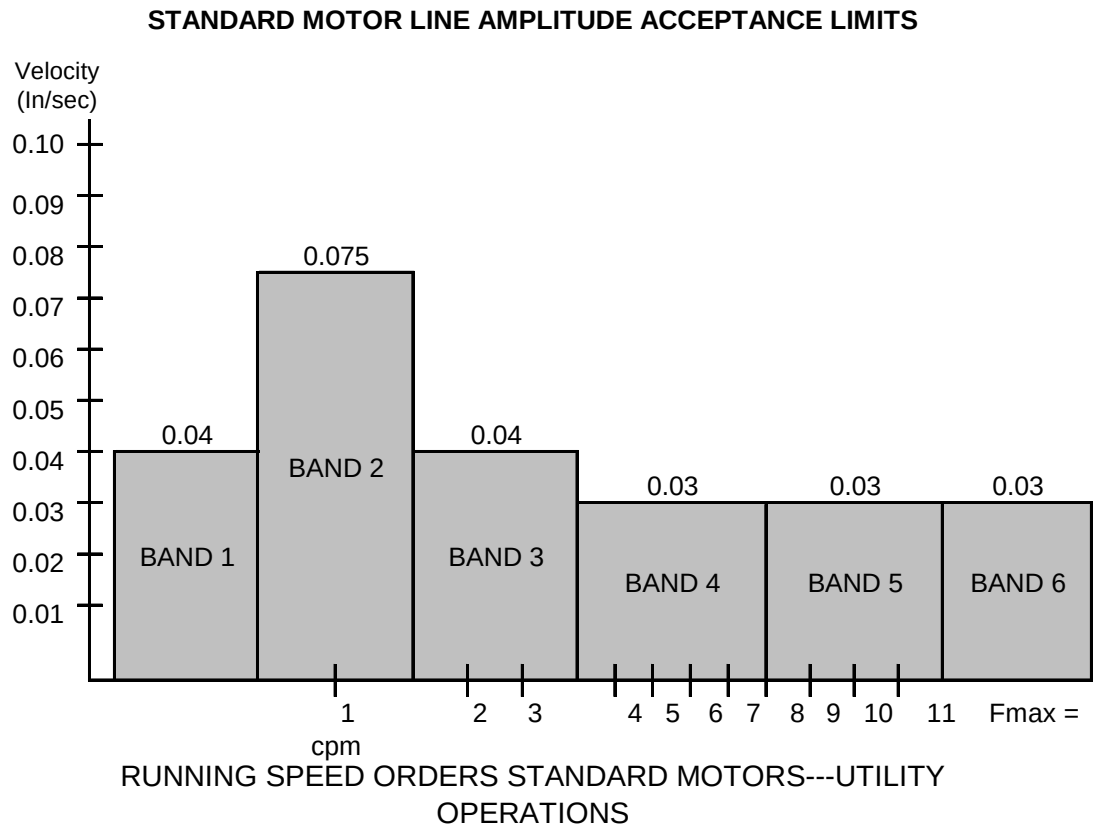


Figure 3.2 Maximum Allowable Vibration Limits for Standard Electrical Motors

3.3 VIBRATION STANDARDS FOR FANS

3.31 Fans are defined as:
All non-positive displacement air handling units including Induced Draft (ID) Fans, Forced Draft (FD) Fans, Overhung Fans, Centerhung Fans, Vaneaxial, Tubeaxial, Blowers, etc.

3.32 BALANCING

A. Permanently attached balancing weights must be secured by welding, bolting, pop-riveting, or of a “clip-on” design.
   1. If bolted, a hardened bolt must be in conjunction with a mechanical locking device (ie. lock washer or lock nut).
   2. “Clip-on” balancing weights can only be used on centrifugal type fans and must be located and attached on the ID pitch of the blades such that the rotation motion of the fan creates a positive seating of the “clip-on” weight against the fan blade.
   3. Balancing weights and methods of attachment must be stable at fan operating temperature, and of a material compatible with the parent material of the fan to which

the balancing weight is attached. The use of stick-on lead weights is not acceptable.

B. Any parent metal removed to achieve dynamic or static balance shall be drilled out in a manner which will maintain the structural integrity of the rotor or sheave.
C. Access to the fan rotor for field balancing shall be designed into the system.
D. It is recommended that components (rotors, shafts sheaves) be balanced individually and then trim balanced as a total assembly.

3.33 SHAFT TOLERANCE

Fan shaft diameter shall meet bearing manufacturer specifications for shaft tolerances.

3.34 RESONANCE

Natural frequencies of the completely assembled fan unit shall not be excited at the operating speed. (Running speed should be at least 25% removed from a natural
frequency for the system.)

3.35 LIMITS

A. New and Rebuilt/Repaired Fans shall conform to the vibration limits specified in Table 3.3A when operating at specified system CFM and Fan Static Pressure
B. The frequency range for fan certification shall be from F_{min} = 0.3 X Running Speed of Fan to 60,000 cpm for velocity and to 120,000 cpm for acceleration.
C. For fan speeds up to 3600 RPM, the maximum velocity amplitude (inch/sec – Peak) of vibration at bearing locations in any direction shall not exceed the Line Amplitude Band Limit values specified in Table 3.3A and graphed in Figure 3.3.1 when determined in accordance with Section 1.09.B.1 using the frequency range defined in Section 3.35.B.
D. For fan speeds up to 3600 RPM, the Band-Limited Overall vibration level of acceleration (g's Peak) at bearing locations in any direction shall not exceed the Band-Limited Overall Amplitude Acceptance Limit values specified in Table 3.3A and graphed in Figure 3.3.2, when determined in accordance with Section 1.09.B.2 using the frequency range defined in Section 3.35.B.
E. Acceptance limits for fans running over 3600 PRM shall be specified by the purchaser.

TABLE 3.3A MAXIMUM ALLOWABLE VIBRATION LEVEL FOR FANS

BAND	FREQUENCY RANGE	VELOCITY LINE AMPLITUDE BAND LIMITS (INCHES/SEC PEAK)
1	0.3 x RPM_{min} 0.8 x RPM_{fan}	0.04 DIRECT COUPLED 0.075 BELT DRIVE
2	0.8 X RPM_{fan} 1.2 x $RPM_{fan/motor}$	0.075
3	1.2 x $RPM_{fan/motor}$ 3.5 x $RPM_{fan/motor}$	0.04
4	3.5 x RPM $_{fan/motor}$ to F_{max} = 60,000 CPM	0.03
		ACCELERATION BAND LIMITED OVERALL AMPLITUDE LIMITS (g's PEAK)
1	0.3 x RPM_{min} to F_{max} = 120,000 CPM	0.5

RPM_{min} = Lowest system speed (e.g. Belt speed if Belt Driven, Fan speed if direct coupled)
$RPM_{fan/motor}$ = Fan or motor speed whichever is greater (IN/SEC)

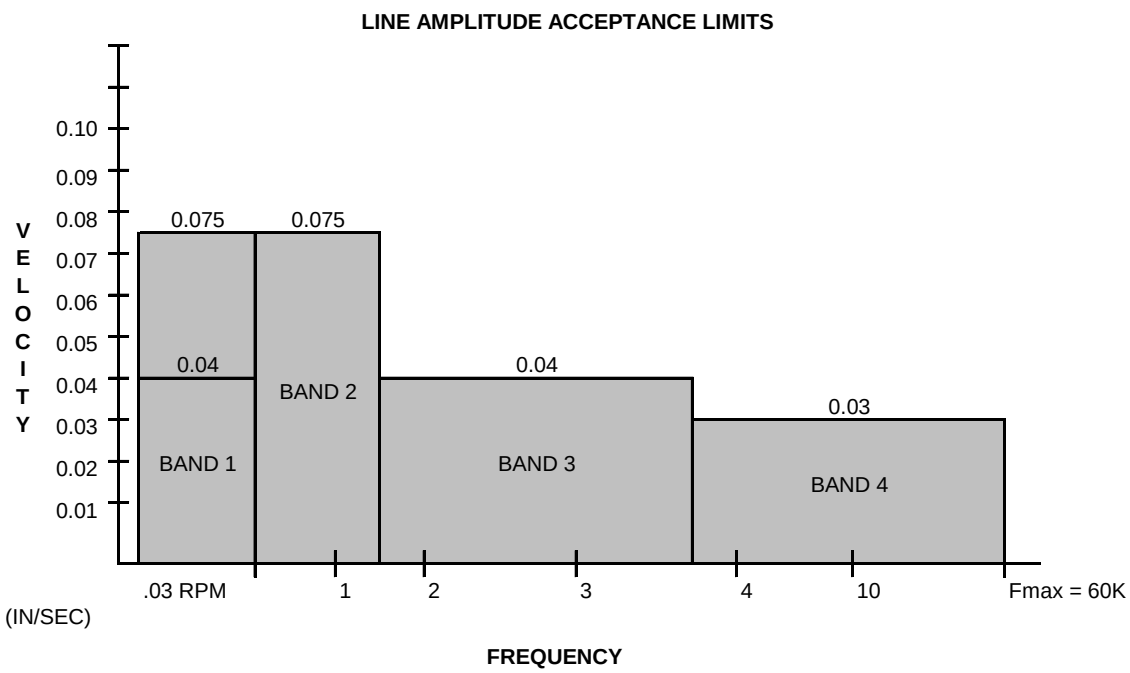


Figure 3.3.1 Line Amplitude Acceptance Limits for Fans

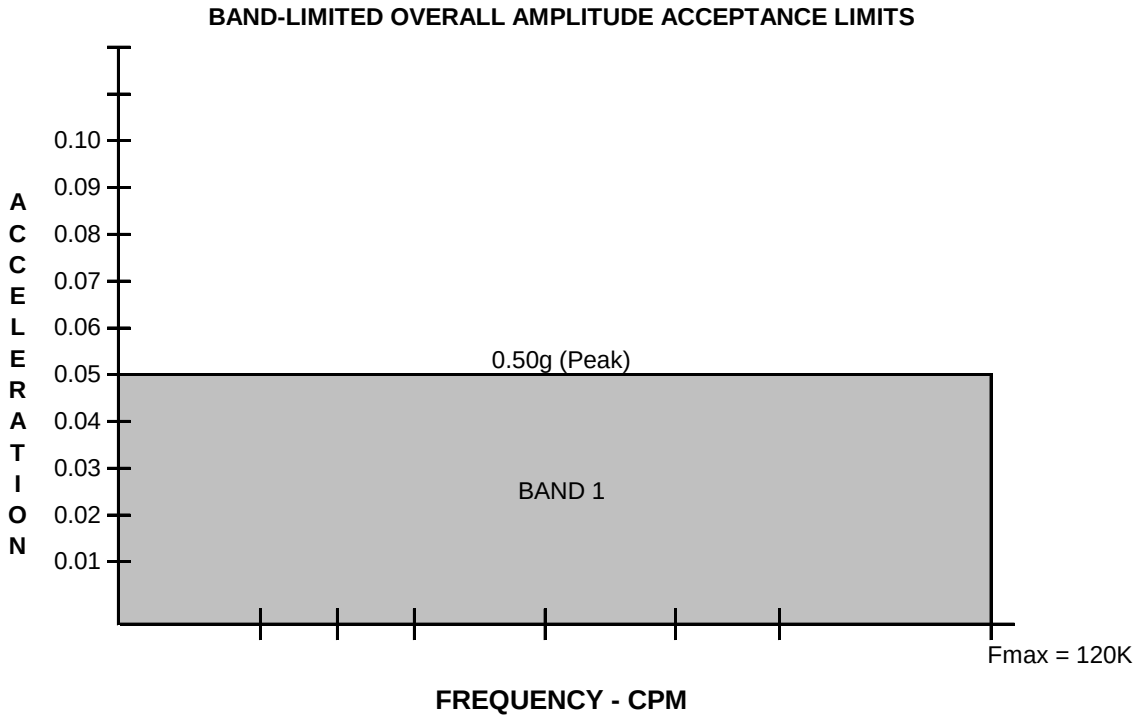


Figure 3.3.2 Band Limited Overall Amplitude Acceptance Limits for Fans

3.36 OTHER REQUIREMENTS

A. Variable speed or adjustable sheaves shall not be used in the final installation.
B. Drive sheave and driven sheave should differ in size by 20% or more to avoid “beat” vibration.

3.4 VIBRATION STANDARDS FOR PUMPS

3.41 Pumps shall be defined in two (2) categories:

A. Positive Displacement – including, but not limited to Piston, Gear, and Vane.
B. Centrifugal.

3.42 OPERATING CONDITIONS

A. Non-cavitating non-separating condition.
B. No piping strain.
C. Shaft coupling aligned
D. Straight suction pipe to pump. (Ref. Hydraulic Institute Standard)
E. Certification shall be performed while pumps are operating within design specifications.

3.43 LIMITS FOR POSITIVE DISPLACEMENT & CENTRIFUGAL PUMPS

A. For purposes of Line Amplitude evaluations a “PUMPING FREQUENCY” (PF) band will be established. The PF Band will be centered on the Pumping Frequency (Number of pumping elements X Pump RPM). The band width will extend + 2 lines of resolution on either side of the line of resolution containing the Pumping Frequency. (ie. Bandwidth = 5 lines of resolution)

B. Excluding the lines of resolution contained in Pumping Frequency (PF) Band, the Velocity Amplitude (Inch/sec-Peak) of any line of resolution, measured at bearing locations in any direction shall not exceed the Line-Amplitude Band Limit values specified in Table 3.4A and graphed in Figure 3.4.1, when determined in accordance with Section 1.09.B.1 using the frequency range from 0.3 X Running Speed (pump RPM) to F_{max} = 120,000 CPM (2000 Hertz).

C. The Velocity Band-Limited Overall Amplitude (Inch/sec-Peak) at bearing locations in any direction shall not exceed the Pumping Frequency Band Limited Overall Amplitude Acceptance Limit value specified in Table 3.4A and graphed in Figure 3.4.1 when determined in accordance with Section 1.09.B.2 using the frequency range from 0.8 X PF to 1.2 X PF.

D. The Acceleration Band-Limited Overall Amplitude (g’s Peak) at bearing locations in any direction shall not exceed the Band-Limited Overall Amplitude Acceptance Limit values specified in Table 3.4A and graphed in Figure 3.4.2 when determined in accordance with Section 1.09.B.2 using the frequency range from 0.3 X Running Speed to 300,000 CPM.

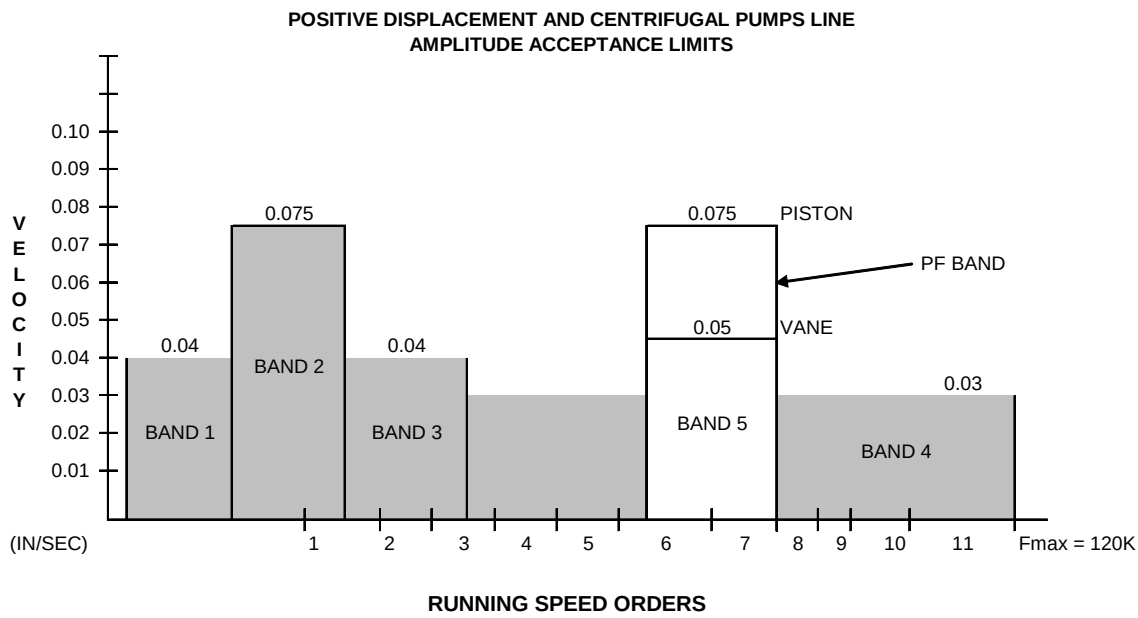
TABLE 3.4A MAXIMUM ALLOWABLE VIBRATION LEVELS FOR POSITIVE DISPLACEMENT AND CENTRIFUGAL PUMPS

BAND	FREQUENCY RANGE (CPM)	VELOCITY (INCH/SEC – PEAK)
1	0.3 x RPM 0.8 x RPM	0.04
2	0.8 x RPM 1.2 x RPM	0.075
3	1.2 x RPM 3.5 x RPM	0.04
4	3.5 x RPM 120,000 CPM	0.03

BAND-LIMITED OVERALL AMPLITUDE LIMITS

BAND	FREQUENCY RANGE (CPM)	ACCELERATION (g's PEAK
1	0.3 x RPM – 300K CPM	1.5g – POSITIVE DESPLACEMENT 1.0g – NON-POSITIVE DISPLACEMENT

PUMPING FREQUENCY BAND (PF)	**FREQUENCY RANGE (CPM)**	**VELOCITY (INCH/SEC – PEAK)**
BAND 5	5 Lines of resolution centered on PF	0.075 PISTON 0.05 VANE



NOTE: BAND 5 IS A FLOATING BAND BANDWITH OF THE PUMPING FREQUENCY ± 2 LINES OF RESOLUTION ACCEPTANCE LIMITS FOR BAND 5 ARE LINE AMPLITUDE VIBRATION LEVELS.

Figure 3.4.1 Line Amplitude Acceptance Limits for Positive Displacement and Centrifugal Pumps

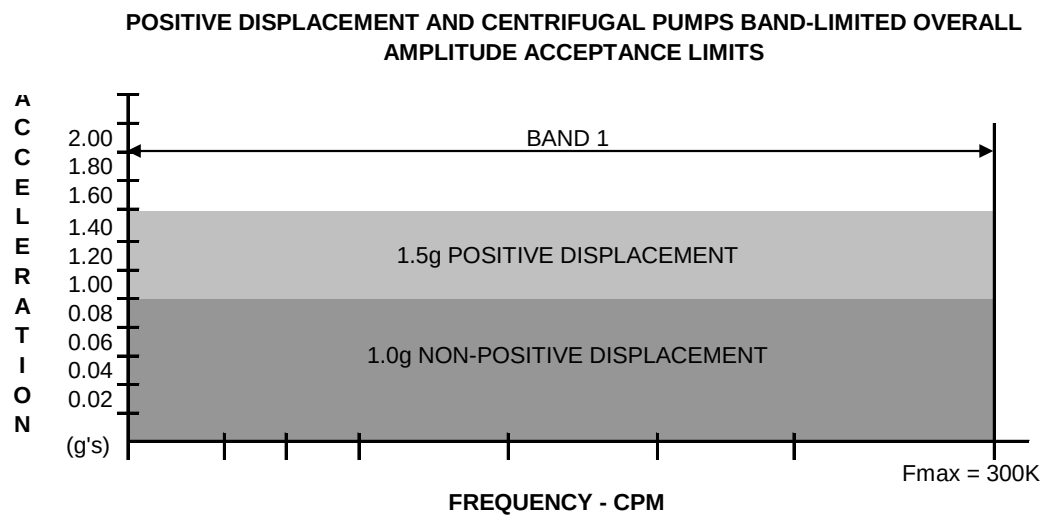


Figure 3.4.2 Band-Limited Overall Amplitude Acceptance Limits for Positive Displacement and Centrifugal Pumps

3.44 VERTICAL MOUNTED PUMPS

A. Vertically mounted pumping systems with a “Vertical Mount Height” greater than 5 feet will have an allowable increase in Velocity Amplitude Acceptance Limit in Bands 1, 2, and 3 of 5% per foot of “Vertical Mount Height” greater than 5 feet. (e.g. A 7 foot Vertical Mount Height would yield a 10% increase [7ft - 5ft) x 5%/ft] in the Table 3.4A Velocity Amplitude Acceptance Limits

specified for Bands 1, 2, and 3. Therefore the limit for Band 1 would be (0.4 Inch/sec + (0.4 Inch/sec x 0.1)] = 0.44 Inch/sec-Peak.

B. Vertical Mount Height is defined as the furthest measurable distance for the machine mounting to the end of the driver or the end of the pump, which ever is greater.

GLOSSARY

ACCELERATION – The time rate of change of velocity. Typical units are ft/sec^2 and g's (1 g = 32.17 ft/sec^2 = 386 in/sec^2 = 9.81 meter/sec^2). Acceleration measurements are made with accelerometers.

Note: By international agreement, the value of 9.80665 m/s^2 = 980,665 cm/s^2 = 386.089 in/s^2 = 32.174 ft/s^2 has been chosen as the standard acceleration due to gravity (g). ISO 2041 (1990)

ACCELEROMETER - Transducer whose output is directly proportional to acceleration. Most commonly used are mass loaded piezoelectric crystals to produce an output proportional to acceleration.

AMPLITUDE – The measure of severity of vibration. Amplitude is expressed in terms of peak-to-peak, zero-to-peak (peak), or rms. For pure sine waves only:

- Peak (P) = 1.414 x RMS
- Peak-to-Peak = 2 x Zero-to-Peak (Peak)

ANTI-ALIASING FILTER – A low-pass filter designed to filter out frequencies higher than ½ the sample rate in order to prevent aliasing.

ANTI-FRICTION BEARING – See ROLLING ELEMENT BEARING.

AVERAGE – The sum of the values of the measurements taken divided by the number of measurements taken.

BALANCE – When the mass centerline and rotational centerline of a rotor are coincident.

BALANCING – A procedure for adjusting the radial mass distribution of a rotor by adding or removing weight, so that the mass centerline approaches the rotor geometric centerline achieving less vibration amplitude at rotational speed.

BAND-LIMITED OVERALL AMPLITUDE – For vibration level limits specified in terms of "BAND-LIMITED OVERALL".

BAND LIMITED OVERALL READING – The vibration severity amplitude measured over a frequency range defined by a F_{min} and a F_{max}.

BEATS – Periodic variations in the amplitude of an oscillation resulting from the combination of two oscillations of slightly different frequencies. The beats occur at the difference frequency. ISO 2041 (1990).

BEAT FREQUENCY – The absolute value of the difference in frequency of two oscillations of slightly different frequencies. ISO 2041 (1990)

BLADE PASS FREQUENCY (PUMPING FREQUENCY) – A potential vibration frequency on any bladed machine (turbine, axial compressor, fan, pump, etc.). It is represented by the number of fan blades or pump vanes times shaft rotating frequency.

COMPLETE MACHINE – A complete machine is defined as the entire assembly of components, sub-components, and structure, which is purchased to perform a specific task(s). On a Complete Machine Assembly with all individual components operating in their normal operating condition, mode, and sequence, the Component Vibration Level Limits for the complete machine acceptance are the same as when the component is tested individually.

CRITICAL SPEED – The speed of a rotating system corresponding to a system resonance frequency.

DECIBEL (dB) – A logarithmic representation of amplitude ratio, defined as 20 times the base tem logarithm of the ratio of the measured amplitude to a reference. dBV readings, for example, are referenced to 1 volt rms. dB amplitude scales are required to display the full dynamic range of an $_F$ Analyzer.

DISPLACEMENT – The distance traveled by a vibrating object. For purposes of this document, displacement represents the total distance traveled by a vibrating part or surface from the maximum position of travel in one direction to the maximum position of travel in the opposite direction (Peak–to–Peak) and is measured in the unit mil (1 mil = 0.001 inch).

DYNAMIC RANGE – The difference between the highest measurable signal level and the lowest measurable signal level that is detectable for a give Amplitude Range setting. Dynamic Range is usually expressed in decibels, typically 60 to 90 dB for modern instruments.

DYNAMIC MASS – To determine if the mass of the transducer is effecting the measurement, perform the following steps:

1. Make the desired measurement with the accelerometer.
2. Place a mass equivalent to the mass of the accelerometer adjacent to the measuring accelerometer.
3. Repeat the measurement.
4. Compare data from 1 and 3.
5. If any differences (i.e. shift in frequencies) between 1 and 3 exist, then a less massive transducer should be used in 1.

FFT ANALYZER – Vibration analyzer that uses the Fast Fourier Transform to display vibration frequency components.

FFT (FAST FOURIER TRANSFORM) – A calculation procedure which produces a mathematical relationship between the time domain and the frequency domain resulting

(FRACTIONAL) AND MEDIUM (INTEGRAL) MACHINES. Part 12. Tests and Performance – AC and DC Motors.

TIME DOMAIN - Presentation of a signal whose amplitude is measured on the Y-axis and the time period is measured on the X-axis.

TRANSDUCER (PICKUP) – VIBRATION – A device that converts shock or vibratory motion into an electrical signal that is proportional to a parameter of the vibration measured. Transducer selection is related to the frequencies of vibration which are important to the analysis of the specific machine(s) being evaluated/analyzed.

UNBALANCE – See IMBALANCE

VELOCITY - The time rate of change of displacement with respect to some reference position. For purposes of this document, velocity is measured in the units Inch per second-Peak.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

PART 1. GENERAL

1.01 This section specifies the products and methods for identification of plumbing systems.

1.02 Plumbing identification systems shall be in accordance with ANSI A13.1.

PART 2. PRODUCTS

2.01 All materials used in plumbing identification shall be waterproof and corrosion resistant.

2.02 IDENTIFICATION PRODUCTS

A. Pipe markers - Vinyl, self-adhering; Seton, Emed, or equal.

B. Pipe markers - Snap-on type, preformed, acrylic plastic with clear overlaminate; Seton "Setmark", Emed "Kwik-koil", or equal.

C. Valve tags - Brass or aluminum, 1-1/2 inch minimum diameter, stamped or engraved, attached to the valve with #12 AWG wire (galvanized or stainless steel) or with chain (galvanized or brass).

D. Equipment tags - Engraved laminated plastic, white letters on black, minimum 3 inch x 1 inch tag with 1/4-inch lettering, unless otherwise noted.

E. Equipment Nameplate Data Sheet - To be submitted per Section 01 33 00. Data sheets shall be provided in the following format for each piece of powered equipment and shall contain appropriate data for each item.:

Submittal Information for Every Piece of Operable Equipment					
Contractor		Ref Drawing #			
Work Order #		Equip ID shown on drawing		MAXIMO # (if known)	
Name Plate Data					
Manufacturer		Motor		Max Temp.	
Model #		Drive		Max Pressure	
Serial #		Size		Sheave Size (motor)	
Cat. # / Part #		Motor rpm		Sheave Size (equip.)	
Mfg. Date		Horsepower		Capacity (gpm, cfm, ton, etc.)	
Voltage		Frame		Equipment rpm	
Phase		Duty		Filter Size	
Amps		Service Factor		Filter Qty.	
KVA Rating		NEMA Rating		Belt Size	
Equipment Type (fan, pump, AHU, CRU, etc.)		Motor % Efficiency		Belt Qty.	

F. Underground Warning Tapes:

1. For metallic piping - color coded polyethylene film, 6 inches wide, with legend identifying the utility below; Seton, Emed, or equal.

2. For non-metallic piping - color coded metallic foil tape, 6 inches wide, with legend identifying the utility below; Seton, Emed, or equal.

PART 3. EXECUTION

3.01 PIPING IDENTIFICATION SYSTEMS

A. Identify contents and flow direction of all new piping unless otherwise indicated. Acceptable methods of identification are as follows:

1. Pipe and covering less than 3/4-inch O.D.

   a. Vinyl pipe markers adhered to non-ferrous plates. Suspend the plates from the piping with galvanized or stainless steel wire.

   b. Paint color bands on the pipe. At each band, provide a non-ferrous plate with a stenciled identifying legend. Suspend plate from piping with galvanized or stainless steel wire.

2. Pipe and covering 3/4-inch O.D. and larger.

   a. Snap-on pipe markers.

   b. Vinyl pipe markers secured at each end with pressure sensitive tape wrapped completely around the pipe and overlapped.

   c. Painted color band with stenciled legend.

B. Minimum dimensions of identification markings shall be as follows.

O.D. of Pipe and Covering	Band Length	Letter Height
3/4" to1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2"to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"

C. Color coding of identification markings shall be as follows.

Service	Legend	Band Color	Legend Color
Potable water, cold	Potable Water Domestic Cold Water	Green	White
Potable water, hot	Potable Water, Hot Domestic Hot Water	Yellow	Black
Industrial water	Industrial Water	Green	White
Deionized water	Deionized water	Green	White
Drain	Drain	Green	White
Sanitary sewer	Sanitary Sewer Sanitary Vent	Green	White
Shop air (<100 psi) (100+psi)	Shop Air or Compressed Air	Blue Yellow	White Black
High purity air (<100 psi) (100+psi)	High Purity Air	Blue Yellow	White Black
Breathing air	Breathing Air	Blue	White
Steam	Steam	Yellow	Black
Steam condensate	Steam Condensate Condensate	Yellow	Black

Service	Legend	Band Color	Legend Color
Argon (<100 psi)	Argon	Blue or Grn	White
(100+ psi)		Yellow	Black
Helium (<100 psi)	Helium	Blue or Grn	White
(100+ psi)		Yellow	Black
Hydrogen	Hydrogen or GH2	Yellow	Black
Nitrogen (<100 psi)	Nitrogen or GN2	Blue or Grn	White
(100+ psi)		Yellow	Black
Oxygen	Oxygen	Yellow	Black
Liquid Argon	Liquid Argon	Yellow	Black
Liquid Helium	Liquid Helium	Yellow	Black
Liquid Hydrogen	Liquid Hydrogen or LH2	Yellow	Black
Liquid Nitrogen	Liquid Nitrogen or LN2	Yellow	Black
Liquid Oxygen	Liquid Oxygen or LOX	Yellow	Black
Vacuum	Vacuum	White	Green

D. Pipe identification markings shall be located as follows.

1. Adjacent to each valve or group of valves.

2. At each side of wall or floor penetrations.

3. At each equipment connection.

4. On long piping runs, at 20-foot maximum intervals.

E. Provide flow direction markings at each identification point. In addition, indicate maximum system pressure for all steam, air, and compressed gas piping.

F. Where pipelines are located more than nine feet above floor level, place the lettering below the horizontal centerline of the pipe.

G. Mark piping which presents a bumping or tripping hazard with black and yellow stripes at the point of hazard.

H. Clean and degrease surfaces to receive adhesive markers. Prior to painting on steel pipe, remove rust and provide one coat of primer.

3.02 VALVE AND EQUIPMENT TAGS

Identification requirements and tag numbers for valves and equipment will be indicated on the drawings, if required.

3.03 WARNING TAPE

A. Place warning tape directly above all buried piping. Note that different warning tapes are required for metallic and non-metallic utilities.

B. Burial depth for polyethylene tape shall be approximately one foot below grade.

C. Burial depth for metallic foil tape shall be 4 to 6 inches below grade.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SUMMARY

This section specifies insulation systems for plumbing piping.

PART 2 PRODUCTS

2.01 MATERIAL PROPERTIES AND QUALITY

A. Insulation materials containing asbestos shall not be used.

B. In accordance with Section 01 35 43, contractor shall submit a report for insulating products covered under the EPA regulations for recoverable materials. When such products cannot be provided the contractor shall provide a non-compliance report stating the reason the product cannot be used and the nature of the product to be used. For an all-inclusive list of products and recoverable material contents see the latest EPA web site for Construction products containing recoverable materials.

C. All insulation systems shall be certified in accordance with ASTM E84, and shall have the following surface burning characteristics.

1. Maximum flame spread rating of 25, without evidence of continued progressive combustion.

2. Maximum smoke development rating of 50.

D. Insulation materials and related products shall be as manufactured by Armstrong, Certainteed, Owens-Corning, Knauf, Pabco, Foster Products, or equal.

E. Insulation material “k-values” specified below are given in units of Btu-inch/hr-ft^2-°F, and are rated at 75 degrees F mean temperature unless otherwise noted.

F. All insulation installed interior to the Building, shall be “Greenguard Certified” in addition to meeting, or exceeding, the minimum requirements as stated elsewhere in these specifications.

2.02 PIPING INSULATION

A. Fiberglass: Preformed, with white reinforced kraft and foil general service jacket, maximum k=0.25; Knauf, Certainteed, Owens-Corning (Vapor Wick) or equal.

B. Calcium Silicate: Fiber-reinforced, preformed, maximum k=0.40 at 200 degrees F, color-coded to indicate asbestos-free; Pabco "Super Cal-Temp Gold," Owens-Corning “Kaylo”, or equal.

C. Closed Cell Foam: Flexible foamed elastomer, maximum k=0.27, maximum water vapor transmission rating of .17 perms; Armstrong "AP Armaflex," Rubatex R-180-FS, Normaco “Normagard,” or equal.

D. Cellular Glass: Rigid closed-cell structure, maximum k=0.35, fabricated per ASTM C585; Pittsburgh Corning "Foamglas" or equal.

E. Fitting Covers: Preformed PVC, 10 mil thickness, UV resistant; CEEL-CO 300 Series, Proto “LoSMOKE,” or equal.

F. Weather Jacket: .016-inch-thick aluminum with moisture barrier; Pabco “Surefit” or equal.

G. Direct-Burial Jacketing: Prefabricated laminate, consisting of an asphalt-impregnated fabric and a 1 mil aluminum foil sandwiched between 3 layers of bituminous mastic; with heat sealable edges; Pittsburgh Corning "Pittwrap" or equal.

H. Gypsum Cement: Water-based, for fabrication of cellular glass; U.S. Gypsum Co. "Hydrocal B-11" or equal.

I. Joint Sealant: Non-hardening butyl sealant for cellular glass; Pittsburgh Corning "Pittseal 444" or equal.

J. Adhesive: For closed cell foam, rubber based, UL listed; Armstrong 520 or equal.

K. Finish: For closed cell foam, white vinyl lacquer based; Armstrong "Armaflex Finish" or equal.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Install insulation in accordance with the manufacturer's recommendations.

B. Install insulation to provide the full specified thickness on all surfaces.

C. Surfaces shall be clean, dry, and oil-free before insulation is applied.

D. Insulation shall not be applied to piping, and equipment until all required testing has been completed, and all necessary repairs have been made.

E. Where a vapor barrier jacket is specified, make the vapor barrier continuous. Seal punctures of the barrier with overlapping patches of matching material and adhesive before concealing the insulation.

F. Insulation surface finishes shall be extended to protect all surfaces, ends, and raw edges of insulation.

G. Insulation shall be continuous through wall, floor, or ceiling penetrations unless otherwise noted.

H. Insulation that becomes wet for any reason shall be removed, and new insulation shall be provided at no additional cost to the Government.

I. Unless specific insulation types are noted on the drawings, the Contractor may select insulation type for each service from the schedule in 3.02.N. However, only one type shall be used per service.

J. All new fiberglass and calcium silicate insulation shall be identified as non-asbestos. The identification markings shall be stenciled with black paint on the finished surface, and shall consist of the following:

1. 2"-wide bands at the extremities of the new installation.

2. Arrows indicating the direction of placement

3. The legend "Non-Asbestos" in 1 inch-high letters at each band and at maximum 20-foot intervals.

3.02 PIPING INSULATION

A. Install piping insulation in whole sections where possible. Otherwise, minimize the number of splices.

B. Apply insulation with joints tightly butted.

C. When applying closed cell foam insulation, coat both surfaces of butt ends and longitudinal joints with adhesive, allowing it to become tacky before joining the surfaces together.

D. Seal all joints in cellular glass insulation with joint sealant (low temperature services) or gypsum cement (high temperature services).

E. Secure longitudinal flaps on fiberglass insulation jackets with adhesive or outward clinching staples (adhesive is required for cold services to maintain vapor barrier). Seal butt joints with manufacturer's standard tape strips.

F. Valves and fittings shall be insulated with preformed fittings, mitered sections of pipe insulation, or insulating material built up to the required thickness. On fiberglass insulated fittings, provide PVC fitting covers. On cold service piping, seal fitting covers with a vapor retardant mastic and pressure sensitive tape.

G. Do not insulate pipe unions and steam traps. Insulate valves so as not to interfere with their normal operation.

H. Where insulation terminates, it shall be neatly beveled and finished.

I. Where insulation passes through a pipe hanger and cannot support the piping without being crushed, provide wood blocking or a section of rigid insulation in the hanger.

J. Paint closed cell foam insulation with two coats of the manufacturer's approved finish outdoors as well as indoors where exposed to view in finished areas.

K. Unless as otherwise noted, all above-ground outdoor piping insulation shall be provided with aluminum jackets, secured with aluminum banding or corrosion resistant screws. Place longitudinal

jacket joints near the bottom of the piping. Seal butt laps with silicone sealant. Deburr all exposed jacket edges.

L. When insulation is applied over electrically heat traced piping, label the outer jacket accordingly. Labels shall be electric heating cable manufacturer's standard warning label, or one of the labeling systems specified in Section 22 05 53.

M. Cover all underground piping insulation with direct-burial jacketing. Heat seal longitudinal overlaps. Heat seal butt joints with a 4"-wide strip of the jacketing material.

N. Piping insulation shall be selected from the following schedule, unless otherwise noted.

SERVICE	CLOSED CELL FOAM	FIBERGLASS	CALCIUM SILICATE	CELLULAR GLASS
POTABLE WATER	X	X		
COLD CONDENSATE	X			
INDUSTRIAL WATER				
Indoors	X	X		
Outdoors	X			X
STEAM &CONDENSATE				
Indoors		X	X	X
Outdoors			X	X
CRYO PIPING				
CRYO PipIPINGing	X			
CRYO VENTent PIPINGiping	X	X		

O. Minimum insulation thickness for piping shall be according to the following schedule and notes, unless otherwise indicated.

MINIMUM INSULATION THICKNESS, INCHES

Service	Runouts (2)	Nominal Pipe Size, Inches Up to 1	1-1/4 to 2	2-1/2 to 4	5 & 6	8 & Up
Potable Water: (1)						
Hot	.5	.5	1.0	1.5	1.5	1.5
Cold	.5	.5	.5	.75	.75	.75
Industrial Water (1)	.5	.5	.5	.75	.75	.75
Cold Condensate (3)	.5	.5	.5	-------	-------	-------
Steam:						
Up to 15 PSIG	1.0	1.5	2.0	3.0	3.0	3.0
16 to 58 PSIG	1.5	2.0	2.5	3.0	3.0	3.0
Above 58 PSIG	1.5	2.5	3.0	3.0	3.5	3.5
Steam condensate	1.0	1.0	1.5	2.0	2.0	2.0
CRYO PIPING						
CRYO Piping	1.0	1.5	1.5	2.0	2.0	2.0
CRYO Vent Piping	1.0	1.0	1.5	1.5	1.5	1.5

Schedule Notes:(1) Increase thickness by 1/2 inch for steam condensate and water services outdoors.
(2) Runouts are branch lines, not exceeding 12 feet in length, for individual pieces of equipment.
(3) For cold condensate drains, insulate only the portions of the line that will not drain by gravity.
(4) Insulate hot gas piping only in conditioned spaces.
(5) CRYO Piping to be two layers. Inner layer to be 1” thick. Above numbers represent outer insulation layer thickness.

P. Cryo Piping insulation is to be double layer w/ PVC vapor barrier. PVC vapor barrier is to have sealed overlap butt joints & adhesive/ sealed lap joints (lap is to secured w/ staples & vapor sealed). Inner layer of insulation is to be secured with wire, tape, band, or tie wrap. All materials are to be non-corrosive.

END OF SECTION

SECTION 22 10 00

PLUMBING PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Pumps for Process Pumps, Utility Pumps & Misc. Pumps.

B. Definitions:

1. Capacity: Gallons per minute (GPM) of the fluid pumped.
2. Head: Total dynamic head in feet of the fluid pumped.
3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

1.02 RELATED WORK

A. Section 22 05 00, Common Work Results For Plumbing

B. Section 22 05 00.01, Laser Alignment For Plumbing Pumps & Rotating Equipment

C. Section 22 05 48, Vibrating Controls for Plumbing Pumps & Rotating Equipment

D. Section 22 11 13, Facility Water Distribution Piping

E. Section 22 11 16, Domestic Water Piping

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00, SUBMITTALS.

B. Manufacturer's Literature and Data:

1. Pumps and accessories.
2. Motors and drives.
3. Variable speed motor controllers.

C. Manufacturer's installation, maintenance and operating instructions. Shall include MOD #, Ser. #, & Date Installed.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and show fluid pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.

PART 2 PRODUCTS

2.01 CENTRIFUGAL PUMPS, BRONZE FITTED (WATER)—NORMAL DUTY

In-Line Type, Base Mounted End Suction or Double Suction Type:

A. Casing and Bearing Housing: Close-grained cast iron, ASTM A48.

B. Casing Wear Rings: Bronze.

C. Suction or Discharge 2-1/2 inches and Larger: Plain face flange, 125 psig, ANSI B16.1.

D. Casing Vent: Manual brass cock at high point.

E. Casing Drain and Gage Taps: 1/2-inch plugged connections minimum size.

F. Bearings: Oil lubricated ball or roller type. Provide lip seal and slinger outboard of each bearing. Bearings are to have a B-10 rated life of 250,000hr. Shop drawings/submittal shall bear manufacturer’s certification of bearing life.

G. Impeller: Bronze, ASTM B62, enclosed type, keyed to shaft.

H. Shaft: Steel, AISI Type 1045 or stainless steel.

I. Shaft Seal: Manufacturer's standard mechanical type to suit pressure and temperature and fluid pumped.

J. Shaft Sleeve: Bronze or stainless steel.

K. Motor: Furnish with pump. To be rated NEMA Premium Efficiency.

L. Base Mounted Pumps:

1. Designed for disassembling for service or repair without disturbing the piping or removing the motor.
2. Impeller Wear Rings: Bronze.
3. Shaft Coupling: Non-lubricated steel flexible type or spacer type with coupling guard, ANSI B15.1, bolted to the baseplate. (Woods or Lovejoy couplings are acceptable)
4. Base: Cast iron or fabricated steel for common mounting to a concrete base.
5. Suction Diffuser:

    a. Body: Cast iron with steel inlet vanes and combination diffuser-strainer-orifice cylinder with 3/16-inch diameter openings for pump protection. Provide taps for strainer blowdown and gage connections.

    b. Provide adjustable foot support for suction piping.

    c. Strainer free area: Not less than five times the suction piping.

    d. Provide disposable start-up strainer.

6. Suction Strainer, "Y" Type: Section 22 11 13, FACILITY WATER DISTRIBUTION PIPING..

    a. May be furnished in lieu of a suction diffuser at the Contractor's option. Provide equivalent support of pump suction piping.

M. Variable Speed Pumps:

1. The pumps shall be the type shown on the drawings and specified herein flex coupled to an open drip-proof motor. Provide motors 40 horsepower and larger with thermal overload switches.
2. Variable Speed Motor Controllers: Refer to Section 26 29 23, VARIABLE FREQUENCY MOTOR CONTROLLERS. Furnish controllers with pumps and motors.
3. Pump operation and speed control shall be as shown on the drawings.

2.02 CENTRIFUGAL PUMPS (ie: SPLIT CASE PUMPS)

A. GENERAL

1. REFERENCES

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

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA 11	Load Ratings and Fatigue Life for Roller Bearings
AFBMA 9	Load Ratings and Fatigue Life for Ball Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1 (1998)	Cast Iron Pipe Flanges and Flanged Fittings

HYDRAULIC INSTITUTE (HI)

HI-01	Standards for Centrifugal, Rotary and Reciprocating Pumps

2. SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, “Submittals,” in sufficient detail to show full compliance with the specification:

SD-01 Data

Design Analysis and Calculations shall show NPSH (net positive suction head) calculations for Centrifugal Pumps.

SD-01 Data

Equipment and Performance Data consisting of pump curves (gallons per minute versus total head in feet per rpm) shall be provided for each type Centrifugal Pump.

SD-01 Data

Equipment Foundation Data shall be submitted for Centrifugal Pumps.

SD-04 Drawings

Installation Drawings for Centrifugal Pumps shall be submitted in accordance with Part 3, “Execution,” of this section.

SD-09 Reports

Test Reports for pumps shall be submitted on the following tests:

Hydraulic Tests
Efficiency Tests
Vibration Tests
Output Efficiency
Surface Hardness Tests
Deflection Tests

SD-13 Certificates of Compliance shall be submitted for the following items showing conformance with the referenced standards contained in this section.
- Base-mounted pumps
- Accessories

3. GENERAL REQUIREMENTS

Pumps shall be used for chilled water service (39-55 degrees F water temperature). Pumps shall be bronze fitted Aurora or approved equal.

B. PUMP CONSTRUCTION

B.1 General Pump Requirements

This specification includes design, construction, installation, and performance features of centrifugal water pumps. Pumps provided shall conform to HI-01, and to requirements specified herein.

Pump, frame, motor, and coupling shall be provided as a complete factory assembled unit.

B.2 Pump Capacity

Pump capacity shall be as indicated in the schedules.

B.3 Classification

Class ADS: Axially (horizontally) split-case, single-stage, double-suction, single- or double-volute centrifugal type.

B.4 Casting

Pump castings shall be bronze-fitted seasoned, cast iron with a design working pressure of not less that 185 pounds per square inch gage (psig) at 100 degrees F. Castings shall be single or double volute with flanged piping connections conforming to ASME B16.1, Class 125. The direction of shaft rotation shall be conspicuously indicated. The casting 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. Drain openings in the volute, intake, or other passages capable of retaining trapped water shall be located in the low point of such passages.

B.5 Impellers

Impellers shall be enclosed cast bronze or stainless steel machined and polished. Waterways shall be machine-or hand-finished. Impellers shall meet maximum and minimum diameters requirements.

B.6 Balancing

Pump Impeller assemblies shall be statically and dynamically balanced to within ½ percent of W times R squared, where W equals weight and R equals impeller radius.

Rotating elements shall be dynamically balanced.

B.7 Wearing Rings

Wearing rings shall be dissimilar bronze composition for non-galling service. Wearing rings shall be provided in every

pump case and on all impellers larger than 7 inches in diameter.

B.8 Shaft

Shafts for mechanical seal service shall be solid sleeveless AISI 400 series stainless steel hardened to 425 Brinell in packing area, or sleeved type with AISI 304 and AISI 316 series stainless-steel sleeves hardened to 425 Brinell.

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 2.0 mils under shutoff-head operating conditions. Flow from ¼ inch 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 casting interface with a bronze throttling bushing.

B.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 250 degrees F.

Seal pressure rating shall be suitable for maximum system hydraulic conditions. (Maximum system pressure – 125 psig).

Materials of construction shall include AISI 300 series stainless steel, solid tungsten-carbide rotating-seal face, and Buna-N vinylidene-fluoride-hexafluoropropylene, EPT, or tetrafluoroethylene seals.

Mechanical seals shall not be subjected to hydrostatic test pressures in excess of the manufacturer's recommendations.

Mechanical seals shall be manufacturer's standard for the specified and indicated service. 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 necessary to the function shall be provided.

B.10 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 0.005 inch. 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 a B-10 rated life of not less than 250,000 hours. Shop drawings shall bear manufacturer's certification of bearing life.

Bearings shall be oil lubricated and shall be provided with oil supply reservoirs located at top of bearings.

Bearing housings shall be cast iron, self-aligning on metal-to-metal surfaces and shall totally enclose bearings.

B.11 Flexible Coupling

Pump shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape in shear, or a solid-mass serrated-edge disc 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. Woods or Lovejoy Couplings are acceptable.

B.12 Bedplate

Pump and driver shall be mounted on a common bedplate, hollow cast iron, multi-ribbed for maximum rigidity, with adequate number of grout holes and grout air vents, and with drip rim and drain tapping.

The 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 ¼ inch steel plate, and provided with adequate grout holes, grout air vents, drip rim, and drain tapping. Formed or bent steel bedplates are not acceptable.

B.13 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, when so specified. Motors shall be TEFC construction, suitable for variable speed frequency inverter service, dynamically and statically balanced.

All motors shall be rated NEMA Premium Efficiency.

B.14 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.

Provide six machines screw taps of a diameter not to exceed ½ inch and a depth not to exceed ¾ inch shall be provided for each pump/motor assembly. To be performed in the field at locations as directed by the Contracting Officer. Taps will be used for predictive maintenance vibration monitoring.

Installed vibration levels shall not exceed those specified in Section 22 05 48, "Vibration Standard for Plumbing Pumps and Rotating Equipment."

PART 3 EXECUTION

3.01 INSTALLATION

A. Pumps shall be stored indoors and protected against dust and moisture. Provide expanded foam on the air inlet and outlet parts of the motor and cover pump suction and discharge flanges to prevent entry of foreign matter.

B. Follow manufacturer's written instructions for pump mounting and start-up. Access/ Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

C. Independently support pumps and piping so that the weight of the piping is not supported by the pumps and the weight of the pumps is not supported by the piping. The first 3 hangers for each pipe shall be spring and neoprene type.

D. Sequence of installation for base-mounted pumps:

1. Level and shim the unit base and grout to the concrete pad.

2. Shim the driver and realign the pump and driver. Correct axial, angular or parallel misalignment of the shafts per Section 22 05 00.01, “LASER ALIGNMENT FOR PLUMBING PUMPS AND ROTATING EQUIPMENT.”

3. Connect properly aligned and independently supported piping.

4. Recheck alignment.

E. Provide drains for bases and seals for base mounted pumps, piped to and discharging into floor drains.

3.02 START-UP

A. Verify that the piping system has been flushed, cleaned and filled.

B. Lubricate pumps before start-up.

C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never

start or run the pump in dry condition. Mechanical Seal or Packing Flush Water Lines must be cleaned before pump start-up.

D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

E. Perform field mechanical balancing if necessary to meet specified vibration tolerance.

F. Ensure the disposable strainer is free of debris prior to testing and balancing of the hydronic system.

G. After several days of operation, replace the disposable start-up strainer with a regular strainer in the suction diffuser.

H. Pump and piping flanges shall be aligned so that the connecting bolts will fit freely with no external forces applied to pump or piping.

I. The contractor shall provide laser alignment of the pump and pump motor shafts after setting pump on foundation, grout has been set, foundation bolts have been tightened, and piping connections have been completed. Other methods of pump alignment will not be accepted. The Government reserves the right to verify pump alignment and to require re-alignment where necessary. Laser alignment shall be per Section 22 05 00.01.

END OF SECTION

SECTION 22 11 00

FACILITY WATER DISTRIBUTION

PART 1 GENERAL

1.01 SUMMARY

Work provided under this section includes the following:

A. Hot and Cold Potable Water Piping and Specialties

B. Industrial Water Piping and Specialties

C. Plumbing Access Doors and Specialties

1.02 RELATED SECTIONS

A.	Section 22 05 00	Common Work Results for Plumbing
B.	Section 22 05 23	General-Duty Valves for Plumbing Piping
C.	Section 22 05 29	Hangers and Supports for Plumbing Piping and Equipment
D.	Section 22 05 53	Identification for Plumbing Piping and Equipment
E.	Section 22 07 19	Plumbing Piping Insulation
F.	Section 36 61 13	Underground Hydronic Energy Distribution Piping
G.	Section 31 23 00	Excavation and Fill

1.03 INSPECTION AND ACCEPTANCE

A. All work done under this section shall comply with the International Plumbing Code, International Mechanical Code, and ANSI B31.9 “Building Services Piping.”

B. Work shall not be enclosed, covered, or insulated until it has been inspected, tested, and approved. Any work that is enclosed, covered, or insulated before such inspection and test shall be uncovered and, after it has been inspected and approved, shall be restored to its prior condition at no additional cost to the Government.

C. "The Government Inspector and COTR reserve the right to witness all qualification test. The Contractor shall notify the Government Inspector in advance, and shall not proceed with testing until the witnesses are present or until the right to witness testing has been waived".

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Potable Water Piping

1. Buried, Exterior (more than 5 feet outside building): HDPE Piping Per Specification Section 33 61 13, unless otherwise specified on the drawings. HDPE piping shall be stamped with NSF (National Sanitation Foundation) Standard 61 and ASTM Standard F 1986 ratings for potable water use.

2. Buried, Below Slab (and to 5 feet outside building):

   a. 2" NPS and smaller: Type K soft annealed copper water tube per ASTM B88. Joints and fittings are not permitted below slab.

   b. 2 -1/2" NPS and larger: Type K hard drawn copper tubing per ASTM B88 with wrought copper or cast brass fittings and lead-free tin-silver solder.

3. Above Grade:

   a. Type L hard drawn copper per ASTM B88 with wrought copper or cast brass fittings and lead-free tin-silver solder. Cast brass threaded fittings shall be per ANSI/ASME B16.15. Cast Copper alloy flanges shall be class 150 per ASME B16.24. Pressed joint fittings with factory installed EPDM O-ring shall be wrought copper per ASME B16.22. or cast copper alloy per ASME B16.18.

b. HDPE piping meeting NSF (National Sanitation Foundation) Standard 61 and ASTM Standard F 1986 ratings (Standards Ratings shall be stamped on piping).

c. HDPE piping may be used above ground, inside buildings, but due to toxic fumes, only if run within a fire-rated wall, or if enclosed in a fire-rated conduit.

B. Industrial Water Piping

1. Buried, Exterior and Below Slab: Same as potable water, except NSF Standard 61 stamp not required.

2. Above Grade: Schedule 40 black carbon steel pipe, ASTM A53 Grade B; Class 150 threaded fittings up to 2" NPS; Schedule 40 welded fittings and 150# flanges for 2-1/2" NPS and larger.

C. Coating System for Buried Steel Water Piping: Shall be one of the following.

1. 50 mil coal tar coated wrap, hot applied, with compatible primer, FED SPEC HHT 30a; TC Manufacturing Co. " Tapecoat 20" with "TC Primecoat" primer, or equal.

2. 35 mil cold-applied tape wrap consisting of an abrasion and UV resistant flexible backing and synthetic elastomeric adhesive with integrated primer. Tape shall conform to AWWA C209; Tapecoat H35 Gray, or approved equal.

2.02 PLUMBING SPECIALTIES

A. Backflow Preventers

1. Type BFP-1: Hazardous Cross-Connections - reduced pressure principle, with integral shut-off valves, ball valve test cocks, strainer, and air gap fitting, complying with A.S.S.E. 1013; Watts Regulator Series 909-S with Series 909AG air gap fitting, or equal.

2. Type BFP-2: Low Hazard Connections - double check valve type, with integral shut-off valves, ball valve test cocks, and

strainers, complying with A.S.S.E. 1015; Watts Regulator Series 709 or equal.

3. Type BFP-3: Low Hazard Residential Type - dual check valve, poppet type, union body, complying with A.S.S.E. 1024; Watts Regulator "Dual Check" Series 7 or equal.

4. The following requirements apply to all backflow preventers, unless otherwise noted:

   a. Full line size.

   b. Minimum 150 PSIG working pressure.

   c. No soldered connections.

   d. Bronze, iron, or stainless steel body construction.

   e. IPC listed.

5. Suggested Manufacturers: Watts, BEECO, Hersey, FEBCO, Conbraco, CLA VAL, ITT Lawler, Rain Bird, or equal

B. Dielectric unions and flanges: Watts, EPCO, Harco, or equal.

C. Water Hammer Arrestors: Piston or bellows type, with precharged air or inert gas cushion; approved per A.S.S.E. Standard 1010 and P.D.I. Standard WH-201; Watts, Sioux Chief, Josam, Precision Plumbing Products, or equal.

D. Combination ball valve/union/strainer/balancing valve may be used in lieu of individual components.

E. Strainers: Water service, Y-type, iron body, bronze cap, 20-mesh monel or stainless steel screen with free area equal to five times inlet line, Class 125; Watts 77S Series or equal.

F. Manual Balancing Valves: Bronze body, threaded, Class 125, gage ports with integral check valves, and pre-formed insulation kit; Bell & Gossett "Circuit Setter" or equal.

G. Automatic Balancing Valves: Piston type, 2-32 psid range unless otherwise noted, factory set for flow indicated on the drawings, with stainless steel or nickel-plated brass internals, NPT connections, and dual P/T ports; Autoflow BR Series, Griswold 3500 and 3600 Series, or equal.

H. Hydronic Flow Metering Stations: Low loss venturi type; steel, iron, or brass body; machined venturi (sheet metal inserts not acceptable); +/- 1% accuracy; 250 psi working pressure; end connections as required; differential pressure sensing ports with valves; Victaulic Style 733, Preso XV Series, or equal. Provide extended dp ports for insulated lines.

I. Automatic Air Vents: Water service, float operated, non-ferrous construction, NPT connections, maximum 150 psig at 240 degrees F; TACO Model 426, Bell & Gossett Model 87, or equal.

J. Pressure and Temperature (P&T) Test Ports: Brass body with dual self-sealing elastomer internal valves, knurled cap, o-ring cap seal, cap retainer, and 1/4" NPT connection. Test ports shall be rated for 500 psig service at 275 degrees F, and shall be designed to receive 0.156-inch O.D. probes. Test ports for insulated piping shall extend beyond insulation; Flow Design Inc. "Super Seal" Models SS25 and SS25L or equal.

K. P&T Test Kit: Compatible with the P&T test ports provided, and consisting of the components specified below.

1. Pressure gage - 3-1/2" dial, aluminum or phenolic case, 0-150 psi range, +/- 3% accuracy.

2. Thermometer - dial type, bimetallic element, 1-3/4" dial, external adjustment, stainless steel case and stem, 25-125°F range
(0-220°F for heating water), +/- 1% accuracy.

3. Adaptor probe for pressure gage, length as required for the P&T ports provided.

4. Silicone lubricant for P&T probes.

5. Form fitting case.

Test kits shall be equal to Flow Systems Inc. Model 300.15.

L. Pump Suction Diffusers: Iron body, permanent and start - up strainers, permanent magnet to capture metallic particles, adjustable pipe support foot, flow straightening vanes, and NPT gage and blowdown ports; connection sizes and types as indicated on the drawings; Bell & Gossett, Armstrong Pump, or equal.

M. Combination Pump Valves: Combination shut - off, flow balancing, and non - slam check valve; iron body, stainless steel stem and spring, soft seated, differential pressure measurement ports; pattern, size, and connection type as indicated on the drawings; Bell & Gossett “Triple Duty” Valve, Armstrong Pump “Flow - Trex” Valve, or equal.

N. Flexible Pump Connectors

1. Type FPC-1: Rubber spool type - reinforced rubber construction, minimum 150 psig working pressure at 180 degrees F, galvanized steel union or flanges ends (or rubber flanges with galvanized back-up rings); sizes, connection types, and tie rod requirements as indicated on the drawings; MetraFlex, M-G Piping Products “C-Flex,” or equal.

2. Type FPC-2: Corrugated metal hose type - bronze hose and braid, Schedule 40 steel NPT or 150# steel flanged ends, 150 psig working pressure; sizes and connection types as indicated on the drawings; MetraFlex, Anaconda Metal Hose, or equal.

2.03 PLUMBING ACCESS DOORS

Plumbing access doors shall be steel, factory primed and ready for painting, with minimum 16 gage door and frame, exposed flush mounting flange, concealed hinge, and screwdriver operated cam latches; Mifab UA Series, Barco Style BAR-100, Karp Model DSC-214M, or equal.

PART 3 EXECUTION

3.01 PIPING

A. General

1. Pipe ends shall be reamed before joint connections are made.

2. Threaded joints shall be made up with tetrafluoroethylene joint compound or tape. Joint compound or tape shall be applied to the male threads only, and care shall be exercised to prevent the compound from reaching the interior of the pipe.

3. Piping inside metal stud walls shall be isolated from the studs with rubber or plastic bushings specifically designed for that purpose.

4. Install piping to pumps and other equipment at full size indicated on drawings with required size changes made at the equipment connections.

5. Provide unions or flanges at equipment and fixture connections to allow servicing and removal of equipment without dismantling piping.

6. Provide dielectric unions or flanges where dissimilar metals subject to galvanic activity are joined together (equipment connections, connections between copper and steel pipe, etc.).

7. Provide a cast-in-place concrete pier under the base of each underground water or sewer riser. Pre-cast blocks are not acceptable.

8. Provide all fittings, drain valves, and bleed valves required for testing of systems. Each system may be tested in sections, or as a whole.

9. Provide utility warning & identification tape in accordance with Section 22 05 53 for all buried piping.

10. Hydrostatically test piping at 1 ½ times maximum operating pressure but not less than 100 psi. Repair leaks and retest until pressure holds for four hours. Conduct tests in the presence of the Government Inspector. Remove or isolate all equipment which could be damaged by the test procedure. Each system may be tested in sections, or as a whole. With Engineering approval, service testing of small sections, or lines that cannot be easily separated from existing piping or equipment may be allowed.

11. The pressure gauge used for hydrostatic testing shall have a range such that the test pressure is between 40 percent and 60 percent of full range. The minimum dial size shall be 4 ½ inches. The full range rotation of the pointer shall be a minimum 270 degree arc. The accuracy of the gauge shall be one percent or better. The gauge shall have been calibrated by an independent lab within six months of the hydrostatic test date. The Government reserves the right to

require recalibration when reasonable doubt of accuracy exists.

12. Route piping approximately as shown on the drawings and as field conditions permit. Install piping so as not to interfere with doors and equipment maintenance access.

13. Install drain and vent connections and suitable valves at all high and low points in hydronic systems to permit rapid filling and draining for maintenance work. Provide a drain at the base of each riser.

14. Remove and repair defects in welded piping in accordance with ANSI B31.9. Drain hydrostatically tested piping with weld leaks to a level below the leak before repairing welds.

15. Use soldering and brazing materials and procedures per ANSI B31.9. Provide composition of filler metal and flux in accordance with the recommendation of the manufacturer for the metals being joined.

16. Flush steam, steam condensate, and hydronic piping systems with potable water to remove dirt and debris prior to making final equipment connections.

B. Potable and Industrial Water Piping

1. Provide cast-in-place concrete piers under buried valves to prevent shear loading of connected piping.

2. Pre-cast concrete piers and thrust blocks are not acceptable.

3. Provide a protective coating system per paragraph 2.01.C for copper pipe in contact with soil. Apply the coating system in accordance with the manufacturer's instructions. Coating shall be continuous and uniform, and shall extend a minimum of 6 inches above grade.

4. Install piping to allow complete draining of systems. Provide drain valves at all low point where fixtures cannot be used to drain piping.

5. Provide shut-off valves in water systems at each branch from mains, and at each fixture or equipment connection. Provide access doors as required for maintenance access to concealed valves.

6. Flush industrial water piping to remove dirt and debris prior to putting into service.

7. Sterilize potable water piping as follows:

   a. Flush thoroughly with potable water until all visible grease, dirt and other contaminants are removed and drain system completely.

   b. Fill new piping with a solution containing 200 ppm (minimum) of available chlorine. Allow to stand for three hours.

   c. Flush system thoroughly with potable water to remove chlorine to less than 4 PPM of available chlorine and obtain test sample per item 10 below. Contractor shall be responsible for approved disposal of contaminated flush water.

   d. Sterilization shall be witnessed by the Government Inspector.

   e. In cases where it is impractical to sterilize entire systems in order to sterilize new, relatively small components or pipe sections, hand cleaning and wiping new parts/components with a chlorine solution is permissible with Engineering approval.

8. Water samples from new potable water piping shall be sent to an independent testing agency for bacteriological evaluation. If samples are found to contain E. Coli or Coliform bacteria, piping shall be re-sterilized and re-tested.

9 . New potable water piping shall not be placed into service until laboratory test reports have been submitted and approved.

D. DEIONIZED WATER

1. Piping to be HDPE as described in Section 36 61 13.

2. Pipe support spacing to be as per manufacturers recommendations for the various sizes.

3. Piping to be tested, cleaned, & sterilized same as "Potable Water", this section.

3.02 PLUMBING SPECIALTIES

A. Backflow Preventers:

1. Provide backflow preventers where potable water is cross-connected with non-potable services, where the potential for back-siphonage of contaminants exists, and as otherwise indicated on the drawings.

2. Install backflow preventers where they are readily accessible for testing and maintenance. Provide access doors as required.

3. Reduced pressure principle backflow preventers shall not be installed in pits or boxes below grade.

B. Water Hammer Arrestors

1. Provide a water hammer arrestor in the hot and cold water supplies for each fixture group, and as otherwise indicated.

2. The capacity of each arrestor shall meet or exceed the total fixture units of the fixture group served.

3. All water hammer arrestors shall be accessible for inspection and replacement. Provide access doors as required.

3.03 FACILITIES WATER DISTRIBUTION SPECIALTIES

A. Provide Facilities Water Distribution specialties in the sizes, capacities, and locations indicated on the drawings. Install per manufacturer's recommendations.

B. Provide one P&T Test Kit to the Government for each project where P&T test ports are specified.

C. Pipe discharges of all automatic air vents to building drains, or to grade outside the building.

D. Remove start-up strainers from pump suction diffusers after completion of hydronic system balancing (ref. Section 23 05 93).

3.04 PLUMBING ACCESS DOORS

A. Provide plumbing access doors as required for maintenance access to all concealed plumbing valves and specialties.

B. Access doors shall be adequately sized for maintenance and removal/replacement of concealed items. Submittals shall indicate the proposed door size for each location.

END OF SECTION

SECTION 22 13 00

FACILITY SANITARY SEWAGE

PART 1 GENERAL

1.01 SUMMARY

Work provided under this section includes the following:

A. Sanitary Drain, Waste, and Vent Piping

B. Plumbing Access Doors

1.02 RELATED SECTIONS

A.	Section 22 05 00	Common Work Results for Plumbing
B.	Section 22 05 23	General-Duty Valves for Plumbing Piping
C.	Section 22 05 29	Hangers and Supports for Plumbing Piping and Equipment
D.	Section 22 05 53	Identification for Plumbing Piping and Equipment
E.	Section 22 07 19	Plumbing Piping Insulation
F.	Section 31 23 00	Excavation and Fill

1.03 INSPECTION AND ACCEPTANCE

A. All work done under this section shall comply with the International Plumbing Code.

B. Work shall not be enclosed, covered, or insulated until it has been inspected, tested, and approved. Any work that is enclosed, covered, or insulated before such inspection and test shall be uncovered and, after it has been inspected and approved, shall be restored to its prior condition at no additional cost to the Government.

C. “The Government Inspector and COTR reserve the right to witness all qualification test. The Contractor shall notify the Government Inspector in advance, and shall not proceed with testing until the

witnesses are present or until the right to witness testing has been waived".

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Sanitary Drain, Waste, and Vent Piping

1. Buried, exterior and below slab: Schedule 40 PVC with solvent welded or push-on elastomer seal fittings.

2. Above Grade, Interior: PVC pipe, Schedule 40 or DWV weight, with solvent welded fittings.

3. No-Hub cast iron pipe may be used in plenum spaces.

4. No-Hub Connectors: For connection of PVC pipe to cast iron pipe or fixture outlets; consisting of a neoprene gasket with stainless steel sleeve and worm gear clamps; CLAMP-ALL or equal.

5. Pressure Relief: TYPE M hard drawn copper water tube per ASTM B88, with wrought copper or cast bronze fittings and lead-free tin-silver solder.

2.02 PLUMBING SPECIALTIES

A. Trap Primers

1. Type TP-1: Flow-thru type - bronze body, threaded connections, integral vacuum breaker and air gap; tested and approved per A.S.S.E. Standard 1018; Watts, Wade, Josam, Zurn, Sioux Chief, or equal.

2. Type TP-2: End-of-line type - threaded connections, integral vacuum breaker and air gap; tested and approved per A.S.S.E. Standard 1018; Mifab M-500 Series Precision Plumbing Products "Oregon #1," or equal. For multiple trap applications, provide with trap primer distribution units.

3. Type TP-3: Overflow type - consisting of a chrome plated cast bronze P-trap with cleanout plug and 1/2" NPT connection for trap primer tubing; Jay R. Smith "Prime-Eze" or equal.

B. Floor Drains

1. Type FD-1: Body and grate only, bottom outlet; Josam Series 30000A or equal.

2. Type FD-2: Side outlet, integral deep-seal trap, ball type backwater valve, and cleanout; Josam Series 38250A or equal.

3. Floor drains shall have cast iron bodies with loose-set, non-tilting, satin finish bronze grates (minimum 8" diameter), and trap primer connections unless otherwise indicated.

4. Grates shall have a minimum free area equal to 1-1/2 times that of the outlet pipe per ANSI A112.21.1M.

5. Suggested manufacturers: Josam, Wade, Zurn, Sioux Chief, or equal.

C. Sanitary Floor Sinks: 12 inch square top, 1/2 inch Nickaloy grate, 8 inch deep cast iron body with acid-resistant interior coating, aluminum domed interior strainer, 3 inch outlet, trap primer connection, and cast iron deep seal trap; Josam Type 49053-3-55 with Type 88100 trap and series 58510 cleanout tee with plug, or equal.

D. Cleanouts

1. Type CO-1: Floor mount, cast iron body with adjustable ABS housing, gasketed ABS plug, and scoriated round satin-finish bronze top; Josam series 56000 or equal.

2. Type CO-2: Wall mount, cast iron no-hub cleanout tee with bronze plug and stainless steel wall access cover plate with center screw; Josam Series 58910 tee with Series 58600 access plate, or equal.

3. Type CO-3: Deep seal cast iron trap with adjustable height cleanout; Josam Series 88100 and series 58510 cleanout tee with plug, or equal.

4. Suggested manufacturers: Josam, Wade, Zurn, Sioux Chief or equal.

E. Air Gap Fittings: Cast iron, with integrally cast air ports, FPT inlet connection, and FPT or spigot outlet connection; Josam Series 88900 or equal.

F. Air Admittance Valves: Automatic pressure sensitive valves air, designed to prevent negative pressure in plumbing vents by admitting but sealing tightly to prevent escape of odors and sewer gases; IPC approved; Studor “Mini-Vent” (1-1/4 to 2 inch), “Maxi-Vent” (2 to 4 inch), or equal.

G. Undersink Insulation Kits: For covering exposed drain and supply piping in accordance with the Americans with Disabilities Act; molded, closed cell, anti-microbial formula vinyl; removable and reusable; white, unless otherwise indicated; Truebro “Handi Lav-Guard” or equal.

2.03 DRAIN PUMPS

Drain pumps shall have a 5 gallon (minimum) polyethylene basin with gasketed lid; NPT inlet, outlet, and vent connections; float switch operated pump with non-clogging impeller, suction strainer, and discharge check valve; capacity and electrical requirements as noted on the drawings; Zoeller Drain Pump Series or equal.

2.04 PLUMBING ACCESS DOORS

Plumbing access doors shall be steel, factory primed and ready for painting, with minimum 16 gage door and frame, exposed flush mounting flange, concealed hinge, and screwdriver operated cam latches; Mifab UA Series, Barco Style BAR-100, Karp Model DSC-214M, or equal.

PART 3 EXECUTION

3.01 PIPING

A. General

1. Pipe ends shall be reamed before joint connections are made.

2. Threaded joints shall be made up with tetrafluoroethylene joint compound or tape. Joint compound or tape shall be applied to the male threads only, and care shall be exercised

to prevent the compound from reaching the interior of the pipe.

3. Polyvinylchloride (PVC) pipe ends and sockets shall be cleaned with a color coded methyl-ethyl-ketone primer/cleaner before assembly. Pipe end shall be rotated 1/4 turn to distribute wet cement in the socket, and held firmly in position until cement sets. Primer color shall be visible at joints.

4. Piping inside metal stud walls shall be isolated from the studs with rubber or plastic bushings specifically designed for that purpose.

5. Install piping to pumps and other equipment at full size indicated on drawings with required size changes made at the equipment connections.

6. Provide unions or flanges at equipment and fixture connections.

7. Provide dielectric unions or flanges where dissimilar metals subject to galvanic activity are joined together (equipment connections, connections between copper and steel pipe, etc.).

8. Belled ends of piping shall point upstream unless otherwise approved.

9. Use the piping manufacturer’s recommended lubricant for push-on gasketed joints.

10. Provide a cast-in-place concrete pier under the base of each underground water or sewer riser. Pre-cast blocks are not acceptable.

11. Provide all fittings, drain valves, and bleed valves required for testing of systems. Each system may be tested in sections, or as a whole.

12. Provide utility warning & identification tape in accordance with Section 22 05 53 for all buried piping.

B. Sanitary Drain, Waste, and Vent Piping (DWV)

1. Prior to beginning installation, verify the exact locations, sizes, and depths of existing sanitary waste lines to which new work is to be connected.

2. Begin installation at the lowest point of the system and work to the highest point.

3. Pitch DWV piping to drain, a minimum of 1/4 inch per foot for piping up to 3 inches, and 1/8 inch per foot for piping larger than 3 inches.

4. Vents through roof shall be a minimum of 3 inches in diameter, and shall extend at least 12 inches above the roof.

5. Provide reducing fittings where different sizes of piping are connected. Bushings may be used in place of reducers only in vent piping.

6. Make branch drainage connections to horizontal mains with combination wye and 1/8 bends. Sanitary tees may be substituted for branch connections to vertical soil stacks. Straight tees may be used only in vent piping.

7. All elbows in drainage systems shall be long sweep type.

8. Prior to installation of fixtures, hydrostatically test sanitary DWV piping at a minimum of 10 feet of water head (5 psig). Repair leaks and retest until pressure holds for one hour.

9. Maintain a minimum distance of 50 ft. between outside HVAC fresh air intake & plumbing vent termination.

10. All piping connections to the sanitary sewer must be made with a mechanical joint in direct compliance with IPC to prevent sewer gasses from entering the equipment or the system.

3.02 PLUMBING SPECIALTIES

A. Trap Primers

1. Provide automatic trap primers for all floor drain and floor sink traps unless otherwise indicated.

2. Trap primers shall be accessible for inspection and replacement. Provide access doors as required.

B. Vacuum Relief Valves

1. Provide a vacuum relief valve on the cold water supply of each storage type water heater.

2. Locate and install the valve in accordance with the manufacturer's instructions.

C. Floor Sinks and Drains

1. Provide floor sinks and drains where indicated.

2. Tops of floor sinks and drains shall not extend above finished floor.

D. Cleanouts

1. Provide cleanouts where indicated, and as required by the International Plumbing Code.

2. Provide line-size cleanouts for pipe sizes up to 4” NPS. Provide 4-inch cleanouts for pipes larger than 4” NPS.

2. Locate cleanouts to have adequate clearance for rodding of lines.

4. Provide dual-direction exterior cleanouts within five feet of the building when adding new sewer service.

5. Interior floor cleanouts shall be flush with finished floor.

6. Interior wall cleanouts shall be above the flood level of the connected plumbing fixtures.

7. Provide square or rectangular cover plates for cleanouts in ceramic tile or resilient tile finished surfaces.

8. Exterior cleanouts in areas other than concrete pavement shall be set in 15 x 15 x 6-inch concrete pads flush with finished grade.

9. Provide to the Government two removal tools for each type and size of cleanout plug provided.

E. Air Admittance Valves

1. Provide automatic air admittance valves as indicated. Install so as to be readily accessible for maintenance and replacement. Provide access doors as required.

2. **Note:** Automatic air admittance devices are intended for use with vented sewer systems only, and shall not be used on vents stacks of septic tank systems.

3.03 PLUMBING ACCESS DOORS

A. Provide plumbing access doors as required for maintenance access to all concealed plumbing valves and specialties.

B. Access doors shall be adequately sized for maintenance and removal/replacement of concealed items. Submittals shall indicate the proposed door size for each location.

END OF SECTION

SECTION 22 14 29.16

SUBMERSIBLE SUMP PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Definitions:

1. Capacity: Gallons per minute (GPM) of the fluid pumped.
2. Head: Total dynamic head in feet of the fluid pumped.
3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

1.02 RELATED WORK

A. Section 22 05 00, Common Work Results Plumbing

B. Section 22 11 13, Facilities Water Distribution Piping

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00, SUBMITTALS.

B. Manufacturer's Literature and Data:

1. Pumps and accessories.
2. Motors and drives.

C. Manufacturer's installation, maintenance and operating instructions. Shall include MOD #, Ser. #, & Date Installed.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity.,

PART 2 PRODUCTS

2.01 SUMP PUMPS

A. Centrifugal, vertical, (submersible acceptable), designed for up to 200 deg. F maximum hot water service. Driver shall be electric motor. Support shall be substantial rigid type. Provide perforated, non-ferrous suction strainer.

B. Impeller: Brass or Bronze

C. Shaft: Bronze, stainless steel or other approved corrosion resisting metal.

D. Bearings: As required to hold shaft alignment, anti-friction type for thrust.

E. Characteristics: Head capacity characteristics shall not permit overloading at any point of the curve.

F. Motor: To be rated NEMA Premium Efficiency. Motor capacity to be sufficient to operate pump without overloading the motor.

G. Automatic control and Level Alarm: Furnish level control mechanism with switches to start and stop pumps automatically and to activate high water alarm. Provide high water alarm with bell, indicating light, transformer and silencing switch. Controls shall be suitable for operation with electrical characteristics listed on Electrical Drawings.

H. Sump (where applicable): Furnish cast iron or fiberglass basin with gas-tight covers. Covers shall have 11” x 15” manhole with bolted cover, vent connection, openings for pumps and controls.

I. Provide a check valve in the discharge of each pump and a gate valve in the combined discharge piping.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pumps shall be stored indoors and protected against dust and moisture. Provide expanded foam on the air inlet and outlet parts of the motor and cover pump suction and discharge flanges to prevent entry of foreign matter.

B. Follow manufacturer's written instructions for pump mounting and start-up. Access/ Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

C. Independently support pumps and piping so that the weight of the piping is not supported by the pumps and the weight of the pumps

is not supported by the piping. The first 3 hangers for each pipe shall be spring and neoprene type.

D. Sump Type Condensate Pump: Apply two coats of asphalt or bituminous compound on the exterior of the receiver tank, and mount level and flush in the floor with waterproofing gaskets and grouting to prevent ground water from entering the building from around the receiver.

3.02 START-UP

A. Verify that the piping system has been flushed, cleaned and filled.

B. Lubricate pumps before start-up.

C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition. Mechanical Seal or Packing Flush Water Lines
must be cleaned before pump start-up.

D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

E. Perform field mechanical balancing if necessary to meet specified vibration tolerance.

F. Pump and piping flanges shall be aligned so that the connecting bolts will fit freely with no external forces applied to pump or piping.

END OF SECTION

SECTION 22 15 13

GENERAL SERVICE COMPRESSED AIR/GAS PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies compressed air and gas piping systems up to 5000 psig operating pressure. Systems include, but are not limited to, shop air, high purity air (a.k.a. missile grade air), breathing air, nitrogen, argon, and helium.

B. System working pressures and materials for each specific application will be noted on the drawings.

1.02 RELATED SECTIONS

A. Section 22 05 00 Common Working Results for Plumbing

B. Section 22 15 13.01 Cleaning for Compressed Air/Gas Piping

C. Section 22 05 19 Meters & Gages for Plumbing Piping

D. Section 22 05 23 General-Duty Valves for Plumbing Piping

E. Section 22 05 29 Hanger and Supports for Plumbing Piping & Equipment

F. Section 22 05 53 Identification for Plumbing Piping & Equipment

PART 2 PRODUCTS

2.01 CARBON STEEL PIPE AND FITTINGS

A. Pipe: Seamless, black carbon steel suitable for bending and forming, conforming to ASTM A106, Grade B. Piping shall be Schedule 40 unless noted otherwise on the drawings.

B. Threaded Fittings, 1/2" To 2" NPS:

1. Black malleable iron, conforming to ASTM A197, ANSI B16.3 and ANSI B1.20.1. Fittings for Schedule 40 pipe shall be Class 150 unless noted otherwise on the drawings.

2. Forged carbon steel, conforming to ASTM A105, ANSI B16.11 and ANSI B1.20.1. Fittings shall be Class 2000 for Schedule 80 and XS pipe, Class 3000 for Schedule 160 pipe and Class 6000 for XXS pipe.

C. Buttweld Fittings, 1/2" NPS and Larger: Seamless, wrought carbon steel conforming to ASTM A234, Grade WPB, ANSI B16.9 and ANSI B16.25. Pressure standard shall be equal to piping.

D. Welded Outlet Fittings: Forged carbon steel conforming to ASTM A105, Grade II and ANSI B16.9. Threaded outlet connections, up to 2" NPS, shall conform to ANSI B1.20.1. Buttweld outlet connections, 1/2" NPS and larger, shall conform to ANSI B16.9 and ANSI B16.25. Outlet connection type shall be as noted on the drawings. Fittings shall be reinforced for 100 percent pipe strength branch connections per ANSI/ASME B31.1. Bonney Forge "Thred-O-Let" and "Weld-O-Let" fittings or equal.

E. Flanges: Forged steel welding neck flanges, 1/2" NPS and larger, conforming to ASTM A105, Grade II, ANSI B16.5 and ANSI B16.25. Pressure standard shall be 150 lb. unless noted otherwise. Flange facings shall be raised face unless noted otherwise. Gasket surface finish for raised face flanges shall be spiral, serrated finish cut with a round-nosed tool.

F. Gaskets: Flat ring, nonmetallic below 600 PSI and spiral wound metal with nonmetallic filler for 600 PSI and higher, unless noted otherwise. Gaskets shall conform to ASME B31.1, Table 112 and ANSI B16.5, Paragraph 6.10 and Appendix E, Group 1A.

G. Ring Joint Gaskets: Octagonal cross section, Brinell Hardness 131, maximum 1/2% Molybdenum, 5% Chrome. Gaskets shall conform to ANSI B16.20.

H. Stud Bolts: Alloy steel per ASTM A193, Grade B7, threaded to conform to ANSI B1.1, Class 2A Unified Screw Threads.

I. Nuts: Semi-finished, heavy hexagonal, carbon steel conforming to ASTM A194, Grade 2H, threaded to conform to ANSI B1.1, Class 2B Unified Screw Threads.

J. Grayloc Connectors: Forged carbon steel hubs per ASTM A105 with nickel coated sealing surfaces. Welding bevel and part tolerances in accordance with ANSI B16.5. Carbon steel clamps per manufacturer's recommended ASTM Standard. Alloy steel stud bolts per ASTM A193, Grade B7. Carbon steel nuts per ASTM A194, Grade 2 or 2H. Seal rings shall be carbon steel with PTFE coating unless noted otherwise. Hubs shall match piping pressure standard. Connectors shall be Grayloc, Reflange, or equal.

K. Dielectric Unions and Flanges: Watts, EPCO, Harco, or equal.

2.02 COATING SYSTEM FOR BURIED CARBON STEEL PIPING

A. Provide all buried carbon steel piping with either of the following applied coatings:
   1. Factory applied Thermosetting Epoxy Coating per FED Spec. L-C-530, Type II. Field-applied plastic tape material used on pipe joints and for repairing damaged areas of shop-applied coatings, FED. Spec. L-T-1512, Type I, 10 mils nominal thickness for pipe joints, and Type II, 20 mils nominal thickness for coating.
   2. Coal tar enamel coating: Exterior of pipe and fittings shall be cleaned, primed with Type B primer, and coated with hot-applied coal tar enamel with a bonded layer of felt wrap in accordance with AWWA C203. Asbestos felt shall not be used; felt material shall be fibrous glass mat as specified in Appendix Section A2.1 of AWWA C203.

B. The coating system shall extend to a minimum of 3 inches above finished grade.

C. The factory-applied coating shall be fault tested at the factory with an impressed voltage of 10,000 volts. Sheath breakdown voltage shall not be less than 13,000 volts.

D. The coating system manufacturer shall supply heat shrinkable sleeves for field joints, and field repair kits for damaged coating.

2.03 COPPER TUBING

Unless otherwise noted, copper tubing shall be Type L, hard drawn, seamless water tube per ASTM B88, with wrought copper fittings and 95-5 tin-antimony solder.

2.04 STAINLESS STEEL TUBING

A. Tubing: Type 304 or 316 stainless steel, cold drawn, seamless, fully annealed, suitable for bending and flaring, conforming to ASTM A213. Maximum operating pressures specified below are based on worst-case dimensional tolerances for maximum outside diameter and minimum wall thickness, an allowable stress of 18,800 psi, a maximum operating temperature of 100° F, and a normal severity of service with moderate shocks. Wall thicknesses specified below are minimums and heavier wall thicknesses shall be substituted for conditions more severe than specified above. Wall thickness of tubing shall be as specified below, unless otherwise specified on the drawings.

MAXIMUM OPERATING PRESSURES, PSIG								
TUBING O.D., IN.	TUBING WALL THICKNESS, INCHES							
	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134
¼	4835	7060						
3/8	3140	4515	6185					
½	2465	3530	4800	6305				
¾	1620	2300	3105	4040	4680	5450		
1	1205	1710	2295	2970	3430	3980	4420	4991
1 ¼	963	1359	1821	2025	2709	3135	3475	3914
1 ½	798	1124	1503	1671	2230	2577	2852	3208

B. Fittings: Type 316 stainless steel, cold formed and passivated per ASTM A182, A276, and A479. Fitting assemblies shall consist of body, sleeve and nut with 37° flared tube end connections per ISO No. 8434-2 and tube end threads per ANSI B1.1, Unified. Adapter fittings shall include fittings with port end connections with tapered pipe threads or straight threads with O-rings. Port end connections with tapered pipe threads shall be per ANSI B1.20.3. Port end connections with straight threads shall be per ISO No. 11926 with threads per ANSI B1.1, Unified, and 90-durometer Nitrile (Buna-N) O-rings. Parker Hannifin Corporation "Triple-Lok" fittings or approved equal.

2.05 STAINLESS STEEL BRAIDED TEFLON HOSE

A. Hose: Extruded TFE inner tube with 300 series stainless steel wire braid outer cover. Maximum working pressures at 75 degrees F shall be 625 PSI, size -20, to 3000 PSI, size -4. Service

temperature range shall be -100 to 450 degrees F. Hose shall be equal to Parflex TFE 919 Hose by Parker Hannifin Corp.

B. Fittings: Reusable or permanent fittings as noted on the drawings and specified below. Provide NPT end connections unless otherwise noted.

1. Reusable, threaded assembly type fittings with 300 series stainless steel nipple, socket and ferrule equal to Parflex 90 Series fittings by Parker Hannifin Corp.

2. Permanent, crimped type fittings with 300 series stainless steel nipple, nut and shell equal to Parflex 91 Series fittings by Parker Hannifin Corp.

2.06 YELLOW GAS DISTRIBUTION PIPE AND FITTINGS

A. Pipe/Tube to be manufactured from Medium Density Polyethylene Material that is classified according to ASTM D3350. Piping shall meet or exceed all industry requirements including:

1. ASTM D2513 specifications for Thermoplastic Gas Pressure Pipe, Tube, and Fittings

2. Department of Transportation title 49, Part 192 “Transportation of Natural and other Gas by Pipe Line Minimum Safety Standards”.

B. Fittings are to meet or exceed all of the above Standards and are to be compatible with the actual pipe/tube used.

C. Acceptable source: U.S. Poly UAC 2000 or equal.

2.07 BREATHING AIR OUTLETS

Breathing air outlets shall consist of a NIOSH approved, Hansen type quick coupling socket with brass body and 3/8 inch MPT connection. Sockets shall be 3M Brand Model W-1449-2 to match existing 3M Brand respiratory equipment.

2.08 PROCESS GAS REGULATORS

A. Type HLR-1: General purpose regulator, hand loaded, non-venting type unless otherwise noted, 300 Series stainless steel body and trim, 10,000 psig maximum operating pressure, NPT inlet and outlet connections unless otherwise noted, 1/4 inch NPT inlet and outlet

gage ports, bubble-tight shutoff, Cv=.06, outlet pressure range as specified on the drawings; Tescom 26-100 Series or equal. Provide panel mounting hardware as required.

B. Type HLR-2: High purity regulator, hand loaded, non-venting type unless otherwise noted, 316 stainless steel body, diaphragm, and trim, Teflon seat, 3500 psig maximum operating pressure, 1/4 inch NPT connections and gage ports, Cv=.06, outlet pressure range as specified on the drawings; Tescom 44-2200 Series or equal. Provide panel mounting hardware as required.

2.09 SHOP AIR FILTER/REGULATORS

A. Shop air filter/regulators shall be general purpose, relieving type with balanced valve design, 250 psig maximum inlet pressure, 5-150 psig outlet pressure range, outlet pressure gage and 3/4 inch FPT ports. Bowls shall be metal, screw-on type with sight glass and liquid level actuated automatic drain, unless otherwise noted.

B. The filter shall be a porous polypropylene element to filter 40 micron size particles unless otherwise noted. Each shop air filter/regulator shall be furnished with a spare filter element.

C. Shop air filter/regulators shall be Norgren Model B74G-6AK-AD3-RMG or approved equal.

2.10 SHOP AIR QUICK COUPLINGS

A. Shop air quick couplings shall consist of steel couplers and plugs rated for 300 psig. Couplers shall be single shut-off type with built-in sleeve guard, Buna-N seals and female pipe thread connection. Plugs shall have end connections as noted on the drawings. Quick couplings shall be equal to Parker 20 Series.

B. Shop air quick couplings shall be "industrial interchange" design conforming to MIL-C-4109F dimensional specifications.

2.11 SHOP AIR DRAIN VALVES

A. Type DV-1: Automatic drip leg drain valve, float operated, zinc body, clear polycarbonate bowl with metal guard; acetal, nitrile, and stainless steel internals; valve designed to drain by gravity in the absence of inlet pressure; 150 psig maximum operating pressure, NPT inlet and discharge connections; Norgren Model 17-016-008 or equal.

B. Type DV-2: For compressed air receivers and after-coolers, automatic float operated, cast iron body, stainless steel internals, NPT connections, 150 psig maximum operating pressure, 1200 pounds of water per hour discharge capacity; ITT Hoffman Model 793 or equal.

2.12 MISCELLANEOUS MATERIALS

A. Pipe Thread Sealant: Teflon tape, conforming to MIL-T-27730.

B. Leak Detection Solution: Conforming to MIL-L-25567D; NUPRO "Snoop" or equal.

2.13 HIGH PRESSURE GAS

A. See chart in section 2.04.A for tubing wall thickness, based on gas pressure.

B. Refer to latest edition of ASME/ANSI B31.3 “Process Piping”

C. Cleaning level for HPA & GN2 piping & valves shall be class 1 as described in TSRC, Section 22 15 13.01 “Cleaning Procedures for Process Piping Systems”

D. Hydrostatically test all piping, valves, fittings, & connections at 1.5 times maximum allowable working pressures prior to cleaning. Pneumatically test piping at working pressure after cleaning. Testing procedures shall be per as described, Section 22 15 13.

PART 3 EXECUTION

3.01 GENERAL

A. Piping and tubing shall be installed and tested in accordance with latest edition of ANSI/ASME B31.1, “Code for Power Piping.” Unless otherwise noted on the drawings.

B. Pipe and tubing ends shall be reamed and deburred before joint connections are assembled.

C. All buried piping shall be welded unless noted otherwise.

D. When adding to an existing system, match the existing piping material and fittings, unless otherwise noted on the drawings.

E. Pipe and tubing inside metal stud walls shall be isolated from the studs with plastic or rubber bushings specifically designed for that purpose.

F. Install pipe and tubing runs to equipment at full line sizes indicated on the drawings, with required size changes made at the equipment connections.

G. Seal all pipe thread connections with Teflon tape.

H. Provide unions or flanges at equipment connections for ease of removal.

I. Provide dielectric unions or flanges where dissimilar metals subject to galvanic activity are connected (equipment connections, connections between copper and steel pipe, etc., and at interface points where building piping is connected to underground distribution piping).

J. Provide all fittings and valves required for testing, cleaning, and draining of systems.

K. Provide utility warning and identification tape in accordance with Section 22 05 53.

3.02 COATING SYSTEM FOR BURIED CARBON STEEL PIPING

A. Packaging, handling, site storage, and testing of coated steel piping shall be in accordance with AWWA C215 and the manufacturer’s recommendations.

B. After all joints have been coated, and prior to backfilling, all underground pipe coating shall be holiday tested at 10,000 volts per NACE Standard RP-02-74. All coating system defects and holidays shall be repaired using the coating manufacturer’s recommended materials and procedures; then retested until satisfactory results are obtained.

C. Perform all testing in the presence of the Government Inspector.

3.03 COPPER TUBING

Soldering and brazing techniques shall be in accordance with the Copper Development Association's "Copper Tube Handbook."

3.04 STAINLESS STEEL TUBING

A. Use tubing benders to form all bends. Do not form any bend with a radius smaller than that recommended by the tubing manufacturer.

B. Deburr tubing ends prior to flaring.

C. Follow tube fitting manufacturer's recommendations for flaring of tubing and installation of fittings.

3.05 YELLOW GAS DISTRIBUTION PIPE AND FITTINGS

A. May be joined by heat fusion or mechanical fittings as recommended by the manufacturer.

B The Code of Federal Regulations (CFR) Title 49, Subchapter D--- Pipeline Safety, shall be consulted for specific guidance regarding installation recommendations and requirements.

C. Outdoor storage of new and unused material shall not exceed 5 years prior to use. Any material not meeting this requirement shall not be used in this project.

D. Do not mix or join different polyethylenes in the same pipeline.

E. Installation, fusion, joining, handling, and storage shall be per manufacturers recommendations and guidelines.

3.06 BREATHING AIR SYSTEMS

A. Breathing air systems shall be constructed with stainless steel tubing and fittings, unless otherwise noted.

B. Clean breathing air systems to Class 1 cleanliness per Section 23 15 13.01.

C. In the presence of the Government Inspector, collect separate samples at each breathing air outlet. Clearly label each sample with the location and date of sampling.

D. The minimum air quality standard, unless otherwise noted, shall be Grade D per Compressed Gas Association Pamphlets G-7-1990, "Compressed Air for Human Respiration" and G-7.1-1989, "Commodity Specification for Air".

E. Submit Independent Test Reports, regarding the air quality at each breathing air outlet. Reports shall list breathing air outlet location, specific contaminants, and contamination levels.

3.07 TESTING

A. Hydrostatically test all air and inert gas systems at 1.5 times the maximum operating pressure, but not less than 150 psig. Repair leaks and retest until pressure holds for one hour.

B. When piping configuration or cleaning requirements make hydrostatic testing impractical, pneumatic testing for one hour at 1.2 times the operating pressure may be substituted, with prior approval from the A/E.

C. The pressure gauge used for hydrostatic or pneumatic testing shall have a range such that the test pressure is between 40 percent and 60 percent of full range. The minimum dial size shall be 4 ½ inches. The full range rotation of the pointer shall be a minimum 270 degree arc. The accuracy of the gauge shall be one percent or better. The gauge shall have been calibrated by an independent lab within six months of the test date. The Government reserves the right to require recalibration when reasonable doubt of accuracy exists,

D. Each system may be tested in sections, or as a whole. Remove or isolate system components which could be damaged by the test pressure.

E. After placing systems into operation, bubble check all fittings and components at normal system operating pressure with a leak detection solution. Repair leaks and retest until all leaks are eliminated.

F. Perform all testing in the presence of the Government Inspector.

END OF SECTION

SECTION 22 15 13.01

CLEANING FOR COMPRESSED AIR AND GAS PIPING

PART 1 GENERAL

1.01 SUMMARY

This section defines four cleanliness classes for process air and gas piping systems. The cleanliness class required for each system or subsystem shall be as noted on the drawings, or in other sections of these specifications.

1.02 SUBMITTALS

Provide submittals per paragraph 3.03.

1.03 REFERENCES FOR CLEANING AND INSPECTION PROCEDURES

A. The following publications contain provisions for cleaning and inspection procedures, and are listed for information only.

B. Marshall Space Flight Center Standards

1. MSFC-SPEC-164B, “Specifications for Cleanliness of Components for Use in Oxygen, Fuel and Pneumatic Systems”

2. MSFC-PROC-166, “Procedure for Cleaning, Testing, and Handling of Space Vehicle Hydraulic System Components and Hydraulic Fluids”

C. Society Of Automotive Engineers (SAE) Standards

1. ARP 598, “Procedure for the Determination of Particulate Contamination of Hydraulic Fluids by the Particle Count Method”

2. ARP 743, “Procedure for the Determination of Particulate Contamination of Air in Dust Controlled Spaces by the Particle Count Method”

1.04 DEFINITIONS

A. Particles - all metallic and non-metallic foreign matter except fibers. Dimensions of particles are described in microns (1 micron equals 0.001 mm). Unless otherwise stated, particle size limitations always refer to the maximum particle dimension.

B. Fibers - all foreign matter having a length greater than 100 microns and a minimum length-to-diameter ratio of 10 to 1.

C. Significant surfaces - all component surfaces that may come into contact with the service medium.

PART 2 PRODUCTS

2.01 CLEANING AND TESTING MATERIALS

A. Trichloroethylene Solvent

1. Solvent used for testing or for immersion cleaning shall conform to Fed Spec O-T-634, Type I or II, except that it shall contain no particle over 175 microns, and no more than 5 particles from 100 to 175 microns.

2. Solvent used for vapor degreasing of stainless steel components shall conform to Fed Spec O-T-634, Type II.

3. Trichloroethylene shall not be used for vessel cleaning where tank entry is required.

B. Trisodium Phosphate shall conform to Fed Spec O-S-642.

C. Nitric Acid shall conform to Fed Spec O-N-350.

D. Citric Acid shall be Industrial Grade.

E Hydrochloric Acid shall conform to Fed Spec O-H-765.

F. Hydroflouric Acid shall conform to Fed Spec O-H-795.

G. Detergents shall conform to MIL SPEC MIL-D-16791.

H. Deionized Water

1. Deionized water shall have a minimum specific resistance of 50,000 Ohm-cm and a pH factor between 6.0 and 8.0.

2. Deionized water used for rinsing and sampling shall be filtered to remove all particles larger than 175 microns. In addition, there shall be no more than 5 particles between 100 and 175 microns per 500 mL sampling.

I. Filter discs for sampling and testing shall be Millipore Mitex Type LS or equal.

2.02 DRYING AND PRESERVATION GASES

A. Gases used in drying and preservation processes shall be filtered to a 100 micron level (absolute).

B. The oil content of gases shall not exceed 3 ppm by weight.

C. The dew point temperature of gases shall be -80 degrees F or lower.

D. Nitrogen gas shall conform to Fed Spec BB-N-411, Type I, Class I, Grade B, in addition to requirements listed in paragraphs A,B, and C above.

2.03 PACKAGING AND PROTECTION MATERIALS

A. Tape used to secure and reinforce protective covers shall conform to Fed Spec PPP-T-60, Type I, Class I.

B. Polyethylene Film shall conform to Fed Spec L-P-378, Type II.

C. ACLAR 33C film shall be as manufactured by Allied Chemical Corp.

D. Aluminum foil shall be common commercial grade.

2.04 GOVERNMENT FURNISHED MATERIALS

Air, gaseous nitrogen, and deionized water for cleaning and drying of piping systems will be furnished by the Government.

PART 3 EXECUTION

3.01 GENERAL CLEANING REQUIREMENTS

A. All gross contamination shall be removed by mechanical processes, flushing, or high velocity blowdown prior to final cleaning. Mechanical and electrical testing shall be accomplished after precleaning and before final cleaning. All lengths of pipe, fittings,

and piping system components shall be precleaned prior to welding and assembly.

B. Corrosion resistant (stainless) steel assemblies shall be treated (pickling and passivating processes) to prevent contamination or latent corrosion.

C. Assemblies not suitable for cleaning as assembled shall have component parts cleaned prior to assembly; or shall be disassembled, cleaned, and reassembled. This shall apply to assemblies composed of materials requiring different cleaning procedures, or assemblies from which cleaning solutions cannot be adequately drained.

D. Flanged and flared joints shall be loosened as required during the cleaning procedure to assure complete drainage of cleaning and rinsing solutions.

E. Components may be provided factory-cleaned if the manufacturer's cleaning and handling procedures are submitted and approved in advance.

F. Air and gaseous nitrogen furnished by the Government will be delivered to the job site. Deionized water will be furnished on the Center to Contractor tankers. Discharge of the tankers shall meet the requirements of paragraph 2.01, H. above. Requests for Government furnished materials shall be made at least two working days prior to the required delivery time.

G. The Contractor is responsible for maintaining the cleanliness of all cleaned systems and components. Any system or component that becomes recontaminated shall be recleaned at no additional cost to the Government.

3.02 CLEANLINESS CLASSIFICATIONS

Cleanliness Classes I, II, and III are defined below, based on the results of applicable quality assurance tests specified in paragraph 3.05. Class IV Cleanliness is defined in terms of cleaning procedures to be used. **NOTE:** These standards meet or exceed the provisions of MSFC-SPEC-164B. Please be advised that the Class definitions in MSFC-SPEC-164B differ from those below.

A. CLASS I CLEANLINESS

1. Visual Examination

a. All significant surfaces shall be free of organic materials such as hydrocarbons, paint, crayon, ink, and welding flux.

b. The presence of visible contamination shall be cause for rejection, and shall necessitate recleaning.

c. Scale-free discoloration due to welding and passivation is acceptable.

d. The presence of any fluorescent particles on any surface shall be cause for rejection, and shall necessitate recleaning of the item.

e. Any component or material from which fluorescence cannot be eliminated shall be replaced at no additional cost to the Government.

2. pH Test

Internal and external surface pH shall be between 6.0 and 8.0.

3. Particle Size Determination

Solid particle contamination per square foot of significant surface area shall not exceed the following:

a. No particles greater than 400 microns.

b. Five particles between 150 and 400 microns.

c. One hundred particles between 5 and 150 microns.

d. Ten fibers.

4. NVR Test

Non-volatile residue contamination shall not exceed 0.001 gram per square foot of significant surface area.

5. Moisture Determination

The dew point of the influent gas at the point of delivery shall be between -80 and -75 degrees F. The dew point of the effluent gas shall be within 5 degrees F of the influent gas.

6. Protection of Cleaned Surfaces

a. Immediately after precleaning, cleaning and drying, all significant cleaned surfaces shall be protected from recontamination by covering the surfaces or openings with a minimum of two layers of "ACLAR 33C" secured and reinforced with tape.

b. Covers for containers shall be designed to facilitate container venting without recontaminating the container.

c. Each protected component that is not installed shall be placed in a clean polyethylene bag. The bag shall be purged with dry, oil-free gas (paragraph 2.02), and the ends of the bag shall be heat-sealed to assure an inert package during storage. The bagged component, with a cleaning certification tag, shall be placed in a second heat-sealed and purged polyethylene bag.

d. Large components and assemblies which cannot be bagged (vessels, lines cleaned in place, etc.) shall be sealed with mating fittings or flanges and pressurized with purge gas to a minimum of 50% of design pressure. The purge pressure shall be monitored, and shall not be allowed to drop below 25% of design pressure.

e. The Contractor may submit alternative preservation procedures for approval if safety concerns preclude the use of the procedure specified above.

f. Overpacking to prevent damage shall be provided as necessary.

g. Protection procedures shall be subject to the approval of the COTR.

B. CLASS II CLEANLINESS

1. Visual Examination

Visual examination criteria shall be the same as Class I.

2. pH Test

Internal and external surface pH shall be between 6.0 and 8.0.

3. Particle Size Determination

The limitations for solid particle contamination shall be the same as specified for Class I Cleanliness.

4. Moisture Determination

The dew point of the influent gas at the point of delivery shall be between -80 and -75 degrees F. The dew point of the effluent gas shall be within 10 degrees F of the influent gas.

5. Protection of Cleaned Surfaces

a. Immediately after cleaning and drying, all significant surfaces shall be protected from recontamination by covering the surfaces or openings with a minimum of two layers of polyethylene film or precleaned dry covers. Polyethylene film shall be secured and reinforced with tape.

b. Covers for containers shall be designed to facilitate container venting without recontaminating the container.

c. Each protected component that is not installed shall be placed in a clean polyethylene bag. The bag shall be purged with dry, oil-free gas (paragraph 2.02), and the ends of the bag shall be heat-sealed to assure an inert package during storage. The bagged component, with a cleaning certification tag, shall be placed in a second heat-sealed and purged polyethylene bag.

d. Large components and assemblies which cannot be bagged (vessels, lines cleaned in place, etc.) shall be sealed with mating fittings or flanges and pressurized

with purge gas to a minimum of 50% of design pressure. The purge pressure shall be monitored, and shall not be allowed to drop below 25% of design pressure.

e. The Contractor may submit alternative preservation procedures for approval if safety concerns preclude the use of the procedure specified above.

f. Overpacking to prevent damage shall be provided as necessary.

g. Protection procedures shall be subject to the approval of the COTR.

C. CLASS III CLEANLINESS

1. Visual Examination

Visual examination criteria shall be the same as Class I.

2. Particle Size Determination

Solid particle contamination per square foot of significant surface area shall not exceed the following.

a. No particles greater than 1500 microns.

b. Fifty particles between 150 and 1500 microns.

c. Five hundred particles between 5 and 150 microns.

d. Fifty fibers.

3. Moisture Determination

The dew point of the influent gas at the point of delivery shall be between -80 and -75 degrees F. The dew point of the effluent gas shall be within 20 degrees F of the influent gas.

4. Protection of Cleaned Surfaces

Protection shall be the same as for Class II Cleanliness.

D. CLASS IV CLEANLINESS

Class IV Cleanliness is general industrial cleaning, and shall be accomplished as follows:

1. Preclean piping, tubing, and other components per paragraph 3.01 to remove loose rust, scale, dirt, and other foreign materials prior to assembly.

2. After assembly and testing is completed, and prior to placing into service, systems shall be cleaned as follows:

   a. Steam and liquid service piping systems, except deionized water, shall be flushed with potable water.

   b. Deionized water piping systems shall be flushed with deionized water.

   c. Air and inert gas piping systems shall be blown down with the service medium. Loosen flanges, unions, or flared fittings as required to permit blow-down for all sections of piping and tubing. After blow-down, tighten these fittings and bubble check for leakage. Repair leaks.

3.03 PROCESS APPROVAL REQUIREMENTS

The following requirements apply to Cleanliness Classes I, II, and III only.

A. Submit written procedures and processes for precleaning, cleaning, handling, preservation, and quality control. Procedures and processes shall be developed by the Contractor and submitted for approval prior to use. Only approved processes shall be used; however, utilization of an approved process will not guarantee acceptance of the final product. Submittals shall include the following information.

1. Processing materials to be used - include trade names, manufacturers' names, specifications, and chemical and physical properties. This information is contained in applicable Material Safety Data Sheets.

2. Estimated quantities of each waste material to be generated as a result of each process.

3. A list of processing equipment to be used for each process.

4. Quality Control and Handling Procedures

a. In-process control procedures to prevent contamination and latent corrosion.

b. Installation procedures for cleaned components in cleaned systems.

c. Procedures and materials to be used to preserve cleanliness of components prior to installation, and clean systems after acceptance.

B. Submit a written plan per paragraph 3.07 for handling and disposal of non-hazardous and non-controlled waste generated.

3.04 QUALITY ASSURANCE PROVISIONS

A. Applicable quality assurance tests are specified in 3.05 below.

B. The Contractor is responsible for the performance of all inspection requirements. Except as otherwise noted, he may use his own, or any other, inspection facilities and services approved by the COTR.

C. Records of the examinations and tests shall be kept complete, and shall be available for inspection by the COTR.

D. At the completion of the project, submit copies of all inspection reports to the COTR for his records.

E. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to insure that the work conforms to the prescribed requirements.

3.05 QUALITY ASSURANCE TESTS

A. Visual Examination

1. Surfaces of all cleaned components shall be visually examined under a strong white light for the presence of moisture or foreign materials such as corrosion, scale, dirt, oil, grease, crayon, etc. A flashlight or borescope may be required for examination of internal surfaces.

2. Surfaces of all cleaned components shall be visually examined under an ultraviolet (UV) light for the presence of moisture and foreign materials such as corrosion, scale, dirt, oil, grease, crayon, etc. The power of the UV light shall be at least 100 watts with a wavelength of approximately 3660 Angstrom units.

B. pH Test

1. External and internal surfaces of all cleaned and rinsed components shall be tested with pH-indicating paper.

2. pH-indicating paper shall be sensitive to pH in the range of 6.0 to 8.0.

3. pH testing shall be performed while surfaces are still wet from the final rinse, or after wetting the surfaces with a few drops of deionized water.

C. Particle Size Determination

The size distribution and quantity of all particles retained on all significant surfaces shall be determined by removing and measuring particles on a minimum 5 percent representative sample of the total surface. The determination shall be made as follows:

1. Flush the selected sample surface of measured or estimated area with approximately 500 mL of deionized water or trichloroethylene (Fed Spec O-T-634, Type I) per square foot.
   a. For individual small components having less than one square foot of surface, a minimum of 500 mL of flushing fluid shall be used.

   b. For piping and large components having greater than three square feet of surface area, three separate samples shall be collected and analyzed.

   c. Piping and piping systems shall be sampled at three locations as directed by the Government Inspector. During sampling, the flow velocity through the pipe shall exceed 8 feet per second, unless otherwise approved.

2. Catch the entire quantity of flushing fluid in a precleaned container.

3. Transfer an equal quantity of unused flushing fluid into a second precleaned container.

4. Filter both samples of flushing fluid through filter discs, and examine the residue under a 10 to 45 power stereomicroscope. The difference in particle count in each size range shall constitute the solid particle contamination of the entire surface represented. If the allowable limit is exceeded in any range, the entire surface shall be recleaned and retested.

5. After satisfactory completion of the particle size determination, all surfaces shall be dried and protected against corrosion or recontamination in accordance with approved procedures, and marked as specified in 3.06.

D. Non-Volatile Residue (NVR) Testing

NVR testing and analysis procedures shall be in accordance with MSFC-SPEC-164B, paragraph 3.3.3.

E. Moisture Determination

1. Small components and assemblies with all significant surfaces exposed shall be examined visually for the presence of surface moisture.

2. Moisture content of surfaces in tanks, piping sections and systems shall be determined as follows:

a. The system shall be under a static lockup for at least 8 hours prior to sampling.

b. Set up a flow of purge gas through the tank or system such that the flow contacts all significant surfaces. If necessary, several checks may be run covering different portions of the system in order to assure the flow of purge gas over all significant surfaces.

c. Purge gas shall be as specified in paragraph 2.02.

d. The velocity of flow at any point in the system being checked shall not exceed 60 feet per minute.

e. Measure the moisture content of the influent gas and the effluent gas using a dew point meter (Alnor Instrument Company or equivalent).

f. Moisture vapor level above the specification in any tank, system, or subsystem shall be cause for rejection and correction. Correction may be achieved by continuing the flow of purge gas, heating the gas and system if preferred, until a satisfactory effluent moisture vapor level is attained.

3.06 MARKING OF CLEANED COMPONENTS

A. All Class I, II, and III cleaned systems, assemblies, and components shall be fully identified with tags (Fed Spec UU-T-81, Type B, Class 1).

B. Tags shall be applied to bagged components as specified in previous paragraphs.

C. Systems and components shall, as a minimum, be tagged near each sealed opening used in the cleaning procedures.

D. Tags shall contain the following information as applicable:

1. Part or identification number.

2. Manufacturer's serial number.

3. Contractor identification.

4. Cleaning Class

5. Date of cleaning.

6. Service medium or intended use.

7. Pressurizing medium and initial pressure.

8. Title, date and number of this specification.

3.07 DISPOSAL OF CLEANING MATERIALS

A. All waste fluids and materials generated during cleaning operations (except Class IV) shall be collected and stored for testing. Testing will be done by the MSFC Environmental Engineering and Management Office (EEMO) or their Hazardous Waste

Management Contractor. Waste shall not be transported from MSFC prior to Government testing.

B. Contractor Responsibilities:

1. Coordinate all waste generating activities with the MSFC Environmental Engineering and Management Office (EEMO).

2. Furnish suitable containers and/or tankage to collect all waste generated.

3. Transport hazardous / controlled liquid wastes to Building 4640 and off-load to designated tankage.

4. Maintain sufficient on-site storage capacity for five working days.

5. Dispose of all waste determined by the Government to be non-hazardous or non-controlled. Disposal shall be accomplished off-site, at no additional cost to the Government, and in a manner approved by the Government. Disposal of these fluids and materials will not be permitted at MSFC or Redstone Arsenal.

6. Comply with additional specific waste collection and management criteria furnished by the Government prior to the start of work.

C. Government Responsibilities:

1. Testing and classification of waste fluids and materials.

2. Disposal of all wastes classified as hazardous or controlled at no cost to the Contractor.

D. Hazardous or Controlled wastes shall not be transported off MSFC property without written authorization from the MSFC Environmental Engineering and Management Office. All costs incurred by MSFC due to unauthorized removal of said materials shall be paid by the Contractor. These costs shall include, but shall not be limited to, independent laboratory analysis, transportation, and disposal fees.

END OF SECTION

SECTION 22 21 23.23

VERTICAL TURBINE PLUMBING PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Pumps for Sump Pumps; Industrial Water Pumps; (IE: Ground Water Sump Pumps @ 4670 Test Stand)

B. Definitions:

1. Capacity: Gallons per minute (GPM) of the fluid pumped.
2. Head: Total dynamic head in feet of the fluid pumped.
3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

1.02 RELATED WORK

A. Section 22 05 00, Common Work Results For Plumbing

B. Section 22 05 00.01, Laser Alignment for Plumbing Pumps & Rotating Equipment

C. Section 22 05 40, Vibration Controls for Plumbing Pumps & Rotating Equipment

D. Section 22 11 13, Facilities Water Distribution Piping

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00, SUBMITTALS.

B. Manufacturer's Literature and Data:

1. Pumps and accessories.
2. Motors and drives.
3. Variable speed motor controllers.

C. Manufacturer's installation, maintenance and operating instructions. Shall include MOD #, Ser. #, & Date Installed.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and show fluid

pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.

PART 2 PRODUCTS

2.01 VERTICAL TURBINE PUMP FOR PLUMBING SERVICE

A. GENERAL

B. REFERENCES

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5 (2003; Errata) Pipe Flanges and Flanged Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 105 Standard Specification for Forgings, Carbon Steel, and for Piping Components

ASTM A 283 Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars

ASTM A 48 Standard Specification for Gray Iron Castings

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1 (2003) Motors and Generators

C. GENERAL REQUIREMENTS

Section 22 05 00, "COMMON WORK RESULTS FOR PLUMBING", applies to work specified in this section.

Vertical Turbine Pump shall be furnished for service in the basin of a sump. The pump motor drive shall be an above-base electric drive.

D. PRODUCTS

1. PERFORMANCE REQUIREMENTS
The operating conditions and performance requirements shall be as indicated.

The driver shall meet speed-torque demand of the pump over the entire operating range at a service factor of unity. Pull-in torque shall not exceed 70 percent of locked rotor value.

Starting shall be across-the-line normal-torque, low-current type.

E. PUMP

1. Pump Capacity
Pump capacity shall be as indicated on the drawings

2. Pump Selection
Pumps shall be designed using hydraulic criteria based upon actual model developmental test data. The manufacturer shall certify that pumps have been hydraulically tested at the factory.

3. 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. Pumps shall be non-overloading at all points of the curve.

4. 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.

5. Pump construction shall be manufacturer's standard, except as noted below:

E.5.1 Impeller: Cast bronze, statically and dynamically balanced, semi-open or closed.

E.5.2 Column: Steel, ASTM A 283, Grade C, 0.25" minimum wall thickness, with discharge elbow and plain end nozzle. The elbow shall have either long-radius pattern (r/d = 1.5 minimum) or have flow vanes.

E.5.3 Bowls: Cast iron, ASTM A 48, Class 35, flanged and bolted, with flow-rectifying vanes.

E.5.4 Suction Bell: Cast iron, ASTM A 48, Class 30, flanged and bolted, with guide vanes.

E.5.5 Suction Strainer: Mounted on bottom bowl and shall be stainless steel. Strainer open area shall be a minimum of five times throat area of suction bell.

E.5.6 Bearings: Leaded bronze, oil-lubricated.

E.5.7 Pump Shaft: Corrosion-resistant steel, ASTM A 283, Type 410 or 416, ground and polished, with 32 micro-inch finish at bearing surfaces.

E.5.8 Surface Plate: The surface-discharge assembly shall be cast iron or fabricated steel and shall be rigid enough to support the entire weight of the motor, bowl assembly, column pipe, cable, and column of water. The cable outlet shall be designed to prevent the entry of foreign matter into the well. Provide two lifting lugs with capacity to support the weight of the entire pump above, plus column of water.

E.5.9 Base Plate: Steel

E.5.10 Lubrication: Bearings shall be oil or water lubricated as standard with the manufacturer.

E.5.11 Corrosion Protection: Approved vinyl coating sprayed on column, bowl assembly, and all stationary ferrous parts, 6-mil minimum thickness.

E.5.12 Discharge: Flanged, above-base discharge per ASTM A 105. Flange drilling shall conform to ASME B16.5 for Class 150.

F. MOTOR

The motor drive shall be surface-mounted conforming to NEMA MG 1, Design B,1760 rpm, 104 deg.F temperature rise, for 460v, 3 ph, 60 hz power. Insulation shall be NEMA Class B. Motor enclosure to be TEFC. Motor to be rated NEMA Premium Efficiency.

Bearings for surface-mounted motors shall be the antifriction oil-lubricated thrust type. Bearing numbers shall be stamped on motor identification plate. Bearings shall have a B-10 rated life of not less than 250,000 hrs. Shop drawings/submittals shall bear the manufacturer's certification of bearing life.

G. SUGGESTED MANUFACTURERS:

Aurora, Worthington, Gould, Byron-Jackson, Peabody-Floway, Peerless, Johnston-Sulzer, or approved equal.

H. EXECUTION

The pumping unit shall be installed in accordance with the contract drawings, approved shop drawings, and the manufacturer’s instructions.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pumps shall be stored indoors and protected against dust and moisture. Provide expanded foam on the air inlet and outlet parts of the motor and cover pump suction and discharge flanges to prevent entry of foreign matter.

B. Follow manufacturer's written instructions for pump mounting and start-up. Access/ Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

C. Independently support pumps and piping so that the weight of the piping is not supported by the pumps and the weight of the pumps is not supported by the piping. The first 3 hangers for each pipe shall be spring and neoprene type.

3.02 START-UP

A. Verify that the piping system has been flushed, cleaned and filled.

B. Lubricate pumps before start-up.

C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition. Mechanical Seal or Packing Flush Water Lines must be cleaned before pump start-up.

D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

E. Perform field mechanical balancing if necessary to meet specified vibration tolerance.

F. Pump and piping flanges shall be aligned so that the connecting bolts will fit freely with no external forces applied to pump or piping.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

Work provided under this section includes the following:

A. Plumbing Specialties, Fixtures, and Equipment

B. Emergency/Safety Equipment

1.02 RELATED SECTIONS

A.	Section 22 05 00	Common Work Results for Plumbing
B.	Section 22 05 23	General-Duty Valves for Plumbing Piping
C.	Section 22 05 29	Hangers and Supports for Plumbing Piping and Equipment
D.	Section 22 05 53	Identification for Plumbing Piping and Equipment
E.	Section 22 07 19	Plumbing Piping Insulation

1.03 INSPECTION AND ACCEPTANCE

A. All work done under this section shall comply with the International Plumbing Code.

B. Work shall not be enclosed, covered, or insulated until it has been inspected, tested, and approved. Any work that is enclosed, covered, or insulated before such inspection and test shall be uncovered and, after it has been inspected and approved, shall be restored to its prior condition at no additional cost to the Government.

C. “The Government Inspector and COTR reserve the right to witness all qualification test. The Contractor shall notify the Government Inspector in advance, and shall not proceed with testing until the

witnesses are present or until the right to witness testing has been waived".

PART 2 PRODUCTS

2.01 PLUMBING FIXTURES

A. Water Closets

1. Type WC-1: Floor mount, flush valve, white vitreous china, elongated bowl, 15-inch rim height, 1-1/2 inch top spud, siphon jet, 1.28 gallons/flush; TOTO CT705E #01 or equal.

a. Trim: Flush valve - TOTO TET1LN or approved equal. Must meet or exceed the EPA "Watersense" label for residential fixtures.

b. Seat: White, open front, without cover; TOTO # SC534 #01 or equal.

2. Type WC-2: Floor mount, flush valve, handicapped, white vitreous china, elongated bowl, 17.5-inch rim height, 1-1/2 inch top spud, siphon jet, 1.28 gallons/flush; TOTO CT705EL #01 or equal.

a. Trim: Flush valve - TOTO TET1LN or approved equal. Must meet or exceed the EPA "Watersense" label for residential fixtures.

b. Seat: White, open front, without cover; TOTO SC534 #01 or equal.

3. Type WC-3: Floor mount, flush tank, white vitreous china, Pressure-Assisted elongated bowl, 14.625 inch rim height, siphon jet, 1.28 gallons/flush, close-coupled tank, with tank/bowl couplings and caps for floor bolts; TOTO CST744E #01 or equivalent meeting EPA "Watersense" criteria.

a. Trim: Chrome plated stop valve and supply tube.

b. Seat: White, open front, with cover; TOTO SC134 #01 or equal.

4. Type WC-4: Floor mount, flush tank, handicapped; white vitreous china, pressure assisted elongated bowl, 16-1/2

inch rim height, siphon jet, 1.28 gallons per flush, close-coupled tank, with tank/bowl couplings and caps for floor bolts; TOTO CST744El #01 or equivalent meeting EPA "Watersense" Criteria.

a. Trim: Chrome plated stop valve and supply tube.

b. Seat: White, open front, with cover; TOTO SC134 #01 or equal.

5. Type WC-5: Wall hung, flush valve, white vitreous china, elongated bowl, 1-1/2 inch top spud, siphon jet, 1.28 gallons per flush; TOTO CT708E #01 or equal.

a. Trim: Flush valve - TOTO TET1LN or approved equal. Must meet or exceed the EPA "Watersense" label for residential fixtures.

b. Seat: White, open front, without cover; TOTO SC534 #01 or equivalent.

c. Carrier: Wade W-300 Series or equal.

d. Mounting height: Top of seat 16 to 17 inches above finished floor.

6. Type WC-6: Wall hung, flush valve, handicapped - same as WC-5 except that mounting height shall be 17 to 19 inches top of seat to finished floor.

7. Type WC-7: Wall hung, flush tank, close-coupled, white vitreous china, pressure assisted elongated bowl, 1.6 gallons per flush; American Standard "Glenwall" No. 2093.100 or equal.

a. Trim: Chrome plated stop valve and supply tube.

b. Seat: White, open front, with cover; TOTO SC134 #01 or equivalent.

c. Carrier: Wade 300 Series or equal.

d. Mounting Height: Top of seat 16 to 17 inches above finished floor.

8. Type WC-8: Wall hung, flush tank, handicapped - Same as WC-7 except that mounting height shall be 17 to 19 inches from top of seat to finished floor.

B. Urinals

1. Type UR-1: Wall hung, flush valve, white vitreous china, integral flushing rim, integral trap, extended shields, 3/4-inch top spud, 0.5 gallons/flush, 2-inch outlet; TOTO UT447E #01 or equal.

   a. Trim: Flush Valve - TOTO TMU1LN or equal.

   b. Carrier: Universal Carrier with hanger plate, steel uprights, support feet, tie rod, flush valve piping supports, and lower bearing plate with studs; Wade Model W-400-AM1-AM11 or equal.

   c. Mounting Height: Top of rim 22 to 24 inches above finished floor.

2. Type UR-2: Wall hung, flush valve, handicapped - Same as UR-1, except that mounting height shall be 16 to 17 inches from top of rim to finished floor.

C. Lavatories

1. Type LAV-1: Counter set, vitreous china, white acid resistant enamel finish, self-rimming, front overflow, 20 X 17-inch bowl, faucet holes on 8-inch centers; American Standard "Aqualyn" No. 0475.020 or equal.

   a. Trim: Self-generating ecopower system sensor faucet, continuous discharge with 8” cc cover plates. 10 Second faucet: 0.17 gallons max water consumption, 1-1/4 inch tailpiece; TOTO TEL5GSC-10 self-generating ecopower system.

   b. Provide chromed stop valves and P-Trap with cleanout.

2. Type LAV-2: Counter set, handicapped - same as LAV-1.

   a. Trim: Self-generating ecopower system sensor faucet, continuous discharge with 8” cc cover plates. 10 Second faucet: 0.17 gallons max water

consumption, 1-1/4 inch tailpiece; TOTO TEL5G9C-10 self-generating ecopower system.

b. Provide chromed stop valves and P-trap with cleanout.

c. Accessories: Where trap and supplies are exposed below counter, provide undersink insulation kit unless otherwise indicated.

3. Type LAV-3: Wall hung, vitreous china, white acid-resistant enamel finish, 20 X 18-inch bowl, faucet holes on 8-inch centers, front overflow, wall hanger; American Standard "Lucerne" No. 0356.015 or equal.

a. Trim: TOTO LT307.8

b. Provide chromed stop valves and P-trap with cleanout.

c. Mounting Height: Top of rim 31 inches above finished floor, unless otherwise indicated.

4. Type LAV-4: Wall hung, handicapped; same as LAV-3.

a. Trim: TOTO LT307.8

b. Provide chromed stop valves and P-trap with cleanout.

c. Mounting Height: Top of rim 34 inches above finished floor.

d. Accessories: Provide undersink insulation kit unless otherwise indicated.

5. TYPE LAV-5: Wall hung, handicapped, white vitreous china, 27 x 20-1/2 inch overall dimensions, faucet holes on 12 inch centers, front overflow, for concealed arm carrier; TOTO LT308.8.

a. Trim: Combination faucet set, renewable seats, 12 inch centers, adjustable 10 to 12- inch gooseneck spout, 4-inch wrist handles, 1/2-inch inlets, aerator with 2.5 gpm restrictor; American Standard "Heritage" No. 2238.129 or equal. Drain trim shall be grid drain with 4 1/2-inch offset for wheelchair access; American Standard No. 7723.018 or equal.

b. Provide chromed stop valves and P-trap with cleanout.

c. Carrier: Concealed arm carrier; Wade Model W520-09-M24 or equal.

d. Mounting Height: Top of rim 34 inches above finished floor.

e. Accessories: Provide undersink insulation kit unless otherwise indicated.

D. Sinks

1. Type SNK-1: Single compartment, counter set, 25 X 21 inch, 18 gage 302 stainless steel, self-rimming, recessed compartment and faucet deck, coated underside, 3-hole, 4-inch centers, 8-inch-deep bowl, 3-1/2 inch drain opening; Elkay "Lustertone" Model LR-2521 or equal.

a. Faucet Trim: TOTO LT307.8

b. Drain Trim: Standard strainer for 3-1/2 inch opening, one-piece stainless steel conical strainer basket with neoprene stopper, and 1-1/2 inch chrome-plated tailpiece; Elkay Model LK-35 or equal. Provide chrome plated P-trap with cleanout.

2. Type SNK-2: Two-compartment, counter set, 33 X 22 inches overall, 18 gage 302 stainless steel, self-rimming, recessed compartment and faucet deck, coated underside, 3-hole, 4-inch centers, 10-inch-deep bowls, 3-1/2 inch drain openings; Elkay "Lustertone" Model DLR-3322-10 or equal.

a. Faucet Trim: TOTO LT307.8

b. Drain Trim: Standard strainer for 3-1/2 inch opening, one-piece stainless steel conical strainer basket with neoprene stopper, 1-1/2 inch chrome-plated tailpiece, and two-sink connector; Elkay Model LK-35 with Model LK-53 connector, or equal. Provide chrome plated P-trap with cleanout.

3. Type SNK-3: Mop sink, precast terrazzo, one-piece, 36 X 36 X 12-inches, 2-inch-wide curb with stainless steel caps, 3" integral drain, stainless steel grid strainer; FIAT Model TSB-500 or equal.

a. Faucet: Service faucet, chrome plated, vacuum breaker, integral stops, adjustable wall brace, 8-inch spout with bucket hook and 3/4-inch hose thread; FIAT Model 830-AA or equal.

b. Hose: Heavy duty flexible rubber, 5/8-inch X 30 inches long, 3/4-inch coupling on one end, stainless steel hose bracket; FIAT Model 832-AA or equal.

c. Mop hanger: Stainless steel, 24 X 3-inches; FIAT Model 889-CC or equal.

4. Type SNK-4: Service sink, wall/trap mounted, cast iron, white acid-resistant enamel finish, rim guard, drilled back, 18x14x12 inch bowl, 3-inch outlet; Kohler “Bannon” No. K-6714 or equal.

a. Faucet Trim: exposed dual-control faucet, renewable seats, lever handles, vacuum breaker, bucket hook, 1/2-inch inlets on 8-inch centers, 3/4-inch hose connection, rough chrome finish; T and S Brass No. B665 or equal.

b. Drain Trim: Cast iron P-trap standard, perforated grid strainer, cleanout plug, adjustable floor flange, 3-inch outlet; Jones Manufacturing No. T00-003 or equal.

5. Type SNK-5: Utility sink, wall hung, white enameled cast iron, drilled back, 24 x 18 x 6-3/4 inch bowl, 3-1/2 inch outlet; Kohler “Sutton” No. K5980 or equal.

a. Faucet Trim: Polished chrome finish, with velvet valves, vacuum breaker, lever handles, loose key stops, and hose with wall hook; Kohler No. K-8928 or equal.

b. Drain Trim: Standard strainer for 3-1/2 inch opening, one piece stainless steel strainer basket with neoprene stopper, 1-1/2 inch chromed tailpiece, and chrome plated p-trap with cleanout plug; Kohler No. K-8801 strainer with No. K-9000 trap, or equal.

c. Carrier: Floor mounted, acid-resistant coating, exposed arms; Jay R. Smith No. 870 or equal.

d. Mounting Height: Top of rim 31 inches above finished floor, unless otherwise noted.

2.02 PLUMBING EQUIPMENT

A. Electric Water Coolers

1. Type EWC-1: Surface mount, stainless steel top, steel cabinet, baked enamel finish, ARI 1010 certified, 14 GPH, 5 year refrigeration system warranty, lead-free construction, 120-volts; OasisModel PLF14M or equal.

a. Trim: P-trap and water supply shut-off valve.

b. Carrier: Universal carrier; Wade W-400 or equal.

c. Mounting Height: Top of rim 40 inches above finished floor, unless otherwise noted.

2. Type EWC-2: Surface mount, handicapped, stainless steel top, vinyl coated steel cabinet, front and side touch-pads, ARI 1010 certified, 7.8 GPH, 5 year refrigeration system warranty, lead-free construction, 120-volts; Oasis Model P8AM or equal.

a. Trim: P-trap and water supply shut-off valve.

b. Carrier: Universal carrier; Wade W-400 or equal.

c. Mounting Height: Spout opening 35 to 36 inches above finished floor, unless otherwise noted.

3. Type EWC-3: Free standing, stainless steel top, steel cabinet, powder coat finish, ARI 1010 certified, 9.6 GPH, 5 year refrigeration system warranty, lead-free construction, 120-volts; Oasis Model P10CP or equal. Provide P-trap and water supply shutoff valve.

B. Water Heaters

1. Type WH-1: Electric, storage type, UL-listed, with glass-lined tank, insulation per ASHRAE 90A, magnesium anode rod, drain valve, adjustable thermostat, manual reset overheat safety, and properly sized ASME temperature and pressure relief valve; capacities and electrical requirements

as shown on the drawings; Bradford-White, State, Rheem, A.O. Smith, or equal.

2. Type WH-2: Electric, instantaneous point-of-use, UL-approved, with flow-switch controller, thermal cut-out safety, and in-line restrictor; capacity and electrical requirements as shown on the drawings; Chronomite, Controlled Energy Corp., Myson-Santon, or equal.

3. Type WH-3: Steam, instantaneous, with counterflow copper tube heat exchanger, temperature blending valve, steam control valve, adjustable feed-forward temperature controls, pressure gages, outlet thermometer, steam traps, and stainers; steam pressure and capacity data as shown on the drawings; Leslie "Constantemp" or equal.

2.03 PLUMBING SPECIALTIES

A. Undersink Insulation Kits: For covering exposed drain and supply piping in accordance with the Americans with Disabilities Act; molded, closed cell, anti-microbial formula vinyl; removable and reusable; white, unless otherwise indicated; Truebro “Handi Lav-Guard” or equal.

B. Ice Maker Box: Wall Mounted; Nails Pre-Loaded; Copper, CPC or Pex Connections, Sioux Chief 696 Series, Oatey 12K, or equal.

C. Vacuum Relief Valves: For water heater protection, brass body, 250 degree F rated, designed to open on vacuum of not over 1/2 inch of mercury, tested and certified per ANSI Z21.22; Watts Model N36 or equal.

2.04 DRAIN PUMPS

Drain pumps shall have a 5 gallon (minimum) polyethylene basin with gasketed lid; NPT inlet, outlet, and vent connections; float switch operated pump with non-clogging impeller, suction strainer, and discharge check valve; capacity and electrical requirements as noted on the drawings; Zoeller Drain Pump Series or equal.

2.05 EMERGENCY/SAFETY EQUIPMENT

A. Emergency/safety equipment installations shall meet or exceed all requirements of ANSI Z358.1, “Emergency Shower and Eyewash

Equipment." Provide Thermostatic or Combination Balanced – Pressure/Thermo Static Valves that conform to the requirements of ASSE 1076 or CSA G125. Provide approved master thermostatic mixing valve per ASSE 1017 for multiple fixtures.

B. Emergency Eye/Face Wash

1. Type EW-1: Twin spray heads mounted in a 12 inch diameter bowl receptor, complete with a chrome plated brass stay-open ball valve, stainless steel push plate activator, individual balance controls, dust caps, and inline strainer; full face flow capacity of 8 gpm minimum; Speakman Model SE-495 (wall mounted), Model SE-496 (pedestal mounted), or equal.

2. Type EW-2: Frost-proof emergency eye/face wash - pedestal mounted, with twin spray heads, dust caps, stainless steel bowl receptor, stay-open frost-proof valve (42 inch burial depth) operated by a panic bar handle, and minimum 8 gpm full face flow; Western Model 262 or equal.

C. Emergency Showers

1. Type ES-1: Single overhead supply with impeller faceplate, minimum 30 gpm flow at 15 psig supply pressure; brass stay-open ball valve activated by a rigid stainless steel pull rod with a triangular or ring shaped handle. Unit shall be provided with all required hardware and accessories for wall, ceiling, or pedestal mounting as indicated on the drawings; Speakman Model SE-227, SE-250, or equal.

2. Type ES-2: Frost-proof, free-standing - same as ES-1 except with a frost-proof stay-open valve (42 inch burial depth) operated by a panic bar handle; Speakman Model SE-260 or equal.

3. Type ES-3: Walk-through type multiple spray emergency shower having 16 spray heads, stay-open ball valve activated by a stainless steel push plate handle, and two stainless steel side panels painted "safety" yellow; Speakman Model SE-340 or equal.

D. Safety Stations

1. Safety stations shall be combination eyewash/shower units, and shall meet all requirements specified above for individual components.

2. Type SS-1: Freestanding safety station; Speakman Model SE-603 or equal.

3. Type SS-2: Freestanding frost-proof safety station; Speakman Model SE-609 or equal.

E. Suggested Manufacturers

Emergency/safety equipment shall be as manufactured by Guardian, Haws, Speakman, Western, or equal.

PART 3 EXECUTION

3.01 PLUMBING FIXTURES

A. Follow manufacturer's instructions for installation of plumbing fixtures and trim.

B. Install supply stops for all plumbing fixtures, except that stops may be omitted on individual fixtures where a group of fixtures within one space can be shut off with a single valve.

C. Where backs of wall hung fixtures join finished walls, finish joints with white caulking compound.

D. When replacing existing fixtures, provide new fixtures with the same rough-in dimensions, if possible, to minimize required plumbing modifications.

3.02 PLUMBING EQUIPMENT

A. Follow manufacturer's instructions for equipment installation.

B. Electric Water Coolers

1. Install water coolers with adequate clearances for maintenance access.

2. Where the backs of wall-hung coolers join finished wall surfaces, finish the joints with caulking compound painted to match the wall.

C. Water Heaters

1. Provide a T&P relief valve and a vacuum relief valve for each storage type water heater.

2. Provide relief valves for instantaneous water heaters if recommended by the manufacturer.

3. Provide a safety pan for each storage water heater per the International Plumbing Code.

4. Pipe relief valve discharge to grade outside the building, to an open drain, or to the safety pan. Terminate discharge piping 6 to 24 inches above grade, or 1 to 2 inches above the flood level rim of the drain or safety pan.

5. Set water heater controls to provide 140°F hot water unless otherwise indicated.

D. Emergency/Safety Equipment

1. Provide identification signs for all emergency/safety equipment. Place signs in a highly visible location adjacent to the equipment. The area around and/or behind the equipment shall be painted with 4"-wide green and white stripes per ANSI Z358.1.

2. Provide P-traps for emergency/safety equipment if drain outlets are to be directly connected to sanitary sewer piping.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

This section applies to, and is a component part of, each section in Division 23, HVAC.

1.02 SCOPE OF WORK

Furnish all labor, material, equipment, and services to construct, install, and test the complete mechanical systems and related work as indicated and specified.

1.03 INTERPRETATION OF DRAWINGS AND SPECIFICATONS

A. It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

B. The provisions of specifications in Division 01 (those beginning with the number 01xxxx) shall apply to and form a part of each section of the specifications.

C. Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements which may be required for proper installation of the work. Such work shall be verified at the site.

D. Except where shown in dimensional detail, the locations of plumbing, mechanical equipment, ducts, piping, and fittings are only approximate; the exact locations shall be field determined, subject to A/E approval.

E. The physical dimensions of equipment indicated are approximate. Before installing any equipment, obtain the exact requirements for the items furnished and install plumbing, piping, fittings, supports, and other items of the correct size and type for the equipment to be installed.

F. Ductwork piping sizes, and equipment ratings shall not be changed without approval of the A/E.

1.04 CODES AND STANDARDS

A. Equipment design, fabrication, testing, installation and system performance shall, unless shown or specified otherwise, comply with the referenced publications to the extent indicated by the references thereto.

B. References to codes and standards shall be understood to mean the latest revision in force at the time of contract award or most recent contract modification.

1.05 COORDINATION AND INTERFERENCES

A. Coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work is avoided.

B. All necessary offsets in ductwork, piping, and all fittings, etc., required to properly install the work shall be furnished complete in place without additional cost to the Government.

C. If interference develops, the COTR will decide which equipment shall be relocated, regardless of which was installed first.

1.06 APPROVAL REQUIREMENTS

A. Except as otherwise specified, approval of materials and equipment will be based on manufacturer's published data. The Contractor shall submit for approval, proof that the items furnished conform to the specified requirements as indicated below and in Section 01 33 00, SUBMITTALS.

B. UL Compliance Requirements

1. Where materials and equipment are specified to conform to the standards of the Underwriter's Laboratories, the label of, or listing with re-examination in, UL PUB. REF. NO. 2, and UL PUB. REF. No. 3 will be acceptable as sufficient evidence of conformance with UL requirements.

2. 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 conform to the specified requirements. Certificate shall include a description of the methods of testing used.

C. Where materials or equipment are specified to be constructed and/or tested in accordance with specific industry or government standards, a manufacturer's certificate of compliance for each item will be acceptable as proof of compliance.

D. Conformance with specified standards does not free the item from being in compliance with any other requirements of these specifications.

1.07 STORAGE AND PROTECTION OF EQUIPMENT AND MATERIALS

All equipment and materials stored at the site shall be fully protected from damage, dirt, debris, and weather per Section 01 60 00, PRODUCT REQUIREMENTS.

1.08 PREVENTION OF CORROSION

A. All metallic materials shall be corrosion resistant, or shall be protected against corrosion.

B. Equipment enclosures shall be given rust-inhibiting treatment and standard finish by the manufacturer.

C. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by approved fittings and treatment.

D. All ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of stainless steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A123 or ASTM A153.

1.09 GENERAL WELDING FOR HYDRONIC PIPING

A. This section specifies the requirements for welding of carbon steel and corrosion resistant (stainless) steel pipe for hydronic utility services.

B. Qualified welders and welding procedures are required for all work, unless otherwise noted on the drawings, or in other sections of these specifications. The contractor shall be responsible for the quality of the welding.

C. WELDING PERMIT

Prior to performing any welding, the Contractor shall obtain a welding permit from the MSFC Safety Office.

D. PROCEDURE QUALIFICATION

1. Except as noted in paragraph 1.09.E below, Welding Procedures shall be submitted for approval prior to procedure qualification testing.

2. Procedures shall conform to applicable regulatory codes including AWS D1.1, ASTM A423, ASTM A370, and The ASME Boiler and Pressure Vessel Code, Section IX.

3. Welding procedure qualification testing shall be performed by the Contractor at no cost to the Government. The procedure testing shall include all types of welding to be used by the Contractor. Procedure Qualification Records and radiographs shall be submitted for approval.

4. Copies of the approved procedures shall be retained by the Contractor, and shall be available for examination by the Government Inspector and other authorized personnel. Deviation from the approved procedure will not be permitted without resubmittal of the procedure for approval, as specified above.

5. No welding shall be accepted by MSFC / NASA / Inspector until the Contractor has received the approved procedures.

6. Approval of the procedures does not relieve the Contractor of responsibility to meet the required quality of the welding.

E. WELDER AND WELDING OPERATOR QUALIFICATION

1. Before a welder or welding operator is assigned to do any work he shall pass qualification tests using the same base

metals, equipment, positions, and procedures that will be encountered in his work.

2. All welders and welding operators employed shall be qualified for each project, except that a prior qualification may be submitted for approval if it meets the following three conditions:

   a. The qualifications submitted comply with requirements specified herein.

   b. Qualification tests have been taken within 6 months.

   c. The welder or welding operator has been employed as a certified welder on work for MSFC within the past 60 days.

3. Qualification tests to weld piping shall conform to the requirements of ASME Boiler and Pressure Vessel Code, Section IX. All welds shall be full penetration welds. Backing rings are not permitted.

4. Materials for pipe joint test coupons shall be as follows:

   a. Wall thickness less than .25 inches- fabricate from sections of 6 inch or larger pipe of the material, wall thickness, and end preparation to be used on the job.

   b. Wall thickness .25 inch and greater -fabricate from 6 to 8 inch long sections of pipe, .760 inch minimum wall thickness, of the material to be used on the job.

5. For each type of welding to be performed, the welder or welding operator shall fabricate test coupons as follows:

   a. Steel stencil stamp the numbers 1-4 at 90- degree intervals around the test sections. Begin welds at #1.

   b. Weld one coupon each in the "2-G" and "5-G" positions, or weld a single coupon in the "6-G" position.

      - For the "2-G" test, the pipe axis shall be fixed in the vertical position.

- For the "5-G" test, the pipe axis shall be fixed in the horizontal position, with the #1 weld position on the bottom.

- For the "6-G" test, the pipe axis shall be fixed at 45-degrees from vertical, with the #1 weld position on the bottom.

6. The Government Inspector and COTR reserve the right to witness all qualification tests. The Contractor shall notify the Government Inspector in advance, and shall not proceed with testing until the witnesses are present, or until the right to witness testing has been waived.

7. All test coupons shall be inspected and evaluated by an independent testing agency. Testing and reporting requirements are specified in Section 01 33 00, SUBMITTALS, under submittal descriptions SD-13 and SD-14.

8. Welder Qualification Reports and radiographs shall be submitted on each welder and welding operator per schedule of submittals for approval.

F. WELDER'S CERTIFICATES

1. Upon successful completion of the applicable qualification tests, each welder shall be provided with a certificate by the Contractor, certifying to the type of welding for which he is qualified, the code under which he is qualified, and the firm or individual certifying the qualification tests.

2. The certificate and a copy of the approved Welder Qualification Report shall be kept on file at the job site by the Contractor, and shall be presented for examination upon request of the Government Inspector or Contracting Officer’s Representative. The certificate will remain in effect for the duration of the job, except when cancellation is required due to questionable workmanship.

G. WELDER'S IDENTIFICATION

1. The Contractor shall assign each welder an identifying number, letter, or symbol which shall be used by the welder to identify all welds made by him. For identification, the

welder shall lightly stamp his symbol adjacent to the weld by means of a metal stamp.

2. When more than one welder is employed to complete a weld, the stamp for the stringer pass welder shall be located on the left side of vertical welds, and on the bottom side of horizontal welds.

3. In the case of seam welds, the stamp shall be adjacent to the weld at 3 ft. intervals.

H. RECERTIFICATION OF WELDERS

1 The Contracting Officer may, at any time after initial qualification, require the requalification of any welder doing questionable work, and identifying stenciled tests specimens shall be submitted.

2. Recertification of the welder shall be made only after the required tests have been passed.

3. Testing required for requalification shall be conducted at no additional expense to the Government.

4. If the welder fails the requalification test, he shall be removed from the project.

I. WELDING PROCESS ABBREVIATIONS

1. SMAW = Shielded Metal Arc Welding

2. GTAW = Gas Tungsten Arc Welding, also known as "TIG"

3. GMAW = Gas Metal Arc Welding , also known as "MIG"

J. MEMBERS UNDER LOAD

1. No welding shall be performed on any structural member while it is supporting a load.

1.10 RADIOGRAPHIC INSPECTION OF WELDED HVAC PIPING

A. The degree of radiographic inspection will be identified on the drawings, or in other sections of these specifications.

PART 2 PRODUCTS

2.01 STANDARD PRODUCTS

Mechanical materials and equipment to be provided under this contract shall be standard catalog products of manufacturers regularly engaged in the manufacture of the products, except as herein modified, and shall duplicate material and equipment that have been in satisfactory use for at least 2 years.

2.02 MATERIAL AND EQUIPMENT

Mechanical material and equipment shall meet the requirements indicated and specified, and shall be suitable for the installation shown. Where two or more units of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable. All materials and equipment shall be new and free from defects.

2.03 WELDING PRODUCTS

A. BASE MATERIALS

Base (pipe) materials for each service shall be as specified on the drawings, or in the applicable sections of these specifications.

B. ELECTRODES AND FILLER METALS

Electrodes and filler metals for each process shall be selected in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

C. SHIELD AND PURGE GAS

Shield and purge gas for GMAW and GTAW processes shall be high purity welding grade argon.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install all materials and equipment in accordance with the requirements of the contract drawings and approved

recommendations of the manufacturers. If the two conflict, request direction from the COTR by filing a Request for Information (RFI).

B. The installation shall be so made that there is no degradation of fire ratings of walls, floors, or ceilings.

C. Install emergency switches and alarms in conspicuous and accessible locations.

D. Install equipment with manufacturer's recommended clearances so that all parts requiring service are accessible.

3.02 CUTTING AND PATCHING

A. Install work in such a manner, and at such time as will require a minimum of cutting and patching of the building structure.

B. All holes in or through existing masonry walls and floors in exposed locations shall be drilled or sawed. The use of a jack hammer will be permitted only where specifically approved. The edges of trenches in concrete floors shall be sawcut. Material between cuts may be broken up with a jackhammer to facilitate removal.

C. Do not cut, or weld to, building structural members unless indicated on the drawings, or approved in advance by the COTR.

3.03 CLEANING

A. Exposed surfaces of piping and equipment which 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.

B. Before final acceptance, all mechanical equipment including piping, ductwork, and fixtures shall be clean and free from dirt, debris, oil, grease, and finger marks.

3.04 DEMOLITION

A. The extent of piping and ductwork removal shall be as shown on drawings. Remove piping, duct, hangers, and attachments to points shown and cap or blank off.

B. Where removed piping or ductwork passed through a wall, floor, or ceiling, patch holes, refinish, and repaint to match existing construction.

C. Remove equipment as shown on drawings, including all associated anchor bolts, pads, hangers, etc.

D. All removed materials and equipment not designated to be salvaged by the Government shall be disposed of at no additional cost to the Government.

E. Removed materials and equipment designated for salvage shall be turned over to the Government at the location specified by the Government Inspector. All piping, electrical, and ductwork connections on salvaged equipment shall be capped or sealed prior to turn-over. Salvaged equipment shall be protected from the weather.

3.05 WELDING OF HYDRONIC PIPING

A. GENERAL

1. Unless otherwise noted, all pipe welds shall be full penetration.

2. The use of backing rings will not be permitted.

3. Safety Precautions:

a. All necessary precautions shall be taken and maintained to minimize the possibility of injury to personnel and existing facilities.

b. Confined areas shall be ventilated where required. Shields and drapes shall be provided as eye protection, and to control air currents and drafts.

c. All items in areas where welding is performed shall be protected from damage by weld spatter.

B. MOISTURE CONTROL

1. Electrode moisture control shall conform to the applicable requirements of AWS D1.1, except that the dry and baking period for low-hydrogen type electrodes shall be for two hours at 450 to 500 degrees F.

2. At the time of removal from sealed container, low-hydrogen electrodes shall contain not more than 0.8% moisture by weight.

3. The Contractor has the option of storing the electrodes in a holding oven at 250 degrees F in lieu of the specified requirements.

4. The electrode manufacturer shall furnish moisture control recommendations. If these recommendations are more stringent than those specified above, the Contractor shall conform to the manufacturer's recommendations at no additional cost to the Government.

5. All filler metals shall be properly identified, and stored in dry areas or containers.

C. JOINT PREPARATION

1. The work to be welded shall be accurately cut to size and shape by mechanical methods.

2. Flame cutting will be permitted, provided that the cut is ground back to remove oxidation before welding.

3. Machine-beveled pipe ends shall be protected with sheet metal caps, or other approved means, during transit and storage.

4. Joint preparation and fit-up for all piping shall be in accordance with ANSI/ASME B31.1.

5. Pipe ends shall be securely held in alignment during welding, but shall not be forced into alignment.

D. CLEANING

1. Prior to fit-up, the surfaces to be joined shall be thoroughly cleaned to remove all foreign material, and degreased to remove all oil or other hydrocarbons.

2. Scale or surface oxides shall be removed by grinding, wire brushing, or by rubbing with an abrasive cloth.

3. After welding operations are completed, the Contractor shall clean all pipes, vessels, containers, etc., of all pieces of welding rods, trimmings, filings, and other pieces of metal and trash.

4. Final passes of all welds shall be thoroughly cleaned.

E. WORKMANSHIP

1. Deposited metal shall be thoroughly fused with the base metal at all sections of the weld & full penetration shall be obtained.

2. Remove all slag, flux, spatter, cracks, blow-holes, inclusions, surface oxides, and foreign matter from each bead before depositing additional weld metal. Flame cleaning will not be permitted. Remove craters and cracks by grinding the full width of the puddle.

3. Heat-sink (suck-back) or burn-through in the root pass shall be controlled to avoid concavity and excessive metal beyond the root side of the weld joint. The deposited metal shall not project more than 3/32 inch beyond the inside wall of the pipe.

4. Mechanical peening of welds will not be permitted.

5. The finished weld shall have an even and regular overlay, free from undercuts, and merging smoothly into the base metal.

6. All items in the area where welding is carried on shall be protected from damage by weld spatter.

F. HEAT TREATMENT

1. All welds on carbon steel pipe with wall thickness exceeding 3/4 inch (or if otherwise required by the approved procedure) shall be preheated and stress relieved.

2. Heat treatment procedures shall be qualified in conjunction with the related welding procedures.

3. Preheating and annealing are not required for stainless steel piping unless specifically noted on the drawings, or on approved welding procedures.

G INERT GAS SHIELD AND PURGE

1. Shield GTAW and GMAW welding with argon gas at flow rates sufficient to create an inert envelope around the molten metal.

2. Take care to avoid drafts and air movements which may disrupt the protective atmosphere around the arc and cause porosity in the weld.

3. Provide an argon gas purge inside piping when GTAW or GMAW root passes are being welded.

H. APPLICATION OF WELDING PROCESSES

1. Welding for carbon and stainless steel piping may be accomplished by either SMAW, GTAW, or GMAW processes, except as specified below.

2. Piping with wall thickness .250 inch and greater, and piping to be cleaned to Class I, II, or III, shall be welded by one of the following processes.

a. GTAW root and filler passes.

b. GMAW root and filler passes.

c. GTAW or GMAW root pass with SMAW filler passes.

I. EXAMINATION AND ACCEPTANCE

1. When noted on the drawings or in other sections of these specifications, the Contractor shall provide radiographic inspection services.

2. In addition, the Government reserves the right to inspect welding, at its own expense, by any or all of the following methods.

a. Dye Penetrant Inspection

b. Radiographic Inspection

c. Magnetic Particle Inspection

d. Ultrasonic Inspection

- The Contractor shall supervise the preparation of reference blocks from material and labor furnished by the Government. The blocks will be of the same material, thickness, and joint design, and shall be fabricated by the same procedure as the weldments to be inspected.

- The reference blocks shall be used to adjust the sensitivity level of the equipment, and shall be compatible with the degree of weld discontinuity established by mutual agreement at the outset of each inspection job.

- At the completion of the work the test blocks will become the property of the Government, and shall be delivered to the Contracting Officer or his representative.

3. Final decisions about the acceptance or rejection of welds will rest with the Contracting Officer, based on the requirements of the contract documents and applicable industry standards.

3.06 RADIOGRAPHIC INSPECTION

A. The Contractor shall notify, schedule, and coordinate all X-ray work with the Government Inspector and the MSFC Radiation Safety Officer.

B. The Contractor shall maintain all the necessary precautions and safeguards to minimize the possibility of radiation injury to personnel.

C. When required, the Contractor shall, at no additional cost to the Government, make test shots to prove that the technique to be used will be satisfactory.

D. RADIOGRAPHIC INSPECTION TECHNIQUES

1. The welds to be inspected shall be radiographed by an X-ray or gamma ray technique which has sufficient sensitivity to indicate the features of the penetrameter.

2. The dimensions of the film shall conform to standard industry practice, and be suitable for the size of the weld and the diameter of the fabrication to be inspected.
3. Radiographic inspection shall be performed in accordance with ANSI B31.1 and the references therein (namely, Section V of the ASME Boiler and Pressure Vessel Code). In addition to the standards for weld acceptability, all radiographic requirements of Article 2, Section V, shall be strictly adhered to.

4. Welds in pipe or tubing up to 2-1/2 inch diameter shall be X-rayed vertically and horizontally at angles that are sufficient to show the entire weld area. The minimum number of radiographs shall be two at 90 degrees for elliptical radiographs or three at 120 degrees for superimposed radiographs.

5. Welds in material larger than 2-1/2 inch diameter shall be X-rayed in sequence around the circumference of the fabrication.

E. IDENTIFICATION OF WELDS

All welds that require radiographic inspection shall be permanently identified with the prefix "X" and the assigned number from the weld map. The Contractor shall assign weld numbers beginning with the number 1, and continuing in a numerical sequence that includes all welds for the subject contract. The piping shall be marked with the weld identification numbers as follows:

1. Material having a wall thickness of 3/16 inch and up shall be steel stencil stamped adjacent to the weld. Weld identifying stamps shall not be sharp edged (V-tool), but shall be rounded edge, non-stress-inducing type.

2. Material having a wall thickness of 1/8 inch and less shall be temporarily identified with a non-soluble ink. After completion of all radiographic inspection, the Contractor shall permanently identify the approved welds with a stainless steel tag (3/8" x 1" x 1/16"). The tag shall be steel stencil stamped with the assigned weld number, and tack welded adjacent to the weld.

3. All sectional film views of welds shall be marked in non-soluble ink around the circumference of the weld joint

alphabetically (i.e., "A-B", "B-C", "C-D", "D-E", etc., returning to view "A").

F. EVALUATION

1. Developed film is to be submittd to the Government Inspector for disposition to the Independent Test Agency.

2. Developed film showing water marks, blemishes, distortion, darkness, or any other condition that interferes with the interpretation of the weld will not be accepted.

3. Acceptability of welding shall be determined in accordance with the standards referenced in this specification.

4. Production and evaluation of radiographs shall be performed by an independent testing agency regularly engaged in such work. The testing agency's report shall include all pertinent information regarding welds that have been judged unacceptable.

5. All radiographs, including those that show weld defects, shall be submitted to the Government. Films shall be marked to identify the inspection agency's name, the date, the weld and view numbers, and the piece or part number (if more than one requires inspection).

6. Final acceptance of all radiographs will be determined by the Government.

G. PROGRESSIVE EXAMINATION

When random radiography (i.e. less than 100% inspection) reveals defective welds, the progressive examination criteria of ANSI B31.3 shall be followed.

H. DEFECTIVE WELDS

A. Repair or replace defective welds and provide additional radiographic inspection at no additional cost to the Government.

B. Identify X-ray film for such welds with the prefix "R" added to the weld number.

END OF SECTION

SECTION 33 61 13

UNDERGROUND HYDRONIC ENERGY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SUMMARY

Work provided under this section includes high density polyethylene (HDPE) piping for underground utility services such as chilled water, hot water, and condenser water.

Uninsulated HDPE piping for underground potable and industrial water services shall be the same as carrier piping specified for chilled water.

1.02 RELATED SECTIONS

A. Section 23 05 23 General- Duty Valves for HVAC Piping

B. Section 23 05 53 Identification for HVAC Piping & Equipment

C. Section 31 23 00 Excavation and Fill

1.03 SUBMITTALS

A. Provide submittals as specified herein, on the drawings, and in the Schedule of Submittals.

When required, the piping manufacturer shall provide detailed installation drawings of the piping system to be installed. Drawings shall include all fittings, offsets, thrust block and anchor locations, expansion loop sizes and locations, and any other information required for installation of a properly functioning system. In addition, the drawings shall indicate all field welds with weld numbers, and lengths of all straight piping sections between welds or fittings.

B. At the completion of installation, the Contractor shall submit shop drawings to the COTR which accurately depict the final “as-built” conditions. These drawings will be incorporated into the record facility drawing files. The “as-built” shop drawings shall be submitted in both electronic and paper (hard copy) formats and shall comply with the format requirements described below.

Electronic files shall be submitted in either Tiff (tg4) or Cals (cals4) image format. Drawings prepared using Computer Aided Design (CAD) software are acceptable substitutes and shall be delivered in dxf, dwg or dgn format only. All Computer Aided Design (CAD) files shall be self-contained and stand-alone. All cross-referenced or reference files shall be electronically merged into the contract drawing such that each drawing file shall be a completely stand-alone document. All levels and/or layers shall be turned on.

All electronic files of drawings shall be delivered on either a CD-ROM.. All media shall be formatted so that it is compatible with Microsoft Windows XP (or above) operating system.

C. For paper (hard copy) drawings, the required drawing size shall be “E” size (40” x 28”) and shall be drawn and lettered to permit reproduction at half size. Lettering shall not be less than 1/8” in height. The AE will properly identify, size, detail, and dimension all the items and conditions on the drawings.

D. When required, the piping manufacturer shall perform a technical review of the A/E’s design drawings, and provide design review comments on the underground piping design. Review shall include recommendations for changes in piping configuration, routing, anchoring, expansion compensation, etc., as required for compliance with the manufacturer’s design and installation guidelines.

1.04 PIPE PACKAGING, HANDLING, STORAGE

A. The manufacturer shall package the pipe in a manner designed to deliver the pipe to the project neatly, intact, and without physical damage. The transportation carrier shall use appropriate methods and provide intermittent checks to insure the pipe is properly supported, stacked, and restrained during transport such that the pipe is not nicked, gouged, or physically damaged.

B. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

C. Sections of pipe having been discovered with cuts or gouges shall be cut out and removed, or repaired by a manufacturer approved extrusion welding process. The choice of repair or replacement

shall be at the discretion of the COTR. When a damaged pipe section is removed, the undamaged portions of the pipe shall be rejoined using the butt fusion joining method.

D. Fused segments of pipe shall be handled so as to avoid damage to the pipe. Care must be exercised to avoid cutting or gouging the pipe.

PART 2 PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. Pipe

Unless otherwise indicated, pipe supplied under this specification shall have a nominal Iron Pipe Size (IPS) OD, and shall be SDR 11 rated at 160 psi at 73 degrees F.

The pipe shall be produced with the dimensions and tolerances specified in ASTM F 714. Additionally, the pipe shall be inspected per industry accepted manufacturer standards for:

Diameter
Wall Thickness
Concentricity
Quick Burst Pressure and Ductility
Joint Length
Straightness
Ovality
Toe-In
Overall Workmanship Inspection on ID and OD
Print Line

The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other deleterious defects and shall be identical in color, density, melt index, and other physical properties throughout.

B. Materials

Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight (EHMW), high density polyethylene with a standard thermoplastic material designation

code of PE3408/3608 and having a minimum cell classification of a 345464C, per ASTM D3550..

The pipe shall be extruded from pre-compounded resin. In plant blending of resin is unacceptable.

The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific product. Said certification shall include a stress life curve per ASTM D 2837. The stress regression testing shall have been done in accordance with ASTM D 2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDR) of 1,600 psi, as determined in accordance with ASTM D 2837.

Further, the material shall be listed by PPI (the Plastics Pipe Institute, a division of the Society of the Plastics Industry) in PPI TR-4 with a 73 degrees F hydrostatic design stress rating of 800 psi, and a 140 degrees F hydrostatic design stress rating of 400 psi. The PPI Listing shall be in the name of the pipe manufacturer and shall be based on ASTM D 2837 and PPI TR-3 testing and validation of samples of the pipe manufacturer's production pipe.

The manufacturer's certification shall state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used, its source, and list its compliance to these specifications.

C. Pipe Extrusion

The pipe shall be extruded using a melt homogenizing/plasticating extruder and "appropriate" die. The extruder screw design should be customized for the HDPE being processed to minimize melt fracture of the molecular structure thus reducing the molecular weight and changing some physical properties from resin to pipe. The resin should be processed at its melt temperature of 500 degrees F to 525 degrees F. The die will have an internally cooled mandrel and an externally cooled bushing. This die will cool the pipe to its solidification point such that it exits the die to specification size, shape, and wall thickness with a polished surface for smooth flow offering a Hazen Williams "C" factor of C=155.

D. Pipe Schedule/Physical Properties

Unless otherwise indicated, HDPE piping shall be SDR-11 rated at 160 PSI at 73 degrees F, and shall have physical properties as noted below.

PROPERTY	SPECIFICATION	UNITS	NOMINAL VALUES
Material Designation	PPI/ASTM	-	PE3408/PE3608
Material Classification	ASTM D 1248	-	III C 5 P34
Cell Classification	ASTM D 3350	-	345464C
Density, Black	ASTM D 1505	gm/cm^3	0.955
Melt Flow	ASTM D 1238	gm/10 min	<0.15 @ 2.16 kg
Flex Modulus	ASTM D 790	psi	136,000
Tensile Str.	ASTM D 638	psi	3500
ESCR, PENT	ASTM F 1473	Hrs	>100
HDB @ 73 deg F	ASTM D 2837	psi	1600
U-V Stabilizer (C)	ASTM D 1603	%C	2.5
Hardness	ASTM D 2240	Shore "D"	64
Compressive Strength (Yield)	ASTM D 695	psi	1600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D 638 (2"/min)	psi	3500
Elongation @ Yield	ASTM D 638	%, min.	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D 638	psi	5000 psi
Elongation @ Break	ASTM D 638	%, min.	800
Modulus of Elasticity	ASTM D 638	psi	125,000
ESCR:			
Slow Crack Growth	Battelle Method	Days to Failure	>32 days
Impact Strength (IZOD) (.125" THK)	ASTM D 256	In-lb/in	144
(.250" THK)	(Method A)	Notch	84
Linear Thermal Expansion Coeff.	ASTM D 696	$in/in/^oF$	1.0×10^{-4}
Thermal Conductivity	ASTM C 177	BTU/in $Ft^2/hrs/^oF$	2.7
Brittleness Temp.	ASTM D 746	^oF	$<-180^oF$
Vicat Soft. Temp.	ASTM D 1525	^oF	+255
Heat Fusion Cond.	--	psi @ ^oF	150 @ 500^oF
NSF Listing	Standard #14	--	"Listed"

E. Fittings

Fittings shall be standard commercial products manufactured by injection molding or by extrusion and machining per ASTM D 1248 or shall be fabricated from PE pipe conforming to this specification. The fittings shall be fully pressure rated by the manufacturer to provide a working pressure equal to the pipe for 50 years service at 73 degrees F with an included 2:1 safety factor. The fittings shall be manufactured from the same resin type, grade, and cell classification as the pipe itself. The manufacture of the fittings shall be in accordance with good commercial practice to provide fittings homogeneous throughout and free from cracks, holes, foreign inclusions, voids, or other injurious defects. The fitting shall be as uniform as commercially practicable in color, opacity, density, and other physical properties. The minimum "quick-burst" strength of the fittings shall not be less than that of the pipe with which the fitting is to be used.

F. Pipe Performance

The pipe will be extruded from resin meeting specifications of ASTM D 3350 with a cell classification of PE-345464C; and ASTM D 1248 pipe grade resin type III, Class C, Category 5, grade P34 polyethylene compound. The pipe shall exhibit the short term tensile and compressive physical properties listed in the schedule and shall provide the long term endurance characteristics recognized by: the compressed pipe ring environmental stress crack resistance greater than 5,000 hrs; the slow crack growth resistance greater than 32 days; the impact strength (toughness) greater than 144 in-lb/in notch; and rotary fatigue endurance at +/- 1600 psi bending stress with Fo greater than 100,000 cycles.

Test results from the manufacturer's testing which show the pipe does not meet appropriate ASTM standards of manufacturer's representation will be cause for rejection of the pipe represented by the testing. These tests may include density and flow rate measurements from samples taken at selected locations within the pipe wall and thermal stability determinations according to ASTM D 3350, 10.1.9.

The Government may request certified lab data from the manufacturer to verify the physical properties of the materials supplied under this specification.

G. QA Deviations

If an approved supplier must supply material that does not meet all requirements of this specification, he must notify the specifying engineer via a written description of the deviation with data that shows the magnitude of the deviation, the justification for the deviation from this specification, and the worst case, long term impact of the deviation on the project. The decision, prior to shipment, to accept material deviating from this specification shall be the responsibility of the specifying engineer.

H. QA Verification

The owner may request certified lab data to verify the physical properties of the compounded materials supplied under this specification or may have random samples taken and have them tested by an independent laboratory.

I. QA Rejection

Polyethylene pipe and fittings may be rejected in whole or in part by the specifying engineer for failure to meet any of the requirements of this specification.

J. QA Records

QA/QC records shall be maintained intact for a minimum of one year from date of production.

K. Pipe Markings

During extrusion production, the HDPE pipe shall be continuously marked with durable printing following this format:

Nominal Size
Dimension Ratio
Pressure Rating
Type
Material Classification
Certification Basis (ASTM)
Pipe Test Category

2.03 UNINSULATED PIPING SYSTEMS

Uninsulated pipe and fittings shall meet all requirements specified herein for the carrier pipe in pre-insulated systems.

2.04 PRE-INSULATED piping systems

A. General

The pre-insulated piping system shall be a product of a manufacturer regularly engaged in providing prefabricated, pre-insulated piping systems. No underground piping system will be acceptable unless the manufacturer has been producing and field testing under actual conditions for a period of 5 years. The manufacturer shall furnish on-site technical instruction as specified herein.

Unless otherwise noted, the system manufacturer and the contractor shall jointly field measure the actual piping lengths and configuration required and shall jointly be responsible for the accuracy of those measurements.

All piping shall be installed as a factory prefabricated pre-insulated system. All pipe shall be insulated with polyurethane foamed-in-place and sealed within a full round HDPE jacket. The exposed ends of each unit shall be factory sealed.

Insulation and jacket may be omitted within 12 inches of fusion welded joints in carrier pipe, provided that exposed ends of insulation are sealed watertight in a manner approved by the piping manufacturer. With Engineering approval, greater than 12 inches may be allowed on larger piping for fusion welding machine placement.

B. Carrier Pipe

The carrier pipe and fittings shall be high density polyethylene (HDPE) as specified in this section.

All fittings shall have the same pressure rating as the carrier pipe. Fittings shall not be insulated or jacketed.

C. Jacket

C. Jacket

The outer protective jacket shall be high density polyethylene to the same specifications as the carrier pipe. The jacket shall be manufactured to a minimum thickness of SDR 32.5.

The carrier pipe jacket and insulated system shall be capable of being field formed to a bending radius of 40 times the outer jacket diameter without damage to the carrier pipe, insulation, or jacket.

D. Insulation

The insulation shall be rigid, closed cell polyurethane with a density of 1.9 to 2.1 pounds per cubic foot. The coefficient of thermal conductivity (k) shall be 0.14 BTU/hour-square foot-F/inch at 73 degrees F. The insulation shall be foamed-in-place and shall completely fill the annular space between the carrier pipe and the jacket. Insulation to be 2 inches thick for all pipe sizes, unless otherwise indicated.

Each end of each length of pre-insulated pipe shall be furnished with a polyethylene disc welded between the service pipe and the jacket. The disk shall be recessed approximately 1/2 inch from the end of the pipe. Mastic or other noncompatible enclosures are not acceptable.

1. Underground HDPE chilled water piping shall be insulated only in sizes below 14" diameter. 14"diameter & greater shall not be insulated.

E. Field Joints

All field joints shall be thermal butt fusion welded.

Weld pressures, temperatures, and time shall be in accordance with the system manufacturer's recommendation. The system manufacturer shall furnish or approve all butt fusion welding equipment.

2.05 VALVES AND ACCESSORIES

Tapping/isolation valves at chilled water main tie-ins shall be Type GTV-1 gate valves or type BLV-2 full-port opening ball valve with roadway extensive type valve boxes per Section 23 05 23.

PART 3 EXECUTION

3.01 GENERAL

A. Construction and installation shall be performed in compliance with the manufacturer's Design Guidelines and Installation Guidelines, and this specification. Conflicts between the contract documents and the manufacturer's guidelines shall be brought to the attention of the COTR for resolution. In general, the manufacturer's guidelines will be given precedence.

B. Provide utility warning & identification tape in accordance with Section 23 05 53 for all buried piping.

3.02 MAIN TAPS

A. Connections to existing mains shall be made with piping manufacturer's recommended branch saddle fittings. Provide tapping/isolation valves at branch outlets and tap the mains using a hot tap machine, unless otherwise indicated.

B. Provide valve boxes and tee handles for all tapping/isolation gate valves.

C. Provide poured-in-place concrete supports under tapping/isolation valves.

3.03 TRENCH CONSTRUCTION

Trench construction, embedment materials, pipe bedding, haunching, and backfill shall be in accordance with Section 31 23 00, the drawing details, and the manufacturer's installation instructions.

In trench sections where flowable fill is to be used, the piping shall be anchored at intervals with poured concrete to prevent floating. Concrete shall be allowed to cure before application of flowable fill material.

Provide utility warning and identification tape in accordance with Section 23 05 53.

3.04 ANCHORING AND EXPANSION COMPENSATION

Provide anchors, thrust blocking, and expansion loops per the contract documents, installation drawings, and the manufacturer's recommendations.

3.05 FIELD JOINTS

A. Sections of polyethylene pipe shall be joined into continuous lengths on the job site. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 500 degrees F, alignment, and 150 psi interfacial fusion pressure.

Butt fusion joining shall be 100 percent efficient offering a joint weld strength equal to or greater than the tensile strength of the pipe. Socket fusion shall not be used. Extrusion welding or hot gas welding of HDPE shall not be used for pressure pipe joints, nor in fabrications where shear or structural strength is important. Flanges, unions, grooved-couplers, transition fittings, and some mechanical couplers may be used to mechanically connect HDPE pipe without butt fusion. Refer to the manufacturer's recommendations.

3.06 TESTING

A. HDPE pressure pipe shall be tested for leakage prior to being placed into service. Water shall be used as the test medium. If it becomes necessary to drain test water, it shall be discharged into storm sewers or open drainage ditches if possible.

B. If required in the contract documents, the Contractor shall provide the COTR with a detailed testing plan for approval 30 days prior to testing. The test plan shall indicate scope, method of section isolation, test procedure, safety precautions, flushing of distribution piping, and repair methods.

C. Prior to testing, the piping system shall be partially backfilled, leaving joints exposed. All concrete thrust blocks and anchors shall be cured for a minimum of 7 days.

<u>Caution:</u> Because of its high coefficient of expansion, temperature changes will affect internal pressures in HDPE systems differently than in steel pipe systems. A temperature rise will cause a decrease in system pressure, and a temperature decrease will cause a pressure increase. For this reason, hydrostatic testing should be performed during periods of stable temperature whenever possible.

Under no circumstances shall the piping remain under test pressure for a period longer than 8 hours. If testing cannot be completed within this time due to leakage, equipment failure, etc., test pressure shall be removed and piping shall be allowed to “relax” for 8 hours before testing is resumed.

All hydrostatic testing shall be witnessed by the Government Inspector and the piping manufacturer’s representative. Results of all testing, regardless of outcome, shall be documented, and shall become part of the project documentation.

Pipe sections which fail to meet the acceptance criteria shall be removed and replaced with new sections of pipe. Tests shall be repeated until criteria are met.

3.07 HYDROSTATIC TEST PROCEDURE

The hydrostatic test procedure shall be as follows, or shall be an approved alternative procedure recommended by the piping manufacturer. The test shall consist of an initial expansion phase and a final test phase. The test phase may be performed by either of the two methods described below, unless otherwise noted.

A. Initial Expansion Phase

Fill the piping with water and purge all free air from the test section. Venting of air may be accomplished by providing high-point bleed valves or by temporarily loosening flanges.

Pressurize the test section to 100 PSI for a duration of 4 hrs, with no drop in test pressure after the system has stabilized, unless otherwise noted. Add make-up water each hour for three hours to return the system to test pressure. The final test phase starts after adding make-up water at the end of the third hour.

B. Final Test - Monitored Make-Up Water Method

The hydrostatic test equipment shall include an in-line water meter or other means for measuring required make-up volume and determining test compliance.

The final test duration shall be 2 hours, unless otherwise noted. The test section shall be visually examined for leakage or abnormal deformation during, and at the conclusion of, the test period.

If pressure in the test section has fallen during the test period, and no visible leakage has been detected, add water as required to restore test pressure. Record the amount of make-up water required, and relieve the test pressure.

Piping shall be considered acceptable if it meets the following criteria:

No visible leakage.

No abnormal or permanent deformation.

Quantity of make-up water required to restore test pressure does not exceed the amount listed in the Plastics Pipe Institute (PPI) Technical Report TR 31, Table 16.

C. Final Test – Non-Monitored Make-Up Water Method

Adjust system pressure to 10 psig below the initial expansion phase pressure.

Test duration shall be one hour, unless otherwise noted. The test section shall be visually examined for leakage or abnormal deformation during, and at the conclusion of, the test period.

Record the final pressure, and relieve system test pressure.

Piping shall be considered acceptable if it meets the following criteria:

No visible leakage.

No abnormal or permanent deformation.

Test pressure holds within 5% of initial setting.

3.08 SYSTEM FLUSHING

After successful completion of testing, flush the system with water to remove dirt, trash, and debris prior to placing in service.

If local system pumps are used to circulate the flush water, temporary strainers shall be provided at pump suction inlets, and pump suction pressure shall be monitored to prevent cavitation.

3.09 MANUFACTURER’S REPRESENTATIVE

A. Unless otherwise noted, the services of a factory trained field service instructor, a full time employee of the manufacturer, shall be required. He shall be present during critical stages of installation and tests including, but not limited to, unloading and storing of piping, butt fusion welding, and hydrostatic testing.

B. The field service instructor shall submit a report to the COTR at each visit to the job site certifying that the underground piping is being installed in accordance with the manufacturer's recommendation. He shall immediately report to the Government Inspector any deviation from accepted installation procedures.

C. Upon completion of the installation, the Contractor shall furnish to the Contracting Officer certification that the system was installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

This section applies to, and is a component part of, each section in Division 23, HVAC.

1.02 SCOPE OF WORK

Furnish all labor, material, equipment, and services to construct, install, and test the complete mechanical systems and related work as indicated and specified.

1.03 INTERPRETATION OF DRAWINGS AND SPECIFICATONS

A. It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

B. The provisions of specifications in Division 01 (those beginning with the number 01xxxx) shall apply to and form a part of each section of the specifications.

C. Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements which may be required for proper installation of the work. Such work shall be verified at the site.

D. Except where shown in dimensional detail, the locations of plumbing, mechanical equipment, ducts, piping, and fittings are only approximate; the exact locations shall be field determined, subject to A/E approval.

E. The physical dimensions of equipment indicated are approximate. Before installing any equipment, obtain the exact requirements for the items furnished and install plumbing, piping, fittings, supports, and other items of the correct size and type for the equipment to be installed.

F. Ductwork piping sizes, and equipment ratings shall not be changed without approval of the A/E.

1.04 CODES AND STANDARDS

A. Equipment design, fabrication, testing, installation and system performance shall, unless shown or specified otherwise, comply with the referenced publications to the extent indicated by the references thereto.

B. References to codes and standards shall be understood to mean the latest revision in force at the time of contract award or most recent contract modification.

1.05 COORDINATION AND INTERFERENCES

A. Coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work is avoided.

B. All necessary offsets in ductwork, piping, and all fittings, etc., required to properly install the work shall be furnished complete in place without additional cost to the Government.

C. If interference develops, the COTR will decide which equipment shall be relocated, regardless of which was installed first.

1.06 APPROVAL REQUIREMENTS

A. Except as otherwise specified, approval of materials and equipment will be based on manufacturer's published data. The Contractor shall submit for approval, proof that the items furnished conform to the specified requirements as indicated below and in Section 01 33 00, SUBMITTALS.

B. UL Compliance Requirements

1. Where materials and equipment are specified to conform to the standards of the Underwriter's Laboratories, the label of, or listing with re-examination in, UL PUB. REF. NO. 2, and UL PUB. REF. No. 3 will be acceptable as sufficient evidence of conformance with UL requirements.

2. 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 conform to the specified requirements. Certificate shall include a description of the methods of testing used.

C. Where materials or equipment are specified to be constructed and/or tested in accordance with specific industry or government standards, a manufacturer's certificate of compliance for each item will be acceptable as proof of compliance.

D. Conformance with specified standards does not free the item from being in compliance with any other requirements of these specifications.

1.07 STORAGE AND PROTECTION OF EQUIPMENT AND MATERIALS

All equipment and materials stored at the site shall be fully protected from damage, dirt, debris, and weather per Section 01 60 00, PRODUCT REQUIREMENTS.

1.08 PREVENTION OF CORROSION

A. All metallic materials shall be corrosion resistant, or shall be protected against corrosion.

B. Equipment enclosures shall be given rust-inhibiting treatment and standard finish by the manufacturer.

C. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by approved fittings and treatment.

D. All ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of stainless steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A123 or ASTM A153.

1.09 GENERAL WELDING FOR HYDRONIC PIPING

A. This section specifies the requirements for welding of carbon steel and corrosion resistant (stainless) steel pipe for hydronic utility services.

B. Qualified welders and welding procedures are required for all work, unless otherwise noted on the drawings, or in other sections of these specifications. The contractor shall be responsible for the quality of the welding.

C. WELDING PERMIT

Prior to performing any welding, the Contractor shall obtain a welding permit from the MSFC Safety Office.

D. PROCEDURE QUALIFICATION

1. Except as noted in paragraph 1.09.E below, Welding Procedures shall be submitted for approval prior to procedure qualification testing.

2. Procedures shall conform to applicable regulatory codes including AWS D1.1, ASTM A423, ASTM A370, and The ASME Boiler and Pressure Vessel Code, Section IX.

3. Welding procedure qualification testing shall be performed by the Contractor at no cost to the Government. The procedure testing shall include all types of welding to be used by the Contractor. Procedure Qualification Records and radiographs shall be submitted for approval.

4. Copies of the approved procedures shall be retained by the Contractor, and shall be available for examination by the Government Inspector and other authorized personnel. Deviation from the approved procedure will not be permitted without resubmittal of the procedure for approval, as specified above.

5. No welding shall be accepted by MSFC / NASA / Inspector until the Contractor has received the approved procedures.

6. Approval of the procedures does not relieve the Contractor of responsibility to meet the required quality of the welding.

E. WELDER AND WELDING OPERATOR QUALIFICATION

1. Before a welder or welding operator is assigned to do any work he shall pass qualification tests using the same base

metals, equipment, positions, and procedures that will be encountered in his work.

2. All welders and welding operators employed shall be qualified for each project, except that a prior qualification may be submitted for approval if it meets the following three conditions:

   a. The qualifications submitted comply with requirements specified herein.

   b. Qualification tests have been taken within 6 months.

   c. The welder or welding operator has been employed as a certified welder on work for MSFC within the past 60 days.

3. Qualification tests to weld piping shall conform to the requirements of ASME Boiler and Pressure Vessel Code, Section IX. All welds shall be full penetration welds. Backing rings are not permitted.

4. Materials for pipe joint test coupons shall be as follows:

   a. Wall thickness less than .25 inches- fabricate from sections of 6 inch or larger pipe of the material, wall thickness, and end preparation to be used on the job.

   b. Wall thickness .25 inch and greater -fabricate from 6 to 8 inch long sections of pipe, .760 inch minimum wall thickness, of the material to be used on the job.

5. For each type of welding to be performed, the welder or welding operator shall fabricate test coupons as follows:

   a. Steel stencil stamp the numbers 1-4 at 90- degree intervals around the test sections. Begin welds at #1.

   b. Weld one coupon each in the "2-G" and "5-G" positions, or weld a single coupon in the "6-G" position.

      - For the "2-G" test, the pipe axis shall be fixed in the vertical position.

- For the "5-G" test, the pipe axis shall be fixed in the horizontal position, with the #1 weld position on the bottom.

- For the "6-G" test, the pipe axis shall be fixed at 45-degrees from vertical, with the #1 weld position on the bottom.

6. The Government Inspector and COTR reserve the right to witness all qualification tests. The Contractor shall notify the Government Inspector in advance, and shall not proceed with testing until the witnesses are present, or until the right to witness testing has been waived.

7. All test coupons shall be inspected and evaluated by an independent testing agency. Testing and reporting requirements are specified in Section 01 33 00, SUBMITTALS, under submittal descriptions SD-13 and SD-14.

8. Welder Qualification Reports and radiographs shall be submitted on each welder and welding operator per schedule of submittals for approval.

F. WELDER'S CERTIFICATES

1. Upon successful completion of the applicable qualification tests, each welder shall be provided with a certificate by the Contractor, certifying to the type of welding for which he is qualified, the code under which he is qualified, and the firm or individual certifying the qualification tests.

2. The certificate and a copy of the approved Welder Qualification Report shall be kept on file at the job site by the Contractor, and shall be presented for examination upon request of the Government Inspector or Contracting Officer’s Representative. The certificate will remain in effect for the duration of the job, except when cancellation is required due to questionable workmanship.

G. WELDER'S IDENTIFICATION

1. The Contractor shall assign each welder an identifying number, letter, or symbol which shall be used by the welder to identify all welds made by him. For identification, the

welder shall lightly stamp his symbol adjacent to the weld by means of a metal stamp.

2. When more than one welder is employed to complete a weld, the stamp for the stringer pass welder shall be located on the left side of vertical welds, and on the bottom side of horizontal welds.

3. In the case of seam welds, the stamp shall be adjacent to the weld at 3 ft. intervals.

H. RECERTIFICATION OF WELDERS

1 The Contracting Officer may, at any time after initial qualification, require the requalification of any welder doing questionable work, and identifying stenciled tests specimens shall be submitted.

2. Recertification of the welder shall be made only after the required tests have been passed.

3. Testing required for requalification shall be conducted at no additional expense to the Government.

4. If the welder fails the requalification test, he shall be removed from the project.

I. WELDING PROCESS ABBREVIATIONS

1. SMAW = Shielded Metal Arc Welding

2. GTAW = Gas Tungsten Arc Welding, also known as "TIG"

3. GMAW = Gas Metal Arc Welding , also known as "MIG"

J. MEMBERS UNDER LOAD

1. No welding shall be performed on any structural member while it is supporting a load.

1.10 RADIOGRAPHIC INSPECTION OF WELDED HVAC PIPING

A. The degree of radiographic inspection will be identified on the drawings, or in other sections of these specifications.

PART 2 PRODUCTS

2.01 STANDARD PRODUCTS

Mechanical materials and equipment to be provided under this contract shall be standard catalog products of manufacturers regularly engaged in the manufacture of the products, except as herein modified, and shall duplicate material and equipment that have been in satisfactory use for at least 2 years.

2.02 MATERIAL AND EQUIPMENT

Mechanical material and equipment shall meet the requirements indicated and specified, and shall be suitable for the installation shown. Where two or more units of the same equipment class are furnished, the equipment shall be from the same manufacturer and shall be interchangeable. All materials and equipment shall be new and free from defects.

2.03 WELDING PRODUCTS

A. BASE MATERIALS

Base (pipe) materials for each service shall be as specified on the drawings, or in the applicable sections of these specifications.

B. ELECTRODES AND FILLER METALS

Electrodes and filler metals for each process shall be selected in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

C. SHIELD AND PURGE GAS

Shield and purge gas for GMAW and GTAW processes shall be high purity welding grade argon.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install all materials and equipment in accordance with the requirements of the contract drawings and approved

recommendations of the manufacturers. If the two conflict, request direction from the COTR by filing a Request for Information (RFI).

B. The installation shall be so made that there is no degradation of fire ratings of walls, floors, or ceilings.

C. Install emergency switches and alarms in conspicuous and accessible locations.

D. Install equipment with manufacturer's recommended clearances so that all parts requiring service are accessible.

3.02 CUTTING AND PATCHING

A. Install work in such a manner, and at such time as will require a minimum of cutting and patching of the building structure.

B. All holes in or through existing masonry walls and floors in exposed locations shall be drilled or sawed. The use of a jack hammer will be permitted only where specifically approved. The edges of trenches in concrete floors shall be sawcut. Material between cuts may be broken up with a jackhammer to facilitate removal.

C. Do not cut, or weld to, building structural members unless indicated on the drawings, or approved in advance by the COTR.

3.03 CLEANING

A. Exposed surfaces of piping and equipment which 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.

B. Before final acceptance, all mechanical equipment including piping, ductwork, and fixtures shall be clean and free from dirt, debris, oil, grease, and finger marks.

3.04 DEMOLITION

A. The extent of piping and ductwork removal shall be as shown on drawings. Remove piping, duct, hangers, and attachments to points shown and cap or blank off.

B. Where removed piping or ductwork passed through a wall, floor, or ceiling, patch holes, refinish, and repaint to match existing construction.

C. Remove equipment as shown on drawings, including all associated anchor bolts, pads, hangers, etc.

D. All removed materials and equipment not designated to be salvaged by the Government shall be disposed of at no additional cost to the Government.

E. Removed materials and equipment designated for salvage shall be turned over to the Government at the location specified by the Government Inspector. All piping, electrical, and ductwork connections on salvaged equipment shall be capped or sealed prior to turn-over. Salvaged equipment shall be protected from the weather.

3.05 WELDING OF HYDRONIC PIPING

A. GENERAL

1. Unless otherwise noted, all pipe welds shall be full penetration.

2. The use of backing rings will not be permitted.

3. Safety Precautions:

a. All necessary precautions shall be taken and maintained to minimize the possibility of injury to personnel and existing facilities.

b. Confined areas shall be ventilated where required. Shields and drapes shall be provided as eye protection, and to control air currents and drafts.

c. All items in areas where welding is performed shall be protected from damage by weld spatter.

B. MOISTURE CONTROL

1. Electrode moisture control shall conform to the applicable requirements of AWS D1.1, except that the dry and baking period for low-hydrogen type electrodes shall be for two hours at 450 to 500 degrees F.

2. At the time of removal from sealed container, low-hydrogen electrodes shall contain not more than 0.8% moisture by weight.

3. The Contractor has the option of storing the electrodes in a holding oven at 250 degrees F in lieu of the specified requirements.

4. The electrode manufacturer shall furnish moisture control recommendations. If these recommendations are more stringent than those specified above, the Contractor shall conform to the manufacturer's recommendations at no additional cost to the Government.

5. All filler metals shall be properly identified, and stored in dry areas or containers.

C. JOINT PREPARATION

1. The work to be welded shall be accurately cut to size and shape by mechanical methods.

2. Flame cutting will be permitted, provided that the cut is ground back to remove oxidation before welding.

3. Machine-beveled pipe ends shall be protected with sheet metal caps, or other approved means, during transit and storage.

4. Joint preparation and fit-up for all piping shall be in accordance with ANSI/ASME B31.1.

5. Pipe ends shall be securely held in alignment during welding, but shall not be forced into alignment.

D. CLEANING

1. Prior to fit-up, the surfaces to be joined shall be thoroughly cleaned to remove all foreign material, and degreased to remove all oil or other hydrocarbons.

2. Scale or surface oxides shall be removed by grinding, wire brushing, or by rubbing with an abrasive cloth.

3. After welding operations are completed, the Contractor shall clean all pipes, vessels, containers, etc., of all pieces of welding rods, trimmings, filings, and other pieces of metal and trash.

4. Final passes of all welds shall be thoroughly cleaned.

E. WORKMANSHIP

1. Deposited metal shall be thoroughly fused with the base metal at all sections of the weld & full penetration shall be obtained.

2. Remove all slag, flux, spatter, cracks, blow-holes, inclusions, surface oxides, and foreign matter from each bead before depositing additional weld metal. Flame cleaning will not be permitted. Remove craters and cracks by grinding the full width of the puddle.

3. Heat-sink (suck-back) or burn-through in the root pass shall be controlled to avoid concavity and excessive metal beyond the root side of the weld joint. The deposited metal shall not project more than 3/32 inch beyond the inside wall of the pipe.

4. Mechanical peening of welds will not be permitted.

5. The finished weld shall have an even and regular overlay, free from undercuts, and merging smoothly into the base metal.

6. All items in the area where welding is carried on shall be protected from damage by weld spatter.

F. HEAT TREATMENT

1. All welds on carbon steel pipe with wall thickness exceeding 3/4 inch (or if otherwise required by the approved procedure) shall be preheated and stress relieved.

2. Heat treatment procedures shall be qualified in conjunction with the related welding procedures.

3. Preheating and annealing are not required for stainless steel piping unless specifically noted on the drawings, or on approved welding procedures.

G INERT GAS SHIELD AND PURGE

1. Shield GTAW and GMAW welding with argon gas at flow rates sufficient to create an inert envelope around the molten metal.

2. Take care to avoid drafts and air movements which may disrupt the protective atmosphere around the arc and cause porosity in the weld.

3. Provide an argon gas purge inside piping when GTAW or GMAW root passes are being welded.

H. APPLICATION OF WELDING PROCESSES

1. Welding for carbon and stainless steel piping may be accomplished by either SMAW, GTAW, or GMAW processes, except as specified below.

2. Piping with wall thickness .250 inch and greater, and piping to be cleaned to Class I, II, or III, shall be welded by one of the following processes.

a. GTAW root and filler passes.

b. GMAW root and filler passes.

c. GTAW or GMAW root pass with SMAW filler passes.

I. EXAMINATION AND ACCEPTANCE

1. When noted on the drawings or in other sections of these specifications, the Contractor shall provide radiographic inspection services.

2. In addition, the Government reserves the right to inspect welding, at its own expense, by any or all of the following methods.

a. Dye Penetrant Inspection

b. Radiographic Inspection

c. Magnetic Particle Inspection

d. Ultrasonic Inspection

- The Contractor shall supervise the preparation of reference blocks from material and labor furnished by the Government. The blocks will be of the same material, thickness, and joint design, and shall be fabricated by the same procedure as the weldments to be inspected.

- The reference blocks shall be used to adjust the sensitivity level of the equipment, and shall be compatible with the degree of weld discontinuity established by mutual agreement at the outset of each inspection job.

- At the completion of the work the test blocks will become the property of the Government, and shall be delivered to the Contracting Officer or his representative.

3. Final decisions about the acceptance or rejection of welds will rest with the Contracting Officer, based on the requirements of the contract documents and applicable industry standards.

3.06 RADIOGRAPHIC INSPECTION

A. The Contractor shall notify, schedule, and coordinate all X-ray work with the Government Inspector and the MSFC Radiation Safety Officer.

B. The Contractor shall maintain all the necessary precautions and safeguards to minimize the possibility of radiation injury to personnel.

C. When required, the Contractor shall, at no additional cost to the Government, make test shots to prove that the technique to be used will be satisfactory.

D. RADIOGRAPHIC INSPECTION TECHNIQUES

1. The welds to be inspected shall be radiographed by an X-ray or gamma ray technique which has sufficient sensitivity to indicate the features of the penetrameter.

2. The dimensions of the film shall conform to standard industry practice, and be suitable for the size of the weld and the diameter of the fabrication to be inspected.
3. Radiographic inspection shall be performed in accordance with ANSI B31.1 and the references therein (namely, Section V of the ASME Boiler and Pressure Vessel Code). In addition to the standards for weld acceptability, all radiographic requirements of Article 2, Section V, shall be strictly adhered to.

4. Welds in pipe or tubing up to 2-1/2 inch diameter shall be X-rayed vertically and horizontally at angles that are sufficient to show the entire weld area. The minimum number of radiographs shall be two at 90 degrees for elliptical radiographs or three at 120 degrees for superimposed radiographs.

5. Welds in material larger than 2-1/2 inch diameter shall be X-rayed in sequence around the circumference of the fabrication.

E. IDENTIFICATION OF WELDS

All welds that require radiographic inspection shall be permanently identified with the prefix "X" and the assigned number from the weld map. The Contractor shall assign weld numbers beginning with the number 1, and continuing in a numerical sequence that includes all welds for the subject contract. The piping shall be marked with the weld identification numbers as follows:

1. Material having a wall thickness of 3/16 inch and up shall be steel stencil stamped adjacent to the weld. Weld identifying stamps shall not be sharp edged (V-tool), but shall be rounded edge, non-stress-inducing type.

2. Material having a wall thickness of 1/8 inch and less shall be temporarily identified with a non-soluble ink. After completion of all radiographic inspection, the Contractor shall permanently identify the approved welds with a stainless steel tag (3/8" x 1" x 1/16"). The tag shall be steel stencil stamped with the assigned weld number, and tack welded adjacent to the weld.

3. All sectional film views of welds shall be marked in non-soluble ink around the circumference of the weld joint

alphabetically (i.e., "A-B", "B-C", "C-D", "D-E", etc., returning to view "A").

F. EVALUATION

1. Developed film is to be submitted to the Government Inspector for disposition to the Independent Test Agency.

2. Developed film showing water marks, blemishes, distortion, darkness, or any other condition that interferes with the interpretation of the weld will not be accepted.

3. Acceptability of welding shall be determined in accordance with the standards referenced in this specification.

4. Production and evaluation of radiographs shall be performed by an independent testing agency regularly engaged in such work. The testing agency's report shall include all pertinent information regarding welds that have been judged unacceptable.

5. All radiographs, including those that show weld defects, shall be submitted to the Government. Films shall be marked to identify the inspection agency's name, the date, the weld and view numbers, and the piece or part number (if more than one requires inspection).

6. Final acceptance of all radiographs will be determined by the Government.

G. PROGRESSIVE EXAMINATION

When random radiography (i.e. less than 100% inspection) reveals defective welds, the progressive examination criteria of ANSI B31.3 shall be followed.

H. DEFECTIVE WELDS

A. Repair or replace defective welds and provide additional radiographic inspection at no additional cost to the Government.

B. Identify X-ray film for such welds with the prefix "R" added to the weld number.

END OF SECTION

SECTION 23 05 00.01

LASER ALIGNMENT FOR HVAC PUMPS & ROTATING EQUIPMENT

PART 1 GENERAL

MSFC requires laser alignment on all shaft coupled machines in keeping with its implementation of Reliability Centered Maintenance. Laser alignment designed into the machine will:

- Minimize machine installation and set-up time.
- Allow verification of pump, fan, and compressor equipment.
- Allow identification of unique errors in machine motions and structure.

Provides engineering performance guidelines for use by maintenance and design personnel as well as pump, fan, and equipment builders during the design and building of new equipment and the rebuild of existing equipment.

1.01 LASER ALIGNMENT SUPPORT SYSTEMS

NOTE: Nominal English/Metric dimensioning is used for Laser/Target Holding Adapter I.D. and Bushings I.D., therefore English to Metric I.D. conversions will not be exact, however the tolerancing integrity must be maintained.

1.01.1 LASER/TARGET HOLDING ADAPTERS shall be

a. Practical to install and use while HVAC Pump/Fan/Equipment is in a production environment.

b. Shall mount to represent the spindle's axis of rotation.

c. Standard inside diameter of each Laser holding adapter shall be ground to .7500 inch +.0010/-.0000 inch I.D. (20mm +.0250/-.0000 mm I.D.). If spacing or center distance constraints do not allow for a .7500 inch (20mm) inside diameter, then the inside diameter may be reduced to the next appropriate nominal size (+.0010/-.0000 inch) + (.0250/.0000 mm). Laser holding adapters shall be of a length that is as long as

is practical and conditions allow, and run out of the inside diameter to the mounting journal shall not exceed .001 inch (0.0254 mm).

d. Standard inside diameter of each target holding adapter shall be ground to .7500 inch +.0002/-.0000 inch I.D. (20 mm +.0051/0000 mm I.D.) If spacing or center distance constraints do not allow for a .7500 inch (20 mm) inside diameter, then the inside diameter shall be reduced to the next appropriate nominal size +.0002/-.0000 inch (+.0051/-.0000 mm).

1.01.2 Adapters are required for each line-up application to secure the laser or target.

1.01.3 Each adapter shall be black oxide coated and have the inside bore diameter clearly stamped and filled with yellow paint on the body of the adapter.

2.0 COUPLED SHAFTS LASER ALIGNMENT

2.01 MSFC COUPLED SHAFT ALIGNMENT REQUIREMENT

MSFC operations require laser alignment on all shaft coupled machines to maximize part quality and productivity, and to eliminate premature machine failure due to misalignment.

2.02 COUPLED SHAFTS ALIGNMENT

Coupled shaft alignment is the positioning of two or more machines so that the rotational centerlines of their shafts are co-linear at the coupling center under operating conditions.

2.03 LASER SHAFT ALIGNMENT SYSTEM REQUIREMENTS

The Laser Alignment System used for coupled shaft alignment shall use either a combined laser emitter and laser target detector unit or separate units for its laser emitter and laser target detector.

2.04 SHAFT ALIGNMENT TOLERANCES

2.04.1 All shaft-to-shaft centerline alignments shall be within the tolerances specified in Table 1 unless more precise tolerances are specified by the HVAC Pump/Fan/Equipment manufacturer or by the design engineer for special applications.

*TABLE 1 COUPLED SHAFT ALIGNMENT TOLERANCE VALUES

	RPM	TOLERANCE SPECIFICATION
SOFT FOOT	ALL	<.002 inch (.0508 mm) at each foot

	RPM	HORIZONTAL & VERTICAL PARALLEL OFFSET	ANGULARITY/GAP Inch/10 inch (mm/254 mm) Coupling Diameter
SHORT COUPLINGS			
	600	.005 in (0.1270mm)	.010 in (0.2540 mm)
	900	.003 in (0.0762 mm)	.007 in (0.1778 mm)
	1200	.0025 in (0.0635 mm)	.005 in (0.1270 mm)
	1800	.002 in (0.0508 mm)	.003 in (0.0762 mm)
	3600	.001 in (0.0254 mm)	.002 in (0.0508 mm)
	7200	.0005 in (0.0127 mm)	.001 in (0.0254 mm)

		HORIZONTAL & VERTICAL PARALLEL OFFSET PER INCH (25.4 mm) OF SPACER LENGTH	
COUPLINGS			
WITH	600	.0018 in (0.0457 mm)	
SPACERS	900	.0012 in (0.0305 mm)	
	1200	.0009 in (0.0229 mm)	
	1800	.0006 in (0.0152 mm)	
	3600	.0003 in (0.0076 mm)	
	7200	.00015 in (0.0038 mm)	

JACKSHAFTS Below “critical speed” of Jackshaft
Short coupling tolerances apply to each coupling of the jackshaft.
Above “critical speed” of Jackshaft
Short coupling tolerances apply relative to the centerlines of the two machines.

*References: “The Optalign Training Book.” 1990, Ludeca Inc., Miami, FL.

2.04.2 The tolerances specified in the Table 1 are the maximum allowable deviations from Zero-Zero Specifications or ALIGNMENT TARGET SPECIFICATIONS (i.e. an intentional targeted offset and/or angularity).

2.04.3 Acknowledging that machines often move after start-up due to THERMAL GROWTH, dynamic load shifts, etc., the alignment parameters shall be measured and adjusted for operating conditions.

2.05 COUPLED SHAFTS ALIGNMENT VERIFICATION

2.05.1 Laser alignment shall be performed on the HVAC pump/fan/equipment supplier's floor on all shaft coupled equipment.

2.05.2 When verifying the alignment of coupled shafts the HVAC pump/fan/equipment supplier must document and provide the following data for each set of coupled shafts:

a. Alignment tolerances used.
b. SOFTFOOT
c. Vertical ANGULARITY (Pitch) at the COUPLING POINT.
d. Vertical OFFSET at the coupling point.
e. Horizontal angularity (Yaw) at the coupling point.
f. Horizontal offset at the coupling point.

This information shall be provided in the submittal (Section 01 33 00).

2.05.3 Verification of alignment and re-alignment shall be conducted at the MSFC facility during installation of the equipment.

2.06 PUMP/EQUIPMENT BASES

2.06.1 PUMP/EQUIPMENT BASE CONSTRUCTION

2.06.1.1 A solid and rigid base is required to achieve and maintain shaft alignment.

2.06.1.2 Where bases are constructed using concrete or grouts, final shaft alignment shall not be conducted until ample curing time has taken place. (A minimum of thirty days is recommended).

2.06.1.3 Where the HVAC pump/fan/equipment foundation installation specification does not require a concrete or grout base or the installation schedule does not permit the proper cure time for the concrete/grout, base construction shall be a structurally rigid steel fabrication or machined casting as determined by the Government.

2.06.1.4 Where corrosion is or may be a problem the base must be fabricated of corrosive resistant materials.

2.07 HOLD-DOWN BOLTS

The use of hold down bolts is the preferred method of fastening components to the base. Hold-down bolts shall meet the following specifications:

a. Hold-down bolts for both the driver and the driven machine(s) (in pairs or in trains) shall be positioned (spotted) after the machine's shafts have been aligned.
b. Hold-down bolts shall be centered in the hole of the machine foot.
c. Hold-down bolts shall not be undercut ("Chicagoed") to achieve HORIZONTAL adjustment.

2.08 PIPING

Piping must be fitted, supported, and sufficiently flexible such that softfoot due to movement caused by tightening pipe flanges doesn't exceed .002" (.051 mm). Piping must not restrict the minimum 180 degree rotation requirement of the laser alignment system.

2.09 SHIMS

Shims shall meet the following specifications:

a. Commercially die-cut.
b. Made of corrosion and crush resistant stainless steel, which is dimensionally stable when subjected to high compression over long periods of time.
c. Consistent over the whole shim area, without seams or folds from bending.
d. Clean, free from burrs, bumps, nicks and dents of any kind.
e. Size, numbers, or trademarks etched into the shim, not printed or stamped.
f. The smallest commercial shim which will fit around the hold down bolts without binding shall be used.
g. The overall shim pack shall not exceed a total of three (3) shims.
h. Shims must rest on bare metal, not paint or other coatings.

2.10 MACHINE VERTICAL MOBILITY

All machines shall be installed with a minimum of .125 inch (3.0 mm) dimensionally stable shims under each surface mounting point for vertical mobility.

2.11 COUPLING PLAY/BACKLASH

OEM's shall use only Lovejoy or Woods Couplings unless otherwise agreed upon by the purchaser. During the alignment process coupling play or backlash shall be eliminated to accomplish a precision shaft alignment.

2.12 AXIAL SHAFT PLAY

Axial shaft play or end play shall be no greater than .025 inch (3.175 mm). Accommodation of end movement must be accomplished without inducing abnormal loads in the connecting equipment.

GLOSSARY

1) ACCESSIBLE: The ability to reach and adjust the aligning feature. Consideration should be given to confined space restrictions, removing guards, bushing plates, hydraulic lines, lubrication lines, electric lines, etc.

2) ALIGNMENT TARGET SPECIFICATIONS: Desired intentional offset and angularity at coupling center to compensate for thermal growth and/or dynamic loads. Most properly specified as an OFFSET, and an angle in two perpendicular planes, horizontal and vertical.

3) ANGULAR ERROR: A misalignment condition characterized by the angular error between the desired centerline and the actual centerline. This misalignment condition may exist in planes both horizontal and vertical to the axis of rotation.

4) ANGULARITY: The angle between the rotational centerlines of two shafts. Angularity is a “slope” expressed in terms of a rise (millimeters or thousandths of an inch) over a run (meter or inches).

5) AXIAL PLAY, AXIAL FLOAT, END FLOAT: Shaft axial movement along its centerline caused by axial forces, thermal expansion or contraction, and permitted by journal bearings, sleeve bearings and/or looseness.

6) BASE PLATE: The surface often made of steel plate or cast iron to which the feet of a pump/motor are attached.

7) Co-linear: Co-linear means two lines that are positioned as if they were one line. Co-linear as used in alignment means two or more centerlines of rotation with no offset or angularity between them. Two or more lines are co-linear when there is no offset or angularity between them (i.e. they follow the same path).

8) COPLANAR: The condition of two or more surfaces having all elements in one plane.

9) COUPLING POINT: The phrase “COUPLING POINT” in the definition of SHAFT ALIGNMENT is an acknowledgment that vibration due to misalignment originates at the point of power transmission, the coupling. The shafts are being aligned and the coupling center is just the measuring point.

10) FLATNESS: The condition of a surface having all elements in one plane.

Note: As used in these specifications, a flat is a small surface flush with or cut into a BASE PLATE, machined flat, and co-planar with the other flats in the base plate. The flats support the shims and/or feet of the machine to be installed. A pad is a small block of metal that serves to elevate the feet of the machine above the surface of the base plate. Pads are commonly used to compensate for differences in machine center line any possible standing fluids. Pads and flats have holes drilled and tapped in their centers to accept hold down bolts.

11) HORIZONTAL: Parallel to the mounting surface.

12) JACKBOLTS, JACKSCREWS, PUSH/PULL BLOCKS: Positioning bolts on the machine base which are located at each foot of the machine and are used to adjust the position of the machines.

13) LASER/TARGET ADAPTER: A laser/target adapter is and adapter which allows the laser/target to be mounted into the spindle or master part.

14) LEVEL: Parallel to a reference plane or a reference line established by a laser.

15) MACHINE: The total entity made up of individual machine components such as motors, pumps, spindles, fixtures, etc. Also reference MACHINE COMPONENT.

16) MACHINE BASE: The structure that supports the machine or machine components under consideration.

17) MACHINE COMPONENT: An individual unit such as a motor, pump, spindle, fixture, etc. often referred to as a machine in its own context.

18) OFFSET: The distance (in thousands of an inch or in millimeters) between two reference centerlines such as a spindle center line and a part characteristic centerline or the rotational centerlines of two parallel shafts.

19) PITCH: An angular misalignment in the vertical plane.

20) POSITION ERROR (CENTERLINE/OFFSET MISALIGNMENT): A misalignment condition that exists when the spindle/shaft centerline is parallel but not in line with (not coincidental) with the desired alignment centerline.

21) PUSH-PULL BLOCKS: Side push-pull adjustment blocks used for aligning machine tool in the horizontal plane.

22) REPEATABILITY: The consistency of readings and results between consecutive sets of measurements.

23) SHAFT ALIGNMENT: Positioning two or more machines components (e.g. a motor driving a centrifugal pump(s). etc.) so that the rotational centerlines of their shafts are co-linear at the coupling center under operating conditions.

24) SPINDLE ALIGNMENT: The geometric relationship between the spindle axis of rotation and a reference datum.

25) SOFT FOOT: A condition that exists when the bottom of all of the feet of the machinery components are not on the same plane (can be compared to a chair with one short leg.) Soft foot is present if the machine frame distorts when a foot bolt is loosened or tightened. It must be corrected before the machine is actually aligned.

PARALLEL SOFT FOOT:	A parallel gap between the machine foot and its support surface.
ANGULAR SOFT FOOT:	An angled gap between the machine foot and its support surface.
INDUCED SOFT FOOT:	A type of soft foot that is caused by external forces, (pipe strain, coupling strain, etc.,) acting on a machine independent of the foot to base plate connection.
“SQUISHY” SOFT FOOT:	A type of soft foot characterized by material, (could be shims, paint, rust, grease, oil, dirt, etc.) acting like a spring between the underside of the machine foot and the base plate contact area.

26) STRESS FREE CONDITION: The condition that exists when there are no forces acting on the structure of a machine, machine component, or machine base that would cause distortion in the structure such as bending, twist, etc.

27) THERMAL EFFECTS (GROWTH OR SHRINKAGE): This term is used to describe displacement of the shaft axis due to machinery temperature changes (or dynamic loading effects) during start-up.

28) TOLERANCE VALUES: Maximum allowable deviation from the desired values, whether such values are zero or non-zero.

29) VERTICAL: Perpendicular to the horizontal plane.

30) YAW MISALIGNMENT: An angular misalignment in the horizontal plane.

END OF SECTION

SECTION 23 05 19

GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

This section specifies pressure gages and thermometers for HVAC systems. Gage requirements and locations are indicated on the drawings.

PART 2 PRODUCTS

2.01 SUGGESTED MANUFACTURERS

Gages and thermometers shall be Ashcroft, Marshalltown, Weiss, Trerice, U.S. Gauge, Helicoid, Weksler, or equal.

2.02 PRESSURE GAGES

A. Gages shall be selected so that the normal operating pressures are between 25 and 75 percent of full scale unless noted otherwise on the drawings.

B. Type PG-1: Industrial quality pressure gauge, pressure ranges up to 1,000 psig, phosphor bronze bourdon tube, brass socket, bottom connection unless noted otherwise, 300 series stainless steel movement, Grade 1A (1%) accuracy per ASME B40.1, adjustable pointer, fiberglass reinforced polypropylene case with solid front and blow out back, shatter proof lens, 4-1/2 inch aluminum dial with white face, black graduations and numerals with 270 degree arc, PSIG/kPa dual scale. Weksler Type BA14-2 or equal.

C. Type PG-2: Process quality pressure gauge, pressure ranges up to 20,000 psig, 316 stainless steel bourdon tube and socket, bottom connection unless noted otherwise, 300 series stainless steel movement, Grade 2A (0.5%) accuracy per ASME B40.1, adjustable pointer, fiberglass reinforced polypropylene case with solid front and blow-out back, shatter proof lens, 4-1/2 inch aluminum dial with white face, black graduations and numerals with 270 degree arc, PSIG/kPa dual scale. Weksler Type AA44-2 or equal.

D. Type PG-3: Same as Type PG-1 except as follows: 316 stainless steel bourdon tube and socket, dual scale of 0-100 psig/0-231 feet of water. Weksler Type BN44-2 or equal.

E. Type PG-4: Same as PG-1 except as follows: 316 stainless steel bourdon tube and socket, liquid-filled case, Grade 2A (0.5%)

accuracy per ASME B40.1. Weksler Type AY44-2 or equal. Provide piston type pressure snubber.

F. Type PG-5: Steam Service - Process quality pressure gauge, pressure ranges up to 400 psig, 316 stainless steel bourdon tube and socket, bottom connection unless noted otherwise, 300 series stainless steel movement, Grade 2A (0.5%) accuracy per ASME B40.1, adjustable pointer, aluminum case with solid front and blow-out back, black epoxy finish, shatter proof lens, 4-1/2 inch aluminum dial with white face, black graduations and numerals with 270 degree arc, PSIG/kPa dual scale. Weksler Type AA44-4 or equal. Provide stainless steel siphon tube for steam service.

G. Type PG-6: Differential Pressure Gage, Low Pressure Service – Cast aluminum case and bezel, silicone rubber blowout plug, acrylic lens, o-ring seal, silicone rubber diaphragm, magnetically actuated linkage with jeweled bearings, red tipped pointer, zero adjustment screw, accuracy 2% of full scale, 4 inch white dial with black graduations and numerals, Inches of Water scale, duplicate 1/8 inch female NPT connections on back and side, surface or flush mounting with included hardware. Dwyer Series 2000 Magnehelic or equal.

H. Type PG-7: Steam Service – Pressure range up to 400 psi, cast aluminum case, adjustable pointer (recalibratable), 4 ½” face, black lettering on white dial face, phosphor bronze bourdon tube, brass movement, 1% accuracy over middle half of range, bottom ¼” NPT connection. Specify “For Steam Service”. Trerice Series 600C w/siphon and Series 735 gagecock.

2.03 THERMOMETERS

A. Thermometers shall be selected so that the normal operating temperatures are between 25 and 75 percent of full scale unless noted otherwise on the drawings.

B. Dial Type Thermometers: Bimetallic coil element, minimum 3 inch diameter dial, 1% accuracy, external adjustment, stainless steel case, adjustable angle pivoting dial.

C. Liquid Filled Thermometers: Liquid Filled Thermometers: Industrial type, adjustable angle, aluminum case, plastic or safety glass window, six inch minimum scale length, liquid filled glass, mercury free, bronze or brass sensing element, 1% accuracy.

2.04 GAGE COCKS AND VALVES

A. Gage Cocks: For water in carbon steel or copper piping - Brass body, tee handle, 1/4” FPT connections; suggested make and model as follows:

1. Working pressure up to 125 psig - Weksler Type A10 or equal.
2. Working pressure 125 to 250 psig - Weksler Type A10E, Ernst Gage Co. Figure 123, or equal.

B. Gage Cocks: For steam and steam condensate service.

1. Working pressure up to 75 psig - Brass body, tee handle, 1/4” FPT connections; Weksler Type A-10 or equal.
2. Working pressure 75 to 300 psig - Bronze body, tee handle, 1/4” FPT connections; Ernst Gage Co. Figure 3 or equal.

C. Trumpet Valves: Brass manifold with push-button valves for multiple point pressure readings with a single gage (number of connections per drawing); complete with spring-return push-buttons, 1/4” o.d. compression connections, mounting bracket, and gage equal to Type PG-3 (unless otherwise noted); 200 psig working pressure; Flow Conditioning Corp. TV Series or equal.

2.05 SIPHON TUBES

Brass or black iron, 1/4" MPT ends, minimum rating of 250 psig at 400°F; Weksler type A03B or A03I, Ernst Gage figure 750, or equal.

2.06 THERMOWELLS

Separable well, nonferrous, sized to accommodate thermal sensing element; Weksler, Trerice, Ernst Gage, or equal.

PART 3 EXECUTION

3.01 Install all gages and thermometers where they are readily accessible for reading and maintenance.

3.02 Provide gage cocks or needle valves for all pressure gages. In addition, provide siphon tubes for all steam pressure gages.

3.03 Provide thermowells for all thermometers .

3.04 On insulated piping, provide lagging extensions or other stand-off fittings for all gages and thermometers.

END OF SECTION

SECTION 23 05 23

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies valves for HVAC piping systems.

B. Metal Tags - all piping equipment, control valves, header branch valves & accessories shall be provided with a 2" dia, brass or aluminum, ID tag indicating the equipment designation number, function of the control, etc. (This must match the drawing or control diagram designations). Also include project drawing number. Tags shall be wired to valve or equipment w/#12 AWG (0.0808 inch dia.) galvanized wire. All information is to be stamped.

PART 2 PRODUCTS

2.01 GENERAL VALVE SELECTION CRITERIA

A. Valve patterns for each installation shall be as indicated symbolically on the drawings (i.e. ball valve, gate valve, etc.).

B. Valves shall be selected from the tables in paragraph 2.02 unless the drawings indicate a specific type designation, or a valve is specified by manufacturer and model number.

C. The working pressure ratings for valves submitted may differ from those specified herein, provided they are adequate for the actual system operating pressures and temperatures.

D. Flow factors and orifice sizes specified are minimums, unless otherwise noted on the drawings.

E. Valves shall be full line size, except where a smaller valve equals or exceeds the flow capacity required herein.

2.02 VALVE TYPE SELECTIONS

A. WATER SERVICE - POTABLE, CHILLED, HEATING, AND INDUSTRIAL WATER UP TO 150 PSIG.

		VALVE TYPE DESIGNATIONS							
LINE SIZE	LOCATION	GATE	GLOBE	CHECK	BALL	BUTTERFLY	NEEDLE	SOLENOID	RELIEF
UP TO 2"	BELOW GRADE	GTV-1							
	ABOVE GRADE	GTV-2	GLV-1**	CHV-1	BLV-1, BLV-2	BFV-1	NV-1*	SOV-1	SRV-1
2 1/2" AND LARGER	BELOW GRADE	GTV-1				BFV-3			
	ABOVE GRADE	GTV-3	GLV-2	CHV-2	BLV-3, BLV-4	BFV-2			SRV-1

*** AVAILABLE UP TO 3/4" NPT ONLY. ** "SEE 2.04A FOR HOSE BIBB SPECIFICATIONS"**

B. STEAM AND STEAM CONDENSATE (VALVES MUST HAVE ID TAG & PSI RATING ON VALVE BOX COVER)

			VALVE TYPE DESIGNATIONS							
MEDIUM	MAX. PSIG	LINE SIZE	GATE	GLOBE	CHECK	BALL	BUTTERFLY	NEEDLE	SOLENOID	RELIEF
STEAM ***	125	UP TO 2"	GTV-2**	GLV-3	CHV-1	BLV-1, BLV-2		NV-1*	SOV-2	
		2 1/2" AND LARGER	GTV-3**	GLV-2	CHV-2	BLV-3, BLV-4	BFV-4			SRV-2
	150	UP TO 2"	GTV-4**	GLV-3	CHV-3	BLV-1, BLV-2		NV-1*	SOV-3	
		2 1/2" AND LARGER	GTV-5**	GLV-4	CHV-4	BLV-3	BFV-4			
	250	UP TO 2"	GTV-6**	GLV-5	CHV-5	BLV-5, BLV-6		NV-1*	SOV-4	
		2 1/2" TO 12"	GTV-5**	GLV-4	CHV-4	BLV-7, BLV-8	BFV-5			
STEAM COND.	125	UP TO 2"	GTV-2**	GLV-1	CHV-1	BLV-1, BLV-2		NV-1*	SOV-2	
		2 1/2" AND LARGER	GTV-3**	GLV-2	CHV-2	BLV-3, BLV-4				

*** AVAILABLE UP TO 3/4" NPT ONLY**
**** MAY BE USED FOR STEAM WHERE POSITIVE SHUTOFF IS NOT REQ'D. IF POSITIVE SHUTOFF IS REQ'D, CAST STEEL, EQUIPMENT VALUES ARE REQ'D.**
***** IF POSITIVE SHUT-OFF IS REQUIRED, VALVE SHALL BE CARBON STEEL BALL VALVE WITH FULL PORT, 2-PIECE DESIGN, ANSI 300# FLANGE CONNECTIONS, AND STAINLESS STEEL TFE SEATS DESIGNED FOR BUBBLE-TIGHT SHUT-OFF. PBM #ANE L1M H---8- OR APPROVED EQUAL.**

C. REFRIGERANT SERVICE

1. VALVE TYPE SELECTION

	VALVE TYPE DESIGNATIONS			
LINE SIZES	GLOBE	CHECK	BALL	SOLENOID
1/4 TO 1-1/8"	GLV-10 GLV-11	CHV-12 CHV-13	BLV-12	SOV-10
1-1/4" TO 3-1/8"	GLV-12	CHV-13		

2. ADDITIONAL SELECTION CRITERIA

a. Refrigerant valve selections shall be made in accordance with the manufacturer's recommendations, based on refrigerant system capacities and operating conditions shown on the drawings.

b. Solenoid and check valves shall be selected by capacity, not by line size.

2.03 VALVE TYPE SPECIFICATIONS

A. GATE VALVE

1. TYPE GTV-1: AWWA approved, iron body, bronze mounted, non-rising stem, double disc, parallel seat, 200 psi water working pressure, square operator nut, end connections as required; Stockham G-700 Series or approved equal.

2. TYPE GTV-2: Bronze body, rising stem, Class 125, solid disc, Stockham Fig. B-100 (threaded), Hammond #IB640 (threaded), Stockham Fig. B-108 (soldered), Hammond #IB635 (soldered), or approved equal.

3. TYPE GTV-3: Iron body, bronze mounted, rising stem, Class 125, flanged, solid wedge disc, OS&Y type; Stockham Fig. G-623, Hammond #IR1140, or approved equal.

4. TYPE GTV-4: Bronze body, rising stem, Class 150, solid disc; Stockham Fig. B-120 (threaded), Hammond #IB629 (threaded), Stockham Fig. B-122 (soldered), Hammond #IB641 (soldered), or approved equal.

5. TYPE GTV-5: Iron body, bronze mounted, rising stem, Class 250, flanged, solid wedge disc, OS&Y type; Stockham Fig. F-667, Hammond #IR330, or approved equal.

6. TYPE GTV-6: Bronze body, rising stem, Class 200, threaded, solid disc; Stockham Fig. B-135, or approved equal.

7. Suggested Manufacturers:

a. GTV-1: Stockham, Mueller, Kennedy, or approved equal.

b. GTV-2 thru GTV-6: Stockham, Crane, Nibco, Powell, Milwaukee, Hammond, or approved equal.

B. GLOBE VALVES

1. TYPE GLV-1: Bronze body and disc, Class 125; Stockham Fig. B16 (threaded), Hammond #IB440 (threaded), Stockham Fig. B17 (soldered), Hammond #IB418 (soldered), or approved equal.

2. TYPE GLV-2: Iron body, bronze mounted, Class 125, flanged, OS&Y type, renewable seat and disc; Stockham Fig. G-512, Hammond #IR116, or approved equal.

3. TYPE GLV-3: Bronze body, Class 150, threaded, plug type, renewable stainless steel seat and disc; Crane No. 14-1/2 P or approved equal.

4. TYPE GLV-4: Iron body, bronze mounted, Class 250, flanged, OS&Y type, renewable seat and disc; Stockham Fig. F-532, Hammond #IR313, or approved equal.

5. TYPE GLV-5: Bronze body, Class 200, threaded, plug type, renewable stainless steel seat and disc; Stockham Fig. B-62, Hammond #IB434, or approved equal.

6. TYPE GLV-6: Not used.

7. TYPE GLV-7: Not used.

8. TYPE GLV-8: Not used.

9. TYPE GLV-9: Not used.

10. TYPE GLV-10: Refrigerant service, packless diaphragm type, 500 PSIG maximum working pressure, UL listed, brass body, solder connections, heat stabilized nylon seat disc, stainless steel and phosphor bronze diaphragms, full-size ports, positive backseating, guided stem; Henry "Golden Bantam" Type 516 or approved equal.

11. TYPE GLV-11: Refrigerant service, front-seating packed stem type, 500 PSIG maximum working pressure, UL listed, brass body, solder connections, metal seats; Henry Type 916, Type 926, or approved equal.

12. TYPE GLV-12: Refrigerant service, back-seating packed stem type, 450 PSIG maximum working pressure, bronze body, solder connections, brass wing cap seal, heat stabilized nylon seat disc for liquid service, lead alloy seat disc for hot gas service, full-size ports;

non-rotating, self-aligning disc; Mueller "Globe Master" Series, Henry Type 203, or approved equal.

13. SUGGESTED MANUFACTURERS:

    a. GLV-1 thru GLV-5: Stockham, Crane, Nibco, Powell, Milwaukee, Hammond, or approved equal.

    b. GLV-6 and GLV-9: Not used.

    c. GLV-10 thru GLV-12: Parker, Primore, Henry, Mueller, Danfoss, or approved equal.

C. CHECK VALVES

1. TYPE CHV-1: Bronze body and disc, swing type, Class 125; Stockham Fig. B319 (threaded), Hammond #IB904 (threaded), Stockham Fig. B-309 (soldered), Hammond #IB912 (soldered), or approved equal.

2. TYPE CHV-2: Iron body, bronze mounted, swing type, Class 125, flanged; Stockham Fig. G-931, Hammond #IR1124, or approved equal.

3. TYPE CHV-3: Bronze body and disc, swing type, Y-Pattern, Class 150, threaded; Stockham Fig. B-321, Hammond #IB944, or approved equal.

4. TYPE CHV-4: Iron body, bronze mounted, swing type, Class 250, flanged; Stockham Fig. F947, Hammond #IR322, or approved equal.

5. TYPE CHV-5: Bronze body and disc, swing type, Y-pattern, Class 200, threaded; Stockham Fig. B-345, or approved equal.

6. TYPE CHV-6: Not Used.

7. TYPE CHV-7: Not used.

8. TYPE CHV-8: Not used.

9. TYPE CHV-9: Not used.

10. TYPE CHV-10: Not used.

11. TYPE CHV-11: Not used.

12. TYPE CHV-12: Not used.

13. TYPE CHV-13: Not used.

14. SUGGESTED MANUFACTURERS:

    a. CHV-1 thru CHV-5: Stockham, Crane, Nibco, Powell, Milwaukee, Apollo, Hammond, or approved equal.

    b. CHV-6 thru CHV-11: Not Used.

D. BALL VALVES

1. TYPE BLV-1: Standard port, bronze body, chromium plated ball, TFE seats, manual lever, minimum 200 psi w.o.g. and 150 PSI w.s.p., threaded or soldered ends; Apollo 70-100 series, Watts B-6000 Series, PBM, or approved equal.

2. TYPE BLV-2: Same specification as BLV-1 except full port; Apollo 77-100 series, Watts B-6080 Series, PBM,or approved equal. Note: Watts valve has a maximum steam pressure of 125 PSIG.

3. TYPE BLV-3: Standard port, cast iron or carbon steel body, reinforced TFE seats and seals, ANSI Class 150 flanged ends, manual lever; Apollo 88-100 Series, Watts CF-1500 Series, PBM, or approved equal.

4. TYPE BLV-4: Full port, cast iron body, reinforced TFE seats and seals, ANSI Class 125 flanged ends, manual lever; Watts G-4000 Series or PBM, approved equal.

5. TYPE BLV-5: Standard port, 250 PSIG steam service, bronze body, 316 stainless steel ball and stem, vented ball, multi-filled Teflon seats, manual lever, threaded ends; Apollo 70-140-64, Watts B-6400-SS-04, PBM, or approved equal.

6. TYPE BLV-6: Same specification as BLV-5 except full port; Watts B-6400-SS-04, or approved equal.

7. TYPE BLV-7: Standard port, 250 PSIG steam service, carbon steel body, 316 stainless steel trim, bronze filled TFE seats, ANSI Class 300 flanges, manual lever; Velan SB-300 Standard Bore PBM, or approved equal.

8. TYPE BLV-8: Same specification as BLV-7, except full port; Velan SB-300 Full Bore, PBM, or approved equal.

9. TYPE BLV-9: Not used

10. TYPE BLV-10: Not used.

11. TYPE BLV-11: Not used.

12. Suggested Manufacturers for BLV-1 through BLV-8: Stockham, Apollo, Watts, Worcester, Velan, Parker, Whitey, or approved equal.

13. TYPE BLV-12: Refrigerant liquid or hot gas, maximum 500 PSI working pressure, UL listed, brass body and ball, extended copper solder ends, carbon filled teflon ball seals, Teflon or O-ring stern seals, gasketed cap, blow-out proof stem with nylon thrust washer and mechanical stem position stops; Mueller "Ballmaster" Series, Henry Type 900, Nibco Fig. RBV, Watts Series REB100, or approved equal.

14. TYPE BLV-13: 600 PS1G W.O.G., bronze full port ball valve w/ stainless steel ball, stem, & latch lock handle, threaded ends. Typically used as a secondary containment block/release valve. Apollo Series # 77-140-27 or approved equal.

E. BUTTERFLY VALVES

1. Except where otherwise indicated, provide manual detent levers for valves up to 8-inch NPS, and manual gear operators for larger sizes.

2. TYPE BFV-1: 350 PSI w.o.g., 29" Hg vacuum, bronze body, stainless steel disc and stem, Viton seals; Milwaukee "Butterball" Series BB2-100 (threaded), Series BB2-350 (soldered) or approved equal.

3. TYPE BFV-2: 200 PSI CWP, lug or wafer pattern (as noted on drawings), cast iron body, aluminum bronze disc, phenolic-backed elastomer seat; Stockham LG Series or approved equal.

4. TYPE BFV-3: Same as BFV-2, with extension stem to raise actuator to a minimum of twelve inches above grade, unless otherwise indicated.

5. TYPE BFV-4: ANSI Class 150, lug or wafer pattern, nickel aluminum bronze body and disc, monel shaft and thrust bearing, filled TFE seats and seals; Jamesbury Type 815 or approved equal.

6. TYPE BFV-5: Same as BFV-4, except ANSI Class 300; Jamesbury Type 830 or approved equal.

7. Suggested manufacturers: Crane, Stockham, Jamesbury, Keystone, Milwaukee, Grinnell, or approved equal.

F. NEEDLE VALVES

1. TYPE NV-1: Class 200, bronze body, threaded ends, globe pattern; Stockham Fig. B-64 or approved equal.

2. TYPE NV-2: Not used.

3. TYPE NV-3: Not used.

4. TYPE NV-4: Not Used.

5. Suggested manufacturers:

   a. Type NV-1: Stockham, Crane, Milwaukee, or approved equal.

   b. Type NV-2 thru NV-4: Not used.

G. SOLENOID VALVES

1. Valve configurations, electrical requirements, and normal position shall be as shown on the drawings.

2. Valves specified by model number below are 2-way valves. 3-way and 4-way valves for the same applications shall meet the same specifications.

3. Unless otherwise indicated, the orifice diameters of all solenoid valves shall equal or exceed the I.D. of the associated pipe or tubing.

4. TYPE SOV-1: 150 PSI w.o.g., slow closing, pilot operated, brass or bronze body, NPT connections, Buna-N disc; ASCO 8221 Series or approved equal.

   Water hammer characteristics of type SOV-1 valves shall meet the requirements of Fluid Controls Institute Standard FCI-82-1, class CC (up to 3/4") or class BB (1" to 2 1/2").

5. TYPE SOV-2: 125 PSI steam working pressure, brass or bronze body, NPT connections, Teflon disc; ASCO Hot Water/Steam Series or approved equal.

6. TYPE SOV-3: Same as SOV-2, except minimum 200 PSI steam working pressure; Atkomatic Series 4000 (up to 1- 1/2"), or approved equal.

7. TYPE SOV-4: 250 PSI steam working pressure, stainless steel body, NPT connections; Atkomatic Series 8000 or approved equal.

8. TYPE SOV-5: Not used.

9. TYPE SOV-6: Not used.

10. TYPE SOV-7: Not used.

11. TYPE SOV-8: Not used.

12. TYPE SOV-9: Not used.

13. TYPE SOV-10: Refrigerant service, direct or pilot operated, 500 PSIG maximum operating pressure, brass or ductile iron body, extended copper solder connections, stainless steel and brass internals, neoprene seats; Parker RA and RB Series or approved equal.

14. Suggested manufacturers:

    a. SOV-1 thru SOV-4: Asco, Atkomatic, J.D. Gould, Magnatrol, Skinner, Parker, or approved equal.

    b. SOV-10: Parker, Sporlan, Alco, Danfoss, or approved equal.

H. SAFETY/RELIEF VALVES (SRV'S)

1. SRV capacities and set pressures shall be as specified on the drawings.
2. SRV capacities shall be A.S.M.E. National Board certified.
3. SRV's shall provide the specified relief capacity with a maximum overpressure of 10% for steam and 25% for water service.
4. Inlet connection sizes shall be determined by required flow capacity,not by service line size. Discharge piping shall be the full

size of the SRV discharge connection, unless the drawings indicate larger.

5. TYPE SRV-1: Water and low-pressure inert gas services.

   a. Body materials - brass, bronze, iron, or carbon steel.
   b. Trim materials - brass, bronze, or stainless steel.
   c. Seat materials - Neoprene, Buna-N, Viton, EPR, or Teflon soft seats.
   d. Connections - NPT or ANSI 150# flanges.

6. TYPE SRV-2: Steam service

   a. Body materials - brass, bronze, iron, or carbon steel.
   b. Trim materials - brass, bronze, or stainless steel.
   c. Seat materials - nonferrous metal seats or Viton, EPR, Teflon, or KEL-F soft seats.
   d. Provide manual lift lever for all steam service SRV's.
   e. Connections - NPT or ANSI flanges appropriate for the maximum line pressure.

7. TYPE SRV-3: Not used.

8. Suggested manufacturers:

   a. Types SRV-1 and SRV-2: Anderson-Greenwood, Kunkle, Conbraco, Watts, Cash/Acme, Crosby, Spirax/Sarco, Armstrong, or approved equal.
   b. SRV-3: Not used.

2.04 MISCELLANEOUS VALVES AND ACCESSORIES

A. Hose Bibbs: Water service, 125 PSI w.o.g., bronze body, NPT or solder inlet connection, 3/4-inch hose thread outlet; Nibco Figure #46 or approved equal.

B. Valve Boxes: Roadway extension box, cast iron, two- or three-piece, adjustable, with tee handle valve wrench and drop lid with service identification; Kennedy, Mueller, or approved equal.

C. Chainwheel Operators: Cast iron construction, stem- or handwheel-mounted type, with chain guide, galvanized chain, and all required mounting hardware; as manufactured by Babbitt Steam Speciality Company or approved equal.

D. Hammer-Blow Chainwheel Operators: Ductile or malleable iron construction, handwheel-mounted, with sprocket rim, hammer-blow mechanism, chain guide, galvanized steel chain, and all required mounting hardware; as manufactured by Babbitt Steam Speciality Company or approved equal.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Provide valves where indicated on the drawings, and as otherwise required for proper system operation.

B. Provide shut-off valves (Ball, Butterfly, or Gate) in all branch connections to mains, and at each piece of equipment.

C. Install all valves to be accessible for maintenance. Where valves are unavoidably concealed in furred spaces, provide maintenance access panels.

D. Install valves with stems vertical if possible. Otherwise, mount with stems horizontal.

E. Remove internal parts of valves, or otherwise protect them from excessive heat during soldering, unless manufacturer’s literature indicates otherwise.

3.02 SAFETY/RELIEF VALVES (SRV'S)

SRV relief pressure settings shall be certified in one of the following ways.

A. Submit a manufacturer's Factory Test Report verifying factory testing and adjustment.

B. Submit an independent agency's Test Report.

C. Perform a bench test in the presence of the Government Inspector.

1. Use a test media that is identical to the contents of the system where the valve will be installed.
2. Use a calibrated test gage to verify the relief pressure setting.
3. Test and adjust the SRV until it consistently relieves at the indicated pressure +/- 5 percent up to 1000 PSIG, and +/- 1 percent above 1000 PSIG.
4. Submit a Field Test Report signed by the witnessing Government Inspector.

3.03 VALVE ACCESSORIES

A. Provide valve boxes and tee handles for all type GTV-1 gate valves.

1. In paved areas, the top of the valve box shall be flush with the pavement. Repair surrounding pavement to match existing.
2. In unpaved areas, provide a 24 inch square or 24 inch diameter round x 4 inch thick reinforced concrete slab around the top of the valve box. The top of the valve box and slab shall be approximately one inch above finished grade. The slab shall taper down to grade at the edges.

B. Chain Operators

1. Provide chain operators for valves as indicated on the drawings.
2. Provide hammer-blow type chainwheel operators for gate valves.
3. When chainwheels are required for butterfly valves, provide valves with manual gear drive operators instead of detent levers.
4. When chain operators are required for ball valves, provide valves with chain levers and dual pull chains.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING & EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

Work specified in this section includes the following:

A. Hangers, supports, supporting elements, and structural attachments for mechanical piping and tubing.

B. Pipe sleeves, seals, and escutcheons.

C. See Section 03 33 00 for mechanical equipment support pads.

PART 2 PRODUCTS

2.01 STANDARDS

A. Type numbers specified below refer to those identified in Manufacturers Standardization Society (MSSP) Standard SP-69.

B. Hangers, supports, and attachments shall be Factory Mutual approved or UL listed.

2.02 HANGERS AND SUPPORTS FOR PIPE AND TUBING

A. Pipe Hangers: Malleable iron or carbon steel, adjustable, Type 1 (Clevis) or Type 6 (Split ring); Anvil Figures 104, 260,and 300, or equal.

B. Vertical pipe supports: Riser clamp, Type 8, black carbon steel; Anvil Figure 261 or equal.

C. Trapeze hangers: For multiple parallel piping - carbon steel channel, properly sized to support the intended load; Anvil Figure 46 or equal.

D. Roller supports: Adjustable, cast iron roll and sockets, steel roll rod, Type 41; Anvil Figures 175 and 177, or equal.

E. Tubing supports: 12 gage steel channel, 1-5/8" square, factory applied finish, with compatible tubing clamps; Unistrut or equal.

F. Tubing cushion: Elastomeric tubing wrap for vibration and temperature isolation, for use with tubing clamps; Unistrut "Unicushion" P-2600 or equal.

G. High-pressure tubing clamps: Interlocking split-block type, aluminum alloy body; as manufactured by the V-G Interlocking Tube Clamp Company or equal.

H. Hydraulic tubing clamps: Galvanized steel clamps with molded resilient elastomer inserts; as manufactured by Hydrazorb, ZSI “Cush-a-Clamp,” Hydro-craft, or equal.

I. Insulation protection shields: Type 40, galvanized carbon steel, minimum 18 gage, minimum 12 inch length, for use with pipe hangers; Anvil Figure 167 or equal.

J. Insulation protection saddles: Type 39A or 39B, steel, minimum 12 inch length, for use on hot pipes with roller supports; Anvil Figures 160 thru 166A, or equal.

K. Pipe & Tubing Roof Mounted Supports: To be "Pipe Pier Pipe Supports" as manufactured by ERICO, Inc.

L. Other types of hangers and supports may be submitted for approval.

2.03 SUPPORTING ELEMENTS

A. Threaded rod: Carbon steel, threaded one end, both ends, or continuous; Anvil Figures 140 and 146 or equal.

B. Turnbuckle: Forged steel, Type 13; Anvil Figure 230 or equal.

C. Clevis: Forged steel, Type 14; Anvil Figure 299 or equal.

D. Angle brackets: Carbon steel, welded construction, type selected according to the supported load; Anvil Figures 194, 195, and 199 or equal.

2.04 STRUCTURAL ATTACHMENTS

A. Welded attachments: Carbon steel, Type 22 (Anvil Figure 66), Type 57 (Anvil Figure 55), or equal.

B. Beam Attachments

1. C-Clamps: For piping 1 1/2" and smaller, black malleable iron body with hardened steel set screw; Type 23, with retaining clip for I-beams or locknut for channel; Anvil Figures 86 and 87 or equal.

2. Beam Clamps: Malleable iron, center loading, Type 21, 28, 29, or 30; Anvil Figures 131, 228, 229, and 292 or equal.

C. Masonry Attachments

1. Concrete inserts: Cast-in-place, single point, carbon steel, Type 18, Anvil Figure 285 or equal.

2. Concrete inserts: Cast-in-place, continuous, carbon steel; Unistrut Series P-3200 or equal.

3. Anchor bolts: Cast-in-place, carbon steel, with steel pipe sleeve; B-Line Figure B3022 or equal.

4. Concrete anchors: For cast concrete; self-drilling, wedge or expansion sleeve type; Phillips "Red-head" or equal.

5. Masonry anchors: For brick and concrete block, full length expansion sleeve type; ITW Ramset "Dynabolt" or equal.

2.05 SUGGESTED MANUFACTURERS

A. Pipe hangers, supports, supporting elements and attachments shall be as manufactured by Anvil, Michigan Hanger Co., Elcen, B-line, Unistrut, or approved equal.

B. Masonry attachments shall be as manufactured by Phillips, ITW Ramset, HILTI, Molly Fastening Systems, Rawl-Plug Co., or approved equal.

2.06 SUPPLEMENTARY STEEL

Supplementary steel for pipe and equipment supports shall be ASTM A36 structural shapes or commercial strut systems (Unistrut or equal).

2.07 VIBRATION ISOLATORS

A. Vibration isolators for mechanical equipment shall be rubber-in-shear or spring type as manufactured by Vibration Mounting and Controls Inc. or equal unless otherwise specified.

B. Unless otherwise specified, vibration isolators for mechanical equipment shall be selected and provided by the equipment manufacturer for the specific type of installation indicated.

2.08 PIPE SLEEVES AND RELATED PRODUCTS

A. Sleeves for masonry walls and floors: Standard weight PVC or galvanized steel pipe.

B. Escutcheons, interior, up to 4" NPS: One or two-piece, chromed steel, sized to conceal the pipe penetration.

C. Escutcheons, exterior, and interior above 4" NPS: Cast iron, black (interior) or galvanized (exterior) with set screws; Grinnell Figure 395 or equal.

D. Wall sleeve seals: Watertight mechanical compression seal consisting of EPDM rubber links with glass reinforced plastic pressure plates and galvanized steel bolting; MetraFlex “MetraSeal” or equal.

PART 3 EXECUTION

3.01 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping within one foot of each elbow, and at maximum intervals specified below.

1. Steel Pipe

Nominal Pipe Size	Maximum Spacing, Ft.	Hanger rod Diam., In.
1/2	6	3/8
3/4 to1-1/2	8	3/8
2 & 2 -1/2	10	3/8 & 1/2
3	12	1/2
4	14	5/8
6	18	3/4
8	20	7/8
10 & 12	22	7/8

2. Copper Pipe (Water Tube)

Nominal Size, In.	Maximum Spacing, Ft.	Hanger rod Diam., In.
1/2-1	6	3/8
1 1/4-2 1/2	8	3/8
3	10	1/2
4	12	1/2

3. PVC Pipe - Support spacing shall be as shown below. For temperatures other than those listed, use spacing for the next highest listed temperature. Spacing is shown in feet.

FLUID TEMPERATURE, ^{o}F

PIPE SIZE	40	60	80	100	120	140	160
1/2 & 3/4	5.5	5.5	5	4.5	4	3	1.5
1 & 1-1/4	6.5	6	5.5	5.5	4.5	3.5	2
1-1/2 & 2	7	6.5	6	5.5	5	3.5	2
2-1/2 & 3	8	7.5	7	6.5	5.5	4.5	2.5
4	8.5	8	7.5	7	6	4.5	2.5
6	9	8.5	8	7.5	6.5	5	3
8 & 10	10.5	10	9	8.5	7	5.5	3
12	11	10.5	10	9	8	6	3.5

4. HDPE PIPE

a. Support spacing as shown is based on SDR-11 HDPE pipe .

b. Support spacing as shown below is based on 70F ambient & fluid temperature and shall be considered as maximum spacing allowed.

c. For warmer temperatures, refer to www.plasticpipe.org, “HDPE Handbook”.

d. Support spacing below allows 1“sag between supports, at above conditions, per HDPE Handbook calculations.

e. HDPE exposed to sunlight shall be, as a minimum, insulated and wrapped with aluminum reflective tape.

f. Support hanger contact shall not be a “point” contract, but a minimum of 4D long either side of the hanger centerline.

g. If no sag is allowable, place HDPE pipe on cable tray or place HDPE pipe in the “V” of an approximately like-sized angle iron. Secure HDPE to angle iron with plastic wire ties every 12”cc.

h.

D (DIAMETER)	HORIZONTAL SPACING*	HORIZONTAL SPACING**	VERTICAL SPACING**
½”	43 3/4”	24” t	48”
¾”	48 1/2”	26 1/2” t	48”
1”	54 3/4”	30” t	48”
1 1/4”	61 3/4”	34” t	48”
1 1/2”	66”	36 1/4” t	48”
2”	73 3/4”	41”	54”tt
3”	89 1/2”	51”	67”tt
4”	101 1/2”	56”	74”tt

*Calculated from HDPE Handbook
**Recommended in 2006 International Building Code
t Interpolated comparing 2006 IBC to Hdpe Handbook Calcs
tt Interpolated

B. Support piping so that connected equipment does not bear piping loads.

C. Provide additional supports near heavy components (valves, filters, in-line pumps, etc.) to minimize load on pipe.

D. Install hangers to provide minimum 1/2-inch clear space between finished covering and adjacent work.

E. Use hangers which are vertically adjustable 1-1/2 inch minimum after piping is erected.

F. Size hangers on insulated piping to accommodate insulation. Use galvanized steel shields to protect the insulation. Where the insulation is soft and will not support the piping without being crushed, install wood blocking or rigid insulation in the shield.

G. Where several pipes can be installed parallel and at the same elevation, trapeze hangers may be used.

H. Where possible, support riser piping independent of connected horizontal piping. In multi-story buildings, support risers at each floor.

I. Hangers for uninsulated copper piping shall be copper plated or plastic coated.

3.02 TUBING SUPPORTS

A. Support stainless steel tubing (except hydraulics) within one foot of bends, elbows, and tees, and at maximum intervals specified below.

Nominal Tube O.D.	Horizontal Tubing Runs	Vertical Tubing Runs
Up to 3/8”	4 Ft	5 Ft
1/2”-3/4”	6 Ft	7 Ft
1”	9 Ft	10 Ft

B. Where multiple tubing runs are supported together on common supports, the spacing shall be as specified for the smallest tubing size supported.

C. “V-G” clamps are required only if specified on the drawings. However, they may be used at the Contractor‘s discretion for supporting all tubing except hydraulics.

D. Support hydraulic tubing with steel strut and hydraulic clamps. Support spacing shall be as follows.

1. Spacing shall not exceed 60 tubing diameters.

2. On straight runs of tubing exceeding 20 feet, vary the spacing between supports by approximately 15% to break up and change vibration frequency.

3. Support tubing as close as possible to each side of bends.

4. Support tubing within one foot of connections to flexible hoses.

5. Support tubing adjacent to all in-line valves.

3.03 CONCRETE INSERTS

Provide a 1-foot (minimum) length of 1/2-inch rebar to anchor each single point insert.

3.04 SUPPLEMENTARY STEEL

Welding of supplementary steel shall be in accordance with the procedures described in AWS D1.1. Welder qualification testing is not required unless noted on the drawings or Schedule of Submittals.

3.05 PIPE SLEEVES

A. Provide sleeves where piping penetrates walls or floors with the following exceptions.

1. Sleeves are not required where penetrations are core drilled through cast concrete.

2. Sleeves are not required for interior partition (frame) walls unless indicated on the drawings to preserve fire rating.

3. Where piping passes through new concrete slab floors, 1/2 inch thick closed cell foam insulation, extending two inches above and below slab, may be used in lieu of a sleeve.

B. Fill voids in pipe sleeves as follows:

1. Interior fire rated walls and floors - provide a fire barrier system per the drawing details and Section 07 84 00, “Firestopping.”

2. Exterior walls above grade - pack with fiberglass insulation and seal ends with a minimum 1/2 inch depth of silicone sealant.

3. Exterior walls below grade - provide a mechanical seal per paragraph 2.08.D.

C. Provide escutcheons where piping penetrates ceilings, walls, or floors into finished areas, or to visible areas of the building exterior.

3.06 MECHANICAL SUPPORT PADS

Concrete support pads for mechanical equipment shall be constructed per Section 03 33 00, ”Cast-In-Place” Concrete.

3.07 DUCT SUPPORTS

Selection of hanging system shall be at the Contractor's option.

A. The following support sizes, configurations, and spacings are given to show the minimal type of supporting component required.

B. Where installed loads are excessive for the specified hanger spacings, hangers, and accessories, be provided, the hanger spacing may be reduced.

C. 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.

D. Hanger rods, angles, and straps shall be attached to beam clamps.

E. Concrete inserts and masonry anchors & fasteners shall be as per 2.04.C or as approved for the application.

F. 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.

1. Fasteners shall be made from steel conforming to AISI type C1055 or C1070, and shall be treated and finished in accordance with ASTM F 1137, zinc phosphate base.

G. Hanger spacing shall be limited to provide 20 -to-1 safety factor for supported load. Maximum weight supported by any two fasteners shall be 100 pounds. Friction rod assemblies are not acceptable.

H. Where support from metal deck systems is required, support requirements shall be coordinated with installation of metal deck.

I. Ductwork and equipment shall not be hung from roof deck, piping, or other ducts or equipment.

J. Maximum span between any two points shall be 10 feet with lesser spans for duct assemblies, interferences, and loads imposed or permitted.

K. There shall be not less than one set of hangers for each point of support.

L. Hangers shall be installed on both sides of all duct turns, branch fittings, and transitions.

M. Hangers shall be sufficiently cross-braced to eliminate vertical and lateral sway.

N. Perforated strap hangers shall not be acceptable.

O. 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.

P. Where trapeze hangers are used, the bottom of the duct shall be supported on angles sized as follows:

30 and smaller	1-1/4 by 1-1/4 by 1/8-
31 to 48	1-1/2 by 1-1/2 by 1/8-
49 to 72	1-1/2 by 1-1/2 by 3/16-
73 to 96	2 by 2 by 1/4-
97 and larger	3 by 3 by 1/4-

Q. 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.

R. 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 400 pounds when support is from a single purlin or 800 pounds when hanger load is applied halfway between purlins by means of auxiliary support steel provided under this section.

S. 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.

T. 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.

U. Duct supports shall be vibration isolated from the structure.

V. Vibration isolators shall be provided in discharge ducting system for a distance not less than 50 feet beyond the air-handling unit. Deflection of duct and equipment mountings shall be coordinated.

END OF SECTION

SECTION 23 05 33

ELECTRICAL HEAT TRACING FOR HVAC PIPING

PART 1 GENERAL

1.01 SUMMARY

This section of the specification applies to supply and installation of electrical heat tracing system for freeze protection as indicated on the drawing and specified herein.

1.02 REFERENCES

The electrical heat tracing system shall conform to this specification. It shall be manufactured, installed, and tested accordance with the applicable requirements of the latest edition of the following codes and standards:

A. Factory Mutual (FM)
B. Institute of Electrical and Electronics Engineers (IEEE 515)
C. National Electrical Code (NFPA 70)
D. National Electrical Manufacturers Association (NEMA)
E. National Electrical Safety Code (NESC)
F. Underwriters' Laboratories, Inc (UL 746B)
G. American National Standards Institute (ANSI 844 and 202)
H. Occupational Safety and Health Association (OSHA)

1.03 SUBMITTALS

The following shall be submitted along with the electrical heat tracing system as per Schedule of Submittals:

A. Product Data (SD -03)

1. Catalog information for heating cable.
2. Catalog information for control panel.
3. Catalog information for thermostat included in the system.
4. Catalog information for accessories included in the system.

B. Test Report (SD-06)

1 Factory Test Report.
2 Site Acceptance Test Report.

PART 2 PRODUCTS

2.01 SELF-REGULATING HEATING CABLES

A. Self-regulating heating cable shall vary its power output relative to the temperature of the surface of pipe or the vessel. The cable shall be designed such that it can be crossed over itself and cut to length in the field.

B. Cable must be of parallel construction so that it can be cut to length without changing its power output per unit length.

C. Long term stability shall be established by the service life performance test per IEEE 515 Std.

D. Self-regulating heating cable shall be designed for a useful life of 20 years or more with “power on” continuously, based on the following useful life criteria:

1. Retention of at least 75 percent of power after 20 years of operation at the maximum continuous exposure (maintain) temperature.
2. Retention of at least 90 percent of rated power after 1000 hours operation at the maximum published intermittent exposure temperature. The testing shall conform to UL 746B.

E. A warranty against manufacturing defect for a period of 10 years shall be available.

F. All cables shall be capable of passing a 2.5 KV dielectric test for one minute after undergoing a 0.5 kg-m impact.

G. The cable shall be capable of maintaining process temperatures up to 150°F while energized, and a continuous exposure to pipeline temperature of 185°F while de-energized.

H. The heating cable assembly shall be a monolithic construction consisting of two parallel 16 AWG or larger nickel-plated copper bus conductors and a semi-conductive PTC polymer heating element. A poly-ethylene dielectric jacket shall be co-extruded over the heating core and be integrally bonded to the heating core.

J. The basic cable will be covered by means of a metallic braid of tinned copper. The braid will provide a nominal coverage of eighty percent (80%) and will exhibit a resistance not exceeding 0.0.0045 ohm/ft.

K. The cable shall be covered with a corrosion resistant over-jacket.

L. For longer circuit lengths and higher heat loss requirements greater than 10 W/ft @ 50°F, the heating cable shall have 14AWG nickel-plated copper bus conductors.

2.02 TERMINATION OF SELF-REGULATING CABLES

A. All connection components used to terminate heating cables, including power connectors, splices, and tees shall be approved for the respective area classification and approved as a system with the particular type heating cable in use.

B. In order to keep connections dry and corrosion resistant, components shall be constructed of non-metallic, electrostatic charge-resistant, glass-filled, engineered polymer enclosure rated NEMA 4X. The components shall be suitable for use with thermal insulation on pipes or vessel up to 4 inches.

C. Terminals shall be spring clamp wire connection type to provide reliable connection, maintenance free operation and ease of re-entry.

D. Heating cable terminations shall use cold-applied materials and shall not require the use of heat gun, torch or hot work permit for installation.

E. Components shall be rated to minimum of -10°F and maximum of 185°F.

2.03 CONTROL PANEL

Unless specified otherwise in the drawing, the control panel for heat tracing cables shall include the following:

A. Thermal magnetic circuit breaker.

B. Ground fault trip (set at 30mA) and alarm.

C. Continuity alarm.

D. Ambient sensing controller.

PART 3 EXECUTION

3.01 The installation of electrical heat tracing system shall be as per the installation standard of the manufacturer of the heat tracing cables, and must comply with the requirements of Article 427 of NFPA 70.

3.02 The cable shall be tested at the factory as per IEE Std 515 prior to shipment. A Factory Test Report shall be furnished for approval as per Schedule of Submittals.

3.03 The installation shall be tested after the installation for acceptance. Site acceptance shall include insulation test of each heating cable using 1000 Volt megger. The megger reading shall be greater than 20 meg-ohms for each heating cable. A Site Acceptance Test Report shall be furnished for approval as per Schedule of Submittals.

END OF SECTION

SECTION 23 05 48

VIBRATION CONTROLS FOR HVAC PUMPS & ROTATING EQUIPMENT

PART 1 GENERAL

1.01 PURPOSE

The purpose of this specification is to:

A. Reduce operating costs at Marshall Space Flight Center by establishing acceptable vibration levels for new and rebuilt HVAC Pumps and rotating equipment.
B. Improve the life and performance of rotating machines and equipment purchased by Marshall Space Flight Center.
C. Provide a uniform procedure for evaluating the vibration characteristics of a machine for certification and acceptance.

1.02 SCOPE

This specification establishes:

A. Acceptable limits for vibration levels generated by new and rebuilt HVAC Pumps & rotating equipment purchased by Marshall Space Flight Center.
B. Measurement procedures—including standardized measurement axis directions and locations, calibration and performance requirements of instrumentation, and procedures for reporting vibration data for machine certification and acceptance.

1.03 INSTRUMENTATION REQUIREMENTS

Vibration measurements shall be made with an FFT analyzer. The type, model, serial numbers(s) and latest certified calibration date of all equipment used in the measurement of vibration levels for machine certification, shall be recorded and made available upon request.

A. The FFT Analyzer shall be capable of a line resolution bandwidth of delta-f = 300 CPM for the frequency range specified for machine certification unless this restriction would result in less than 400 lines of resolution, in which case the requirement defaults to 400 lines of resolution. (Higher resolution may be required to resolve “Side Bands”, or in Band 1 to resolve machine vibration between 0.3X and 0.8X Running Speed.)
B. The Dynamic Range shall be a minimum of 72 dB.
C. The FFT analyzer shall be capable of applying a Hanning window.

D. The FFT analyzer shall be capable of linear non-overlap averaging.
E. The FFT analyzer shall have anti-aliasing filters.

1.04 MEASUREMENT SYSTEM ACCURACY

The measurement system (FFT analyzer, cables, transducer and mounting) used to take vibration measurements for machine certification and acceptance shall have a measurement system Amplitude accuracy over the selected frequency range as follows:

A. For displacement and velocity measurements +/- 10% or +/- 1 dB.
B. For acceleration measurements +/- 20% or +/- 1.5 dB.

1.05 MEASUREMENT SYSTEM CALIBRATION

A. Vibration equipment (transducer, preamplifier, FFT analyzer, recorder and connecting cable) used to take vibration measurements for machine certification and acceptance must be calibrated by a qualified instrumentation laboratory in accordance with Sections 5.1 and 5.2 of ASNSI S2.17-1980 “Technique of Machinery Vibration Measurement” within one (1) year prior to the date of machine certification.
B. Calibration shall be traceable to the National Institute of Standards and Technology (NIST) in accordance with MIL-STD45662 “Military Standard Calibration Systems Requirements” (June 10, 1980) or latest revision.

1.06 VIBRATION TRANSDUCERS

A. An accelerometer shall be used in the collection of data for machine certification and acceptance. The accelerometer must be selected and attached to the machine in such a way that the minimum frequency (F_{min}) and maximum frequency (F_{max}) as specified in Section 3.1 or specified otherwise by the purchaser, are within the useable frequency range of the transducer and can be accurately measured (reference recommendations of pickup manufacturer and /or Section 6.3, ANSI S2.17-1980).
B. The mass of the accelerometer ands its mounting shall have minimal influence on the frequency response of the system over the selected measurement range. (Typical mass of accelerometer and mounting should not exceed 10% of the dynamic mass of the structure upon which the accelerometer is mounted.) Reference Appendix for Dynamic Mass definition and Procedure to Determine Mass Effect.
C. Integration is acceptable as a means of converting acceleration

measurements to velocity or displacement, or for converting velocity measurements to displacement.

1.07 MEASUREMENT LOCATION DOCUMENTATION CONVENTION

EQUIPMENT ID #	COMPONENT	POSITION	ORIENTATION
AHU-001	MTR	O	V

Figure 1.

EQUIPMENT ID # - MAXIMO # or other identifying tag#
COMPONENT ---- MTR – motor
GBX – gearbox
FAN – fan
PMP – pump
Others as required

POSITION – as noted on sketch which is to be attached to the report
ORIENTATION – H – horizontal
V – vertical
A – axial

1.08 TRANSDUCER & MACHINE MOUNTING CONDITIONS

A. VIBRATION TRANSDUCER MOUNTING

At the designated measurement positions, suitable surfaces shall be provided such that the mounted transducer will attach securely.

1. Hand-held pickups are not acceptable for measurement by this specification.
2. For a magnetic based mounted transducer the location on a machine's surface at which vibration measurements are to be taken shall be machined, if necessary, such that the magnet base can be attached firmly without "rocking".
3. For a stud mounted transducer the machine's surface at which vibration measurements are to be taken shall be in accordance with that specified by the transducer manufacturer (torque, grease, etc.) Designated transducer type to be specified by the purchaser.
4. If an adhesive is used to attach either the transducer or a magnetic mounting pad, the upper frequency limit of the transducer shall be reduced by 20% of the manufacturer's stated resonance for "hard" adhesives and 50% of the manufacturer's stated resonance for "soft" adhesives. Transducer manufacturer's specifications should be consulted.

5. The vibration transducer as mounted must be such that the measurement system Amplitude accuracy over the selected frequency range equals or exceeds the requirements specified in Section 1.03.

B. MACHINE MOUNTING

1. Where a machine can be tested as an individual unit (motor, spindle, etc.) the machine must be mounted as specified in Section 3.21
2. Where an individual machine can be tested only as an assembled unit (eg: motor/pump, motor/fan, etc.) the machine mounting conditions shall be as equivalent as possible/feasible to those to be encountered upon installation at the Government's site.

1.09 TECHNICAL REQUIREMENTS

A. VIBRATION MEASUREMENT UNITS

1. Vibration data for machine certification and acceptance shall be expressed in the following measurement units:

TABLE 1 VIBRATION MEASUREMENT UNITS

Frequency	Hertz (cycles/sec) or cycles per minute (CPM)
Rotation Speed	Revolutions/sec (RPS) or revolutions per minute (RPM)

Amplitude	METRIC	ENGLISH
-Displacement (peak-to-peak)*	Micrometers	Inch (also mil in U.S.)**
-Velocity (Peak)*	Millimeter/sec	Inch/sec
-Acceleration (Peak)*	Meter/sec^2	g's

*Can also use Root-Mean-Square (RMS) **1 "Mil" = 0.001 inch

2. The "Peak" and "Peak-to-Peak" Vibration Amplitude Measurements will be a Calculated Peak not a True Peak. The Calculated Peak will be derived form the RMS level based on the following equations:

   Peak (P) = 1.414 x RMS

   Peak-to-Peak (P-to-P) = 2 x (P) = 2 x 1.414 x RMS

3. If a "True Peak" is required, the units of vibration measurement will be designated by the words "True Peak".

B. FREQUENCY BANDS

The frequency range of measurement shall be divided into sub-groups called bands. The F_{min} and F_{max} for each band will be defined in units of frequency or orders of running speed of the machine. (ref.. Figure 1)

1. Mandatory Bands – Band 1 shall be (0.3 – 0.8) X Running Order, Band 2 shall be (0.8 – 1.2) X Running Order, Band 3 shall be (1.2 – 3.5) X Running Order.
2. Other Bands – Bands 4 through N shall be defined by the specific equipment application.

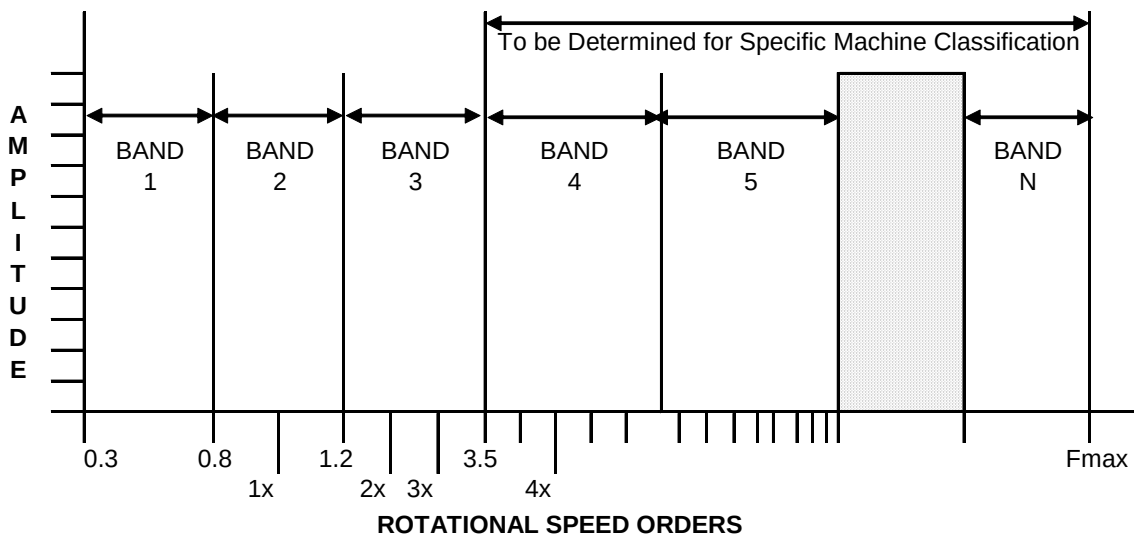


Figure 1 Frequency Bands

C. LINE AMPLITUDE ACCEPTANCE LIMITS

For vibration level limits specified in terms of “LINE AMPLITUDE ACCEPTANCE LIMITS”:

1. A line of resolution will have a band width delta-f = 300 CPM unless specified otherwise (Reference Section 1.09.D.1) requirement for total energy in a peak), or unless the delta-f = 300 CPM restriction would result in less than 400 lines of resolution over the frequency range specified for certification, in which case the resolution requirement will default to 400 lines. (Greater resolution may be required to resolve “Side Bands”, or in Band 1 to

resolve machine vibration between 0.3X and 0.8X Running Speed.)

2. The maximum amplitude of any line of resolution contained within a band shall not exceed the Line Amplitude Acceptance Limit for the Band.

D. BAND-LIMITED OVERALL AMPLITUDE ACCEPTANCE LIMITS

1. For vibration level limits specified in terms of "BAND-LIMITED OVERALL AMPLITUDE ACCEPTANCE LIMITS" the Total vibration level "A" in a band, as defined by the following equation, shall not exceed the Overall Amplitude Acceptance Limit specified for the Band

$$A = \sqrt{\frac{\sum_{i=1}^{N} A_i}{1.5}}$$

sq.root of (sum divided by 1.5)

A = Overall vibration level in the Band

A_i = Amplitude in the ith line of resolution in the Band

(I=1) = The first line of resolution in the Band

(i=N) = The last line of resolution in the Band

N = The number of lines of resolution in the Band. If the total energy in a peak is to be measured, a minimum of 5 lines of resolution must be used and the peak must be centered in the band.

E. If a line of resolution is coincidental with the F_{min}/F_{max} of two adjacent bands, the line of resolution will be included in the band having the lowest acceptance level limit.

F. The amplitude range sensitivity of the FFT Analyzer shall be set to the maximum input sensitivity possible without overloading such that the actual measurement uses at least 60 dB of the Dynamic Range.

G. Certification shall be based on:

1. Hanning Window
2. Four (4) averages (Linear non-overlapping)

H. The transducer mounting shall be such that the measurement system Amplitude accuracy over the selected frequency range equals or exceeds the requirements specified in Section1.03. This may require the use of more than one accelerometer where potentially high frequencies might occur (such as gear

mesh, or harmonics of gear mesh) along with lower frequencies (such as due to unbalance, misalignment, looseness, etc.)

I. ALIGNMENT

1. All coupled rotating machines consisting of consecutive shafts connected through a coupling (whether rigid or flexible) shall be aligned within the tolerances specified in TSRC-8, Section 23 05 00.01 “LASER ALIGNMENT FOR HVAC PUMPS AND ROTATING EQUIPMENT.”
2. Consideration shall be given to any ‘thermal growth” that may occur during the normal operation of the machine the would cause the machine to “grow out of alignment” to the extent that the alignment tolerances of this specification would not be met.

J. BALANCING

1. STANDARD KEY – For rotating machines and machine components with a keyed shaft, balancing will be achieved using a standard one-half key in the key seat in accordance with ISO 8821-1989. If a “full key”, corresponding to the half key used for balancing, is not provided with the rotating machine, a tag will be attached to the machine indicating the dimension of the key used to perform the balance test.
2. The use of solder or similar deposits to achieve rotor balance is not acceptable. Any parent metal removed to achieve dynamic balance or static balance shall be drilled out in a manner which will maintain the structural integrity of the rotor.

1.10 MACHINE QUOTATION, CERTIFICATION, AND ACCEPTANCE

A. SUBMITTALS

1. The submittal shall specify that the equipment meets the applicable vibration limits in Section 3.1 of this Specification or the vibration level limits (if different from Section 23 05 48) as noted on the drawings.
2. The submittal shall indicate the applicable specification vibration level limits being provided.

B. MEASUREMENT REQUIREMENTS FOR MACHINE CERTIFICATION

Vibration measurements shall:

1. Be the responsibility of the supplier unless specified otherwise on the drawings.
2. Be performed by technically qualified person who is trained and experienced in vibration measurement. The technical qualifications of the person doing the vibration certification shall be submitted as a part of the machine vibration certification data.

3. Be taken with the machine operating as specified in Section 3.1 where “no load” is specified, no actual work is taking place during the collection of machine vibration data. Where “rated load” is specified, rated operating load—either actual or simulated—will be applied during collection of machine vibration data.
4. Prior to taking vibration measurements, the machine will be “run in” until it reaches speed and thermal stability.
5. Vibration Signatures as required by Section 3.1 of this specification shall be submitted to the MSFC Maintenance Engineering Department (AS-24) or other authorized representative before acceptance of the machinery or equipment being purchased will be authorized.
6. Vibration data for machine certification shall be measured during “run-off” at the vendor’s facility. Where it is impractical to set-up and test a complete machine at the vendor’s facility, arrangements shall be made to perform the test at the Government’s facility. Under this circumstance, shipment of the equipment does not relieve the vendor of the responsibility for meeting the specified vibration level limits. The Government shall have the option to verify vibration data of equipment during machine “run-off” at the vendor’s test site prior to shipment – or at the Government’s site per Section 1.10.B.6 - prior to final acceptance authorization.
7. The machine layout drawing shall be submitted as part of the Machine Vibration Certification. Vibration measurement locations on the machine’s surface at which vibration measurements are taken shall be designated on the drawing per Section1.07 requirements. At the option of the purchaser, shaft speeds (RPM), gear type and number of teeth, gear mesh frequencies (CPM), bearing manufacturer’s name, bearing type number and class, shall be identified on the machine layout drawing.

C. ACCEPTANCE
Authorization for machine/equipment acceptance based on the vibration limits of this specification requires signature by the Government's authorized representative. A copy of the acceptance must be sent to the purchaser's Purchasing department before final acceptance is authorized.

PART 2 PRODUCTS (none)

PART 3 EXECUTION

3.1 VIBRATION LEVEL LIMITS

A. Electric Motors -- Refer to Section 3.2 "Vibration Standards for Electric Motors"
B. Fans – Refer to Section 3.3 "Vibration Standards for Fans"
C. Pumps – Refer to Section 3.4 "Vibration Standards for Pumps"

3.2 VIBRATION STANDARDS FOR ELECTRIC MOTORS

3.21 ELECTRIC MOTOR REQUIREMENTS

A. Motors will be defined for the purposes of this specification as: "Standard Motor—Utility".
B. The frequency range for motor certification will be F_{min} = 0.3 X Running Speed (synchronous speed) to F_{max} = 120,000 CPM (2000Hertz).
C. Alternating current motors will be tested at rated voltage and frequency, and no load. Single speed alternating current motors will be tested at synchronous speed. A multi-speed alternating current motor will be tested at all its rated synchronous speeds. Direct current motors will be tested at their highest rated speed. Series and universal motors will be tested at operating speed.
D. MOTOR ISOLATION
    1. Place the motor on an elastic mounting so proportioned that the up and down natural frequency shall be at least as low as 25 percent of the test speed of the motor. To accomplish this it is required that the elastic mounting be deflected downwards at least by the amounts shown in the following table due to the weight of the motor. When a flexible pad is used the compression shall in no case

be more than 50 percent of the original thickness of the flexible pad; otherwise the supports may be too stiff.

MOTOR SYNCHRONOUS SPEED (RPM)	ISOLATION PAD COMPRESSION (INCHES)
900	1
1200	9/16
1800	1/4
3600	1/16
7200	1/64

Note: The required deflection is inversely proportional to the speed squared

2. All new and rebuilt motors shall conform to the vibration limits specified in Table 3.2A when tested in accordance with this specification.

E. CRITICAL SPEED

Completely assembled motors shall have a percentage separation between the rotor shaft first actual critical speed and rated motor speed as specified:

ROTOR DESIGN	FIRST ACTUAL CRITICAL SPEED LOCATION
Rigid Shaft	At least 25% Above Rated Motor Speed
Flexible Shaft	Maximum of 85% of Motor Speed

3.22 LIMITS

A. All electric motors defined by NEMA Standard MG-1-1993 Section I “Classification According to Size”, Small (fractional), Medium (integral) and Large Machines, shall meet the following requirements:

1. The Velocity Amplitude (inch/sec-Peak) of any line of resolution, measured at bearing locations in any direction shall not exceed the Line-Amplitude Band Limit values specified in the Table 3.2A and graphed in Figure 3.2 when determined in accordance with Section 1.09.B using the frequency range defined in Section 3.21.B.
2. The Acceleration Overall Amplitude (g’s Peak) at bearing locations in any direction shall not exceed the Band-Limited Overall Amplitude Acceptance Limit values specified in Table 3.2A and graphed in Figure 3.2, when determined in accordance with Section 1.09.B using the frequency range defined in Section 3.21.B.

VELOCITY LINE-AMPLITUDE BAND LIMITS		
BAND	**FREQUENCY RANGE (CPM)**	**STANDARD (INCH/SEC – PEAK)**
1	0.3 x RPM – 0.8 x RPM	0.04
2	0.8 x RPM – 1.2 x RPM	0.075
3	1.2 x RPM – 3.5 x RPM	0.04
4	3.5 x RPM – 8.5 x RPM	0.03
5	8.5 x RPM – 60,000 CPM	0.03
6	60,000 CPM – 120,000 CPM	0.03

ACCELERATION BAND-LIMITED OVERALL AMPLITUDE LIMITS		
BAND	**FREQUENCY RANGE (CPM)**	**STANDARD (g's peak)**
1	0.3 x RPM – 120,000 CPM	0.5

TABLE 3.2A MAXIMUM ALLOWABLE VIBRATION LEVELS FOR ELECTRIC MOTORS (FRACTIONAL AND INTEGRAL HORSEPOWER AC/DC MOTORS

3.23 ELECTRIC MOTOR CERTIFICATION

A. The amplitude of vibration at bearing locations in any direction (radialand axial shall not exceed the values listed in Table 3.2.A.
B. Vibration signatures of velocity and acceleration, and a listing of the maximum peak velocity in each band for vibration measurements taken at position 1 horizontal, position 2 vertical, and position 3 axial shall be submitted as part of the motor certification. The data shall be identified with the Motor Serial Number, Frame Number, Model Number, Horsepower and Synchronous speed.
C. The motor nameplate shall carry the following designation: "0.075 IN/S MAX VIB 1X"
D. Vibration data and signatures must be submitted with the motor to the MSFC Maintenance Department (AS-24) or other authorized representative before acceptance of the motor will be authorized.
E. Motor not meeting the certification shall be rejected.

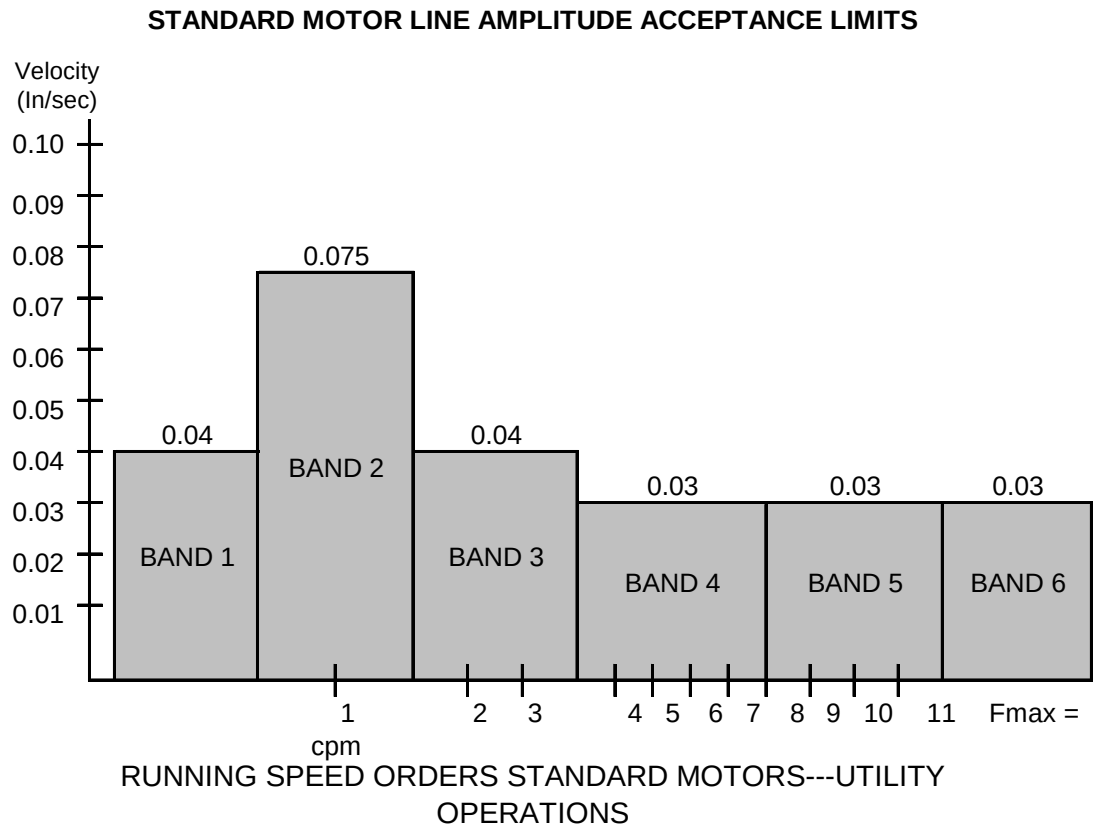


Figure 3.2 Maximum Allowable Vibration Limits for Standard Electrical Motors

3.3 VIBRATION STANDARDS FOR FANS

3.31 Fans are defined as:
All non-positive displacement air handling units including Induced Draft (ID) Fans, Forced Draft (FD) Fans, Overhung Fans, Centerhung Fans, Vaneaxial, Tubeaxial, Blowers, etc.

3.32 BALANCING

A. Permanently attached balancing weights must be secured by welding, bolting, pop-riveting, or of a “clip-on” design.
   1. If bolted, a hardened bolt must be in conjunction with a mechanical locking device (ie. lock washer or lock nut).
   2. “Clip-on” balancing weights can only be used on centrifugal type fans and must be located and attached on the ID pitch of the blades such that the rotation motion of the fan creates a positive seating of the “clip-on” weight against the fan blade.
   3. Balancing weights and methods of attachment must be stable at fan operating temperature, and of a material compatible with the parent material of the fan to which

the balancing weight is attached. The use of stick-on lead weights is not acceptable.

B. Any parent metal removed to achieve dynamic or static balance shall be drilled out in a manner which will maintain the structural integrity of the rotor or sheave.
C. Access to the fan rotor for field balancing shall be designed into the system.
D. It is recommended that components (rotors, shafts sheaves) be balanced individually and then trim balanced as a total assembly.

3.33 SHAFT TOLERANCE

Fan shaft diameter shall meet bearing manufacturer specifications for shaft tolerances.

3.34 RESONANCE

Natural frequencies of the completely assembled fan unit shall not be excited at the operating speed. (Running speed should be at least 25% removed from a natural
frequency for the system.)

3.35 LIMITS

A. New and Rebuilt/Repaired Fans shall conform to the vibration limits specified in Table 3.3A when operating at specified system CFM and Fan Static Pressure
B. The frequency range for fan certification shall be from F_{min} = 0.3 X Running Speed of Fan to 60,000 cpm for velocity and to 120,000 cpm for acceleration.
C. For fan speeds up to 3600 RPM, the maximum velocity amplitude (inch/sec – Peak) of vibration at bearing locations in any direction shall not exceed the Line Amplitude Band Limit values specified in Table 3.3A and graphed in Figure 3.3.1 when determined in accordance with Section 1.09.B.1 using the frequency range defined in Section 3.35.B.
D. For fan speeds up to 3600 RPM, the Band-Limited Overall vibration level of acceleration (g's Peak) at bearing locations in any direction shall not exceed the Band-Limited Overall Amplitude Acceptance Limit values specified in Table 3.3A and graphed in Figure 3.3.2, when determined in accordance with Section 1.09.B.2 using the frequency range defined in Section 3.35.B.
E. Acceptance limits for fans running over 3600 PRM shall be specified by the purchaser.

TABLE 3.3A MAXIMUM ALLOWABLE VIBRATION LEVEL FOR FANS

BAND	FREQUENCY RANGE	VELOCITY LINE AMPLITUDE BAND LIMITS (INCHES/SEC PEAK)
1	0.3 x RPM_{min} 0.8 x RPM_{fan}	0.04 DIRECT COUPLED 0.075 BELT DRIVE
2	0.8 X RPM_{fan} 1.2 x $RPM_{fan/motor}$	0.075
3	1.2 x $RPM_{fan/motor}$ 3.5 x $RPM_{fan/motor}$	0.04
4	3.5 x RPM $_{fan/motor}$ to F_{max} = 60,000 CPM	0.03
		ACCELERATION BAND LIMITED OVERALL AMPLITUDE LIMITS (g's PEAK)
1	0.3 x RPM_{min} to F_{max} = 120,000 CPM	0.5

RPM_{min} = Lowest system speed (e.g. Belt speed if Belt Driven, Fan speed if direct coupled)
$RPM_{fan/motor}$ = Fan or motor speed whichever is greater (IN/SEC)

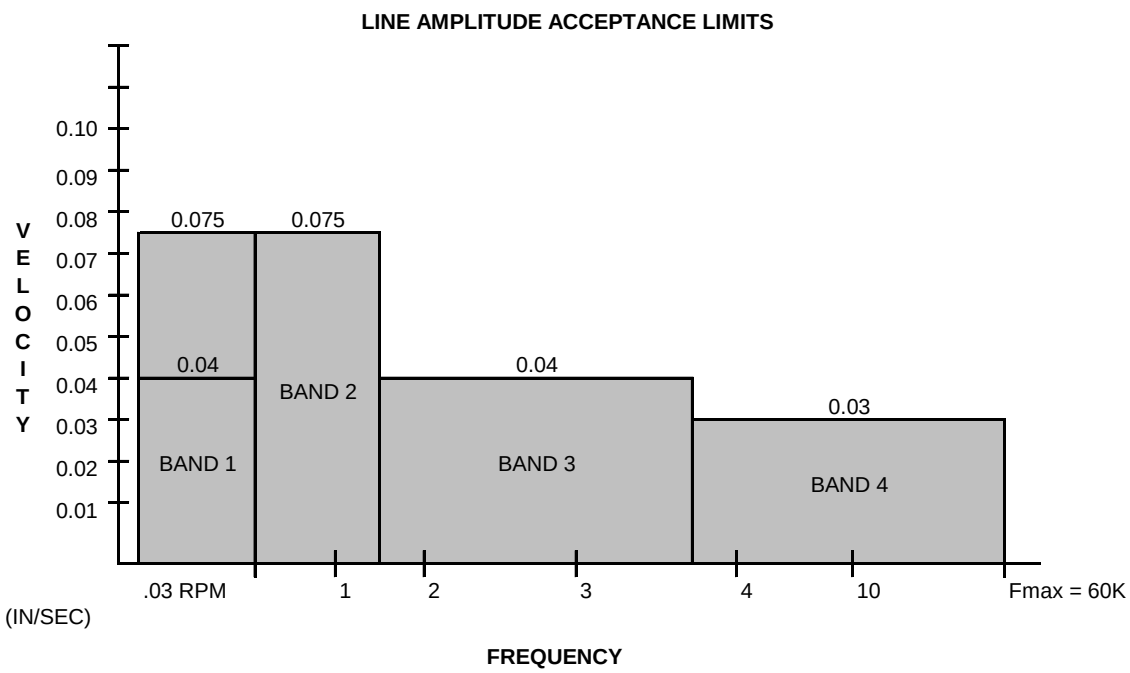


Figure 3.3.1 Line Amplitude Acceptance Limits for Fans

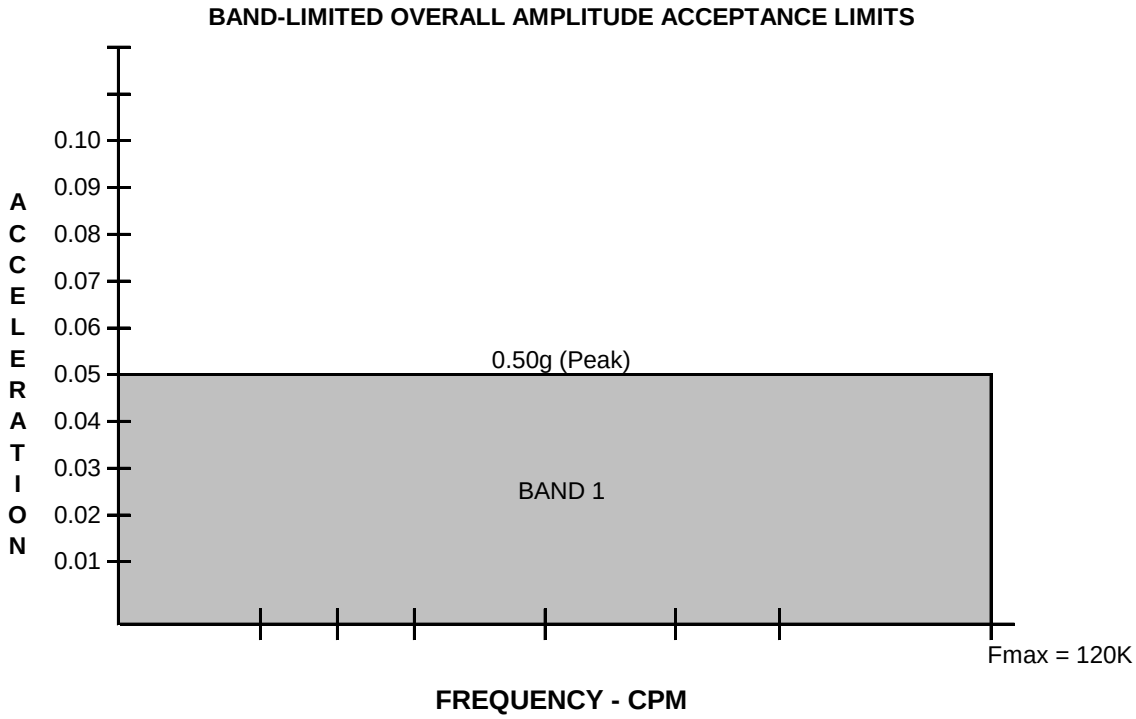


Figure 3.3.2 Band Limited Overall Amplitude Acceptance Limits for Fans

3.36 OTHER REQUIREMENTS

A. Variable speed or adjustable sheaves shall not be used in the final installation.
B. Drive sheave and driven sheave should differ in size by 20% or more to avoid “beat” vibration.

3.4 VIBRATION STANDARDS FOR PUMPS

3.41 Pumps shall be defined in two (2) categories:

A. Positive Displacement – including, but not limited to Piston, Gear, and Vane.
B. Centrifugal.

3.42 OPERATING CONDITIONS

A. Non-cavitating non-separating condition.
B. No piping strain.
C. Shaft coupling aligned
D. Straight suction pipe to pump. (Ref. Hydraulic Institute Standard)
E. Certification shall be performed while pumps are operating within design specifications.

3.43 LIMITS FOR POSITIVE DISPLACEMENT & CENTRIFUGAL PUMPS

A. For purposes of Line Amplitude evaluations a “PUMPING FREQUENCY” (PF) band will be established. The PF Band will be centered on the Pumping Frequency (Number of pumping elements X Pump RPM). The band width will extend + 2 lines of resolution on either side of the line of resolution containing the Pumping Frequency. (ie. Bandwidth = 5 lines of resolution)

B. Excluding the lines of resolution contained in Pumping Frequency (PF) Band, the Velocity Amplitude (Inch/sec-Peak) of any line of resolution, measured at bearing locations in any direction shall not exceed the Line-Amplitude Band Limit values specified in Table 3.4A and graphed in Figure 3.4.1, when determined in accordance with Section 1.09.B.1 using the frequency range from 0.3 X Running Speed (pump RPM) to F_{max} = 120,000 CPM (2000 Hertz).

C. The Velocity Band-Limited Overall Amplitude (Inch/sec-Peak) at bearing locations in any direction shall not exceed the Pumping Frequency Band Limited Overall Amplitude Acceptance Limit value specified in Table 3.4A and graphed in Figure 3.4.1 when determined in accordance with Section 1.09.B.2 using the frequency range from 0.8 X PF to 1.2 X PF.

D. The Acceleration Band-Limited Overall Amplitude (g’s Peak) at bearing locations in any direction shall not exceed the Band-Limited Overall Amplitude Acceptance Limit values specified in Table 3.4A and graphed in Figure 3.4.2 when determined in accordance with Section 1.09.B.2 using the frequency range from 0.3 X Running Speed to 300,000 CPM.

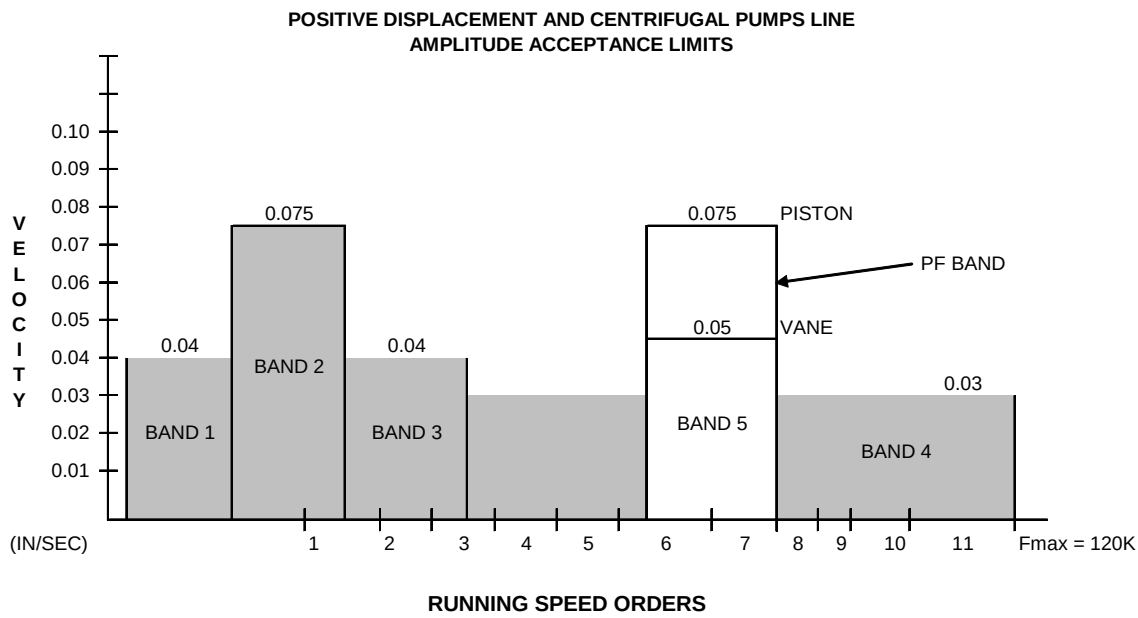
TABLE 3.4A MAXIMUM ALLOWABLE VIBRATION LEVELS FOR POSITIVE DISPLACEMENT AND CENTRIFUGAL PUMPS

BAND	FREQUENCY RANGE (CPM)	VELOCITY (INCH/SEC – PEAK)
1	0.3 x RPM 0.8 x RPM	0.04
2	0.8 x RPM 1.2 x RPM	0.075
3	1.2 x RPM 3.5 x RPM	0.04
4	3.5 x RPM 120,000 CPM	0.03

BAND-LIMITED OVERALL AMPLITUDE LIMITS

BAND	FREQUENCY RANGE (CPM)	ACCELERATION (g's PEAK
1	0.3 x RPM – 300K CPM	1.5g – POSITIVE DESPLACEMENT 1.0g – NON-POSITIVE DISPLACEMENT

PUMPING FREQUENCY BAND (PF)	**FREQUENCY RANGE (CPM)**	**VELOCITY (INCH/SEC – PEAK)**
BAND 5	5 Lines of resolution centered on PF	0.075 PISTON 0.05 VANE



NOTE: BAND 5 IS A FLOATING BAND BANDWITH OF THE PUMPING FREQUENCY ± 2 LINES OF RESOLUTION ACCEPTANCE LIMITS FOR BAND 5 ARE LINE AMPLITUDE VIBRATION LEVELS.

Figure 3.4.1 Line Amplitude Acceptance Limits for Positive Displacement and Centrifugal Pumps

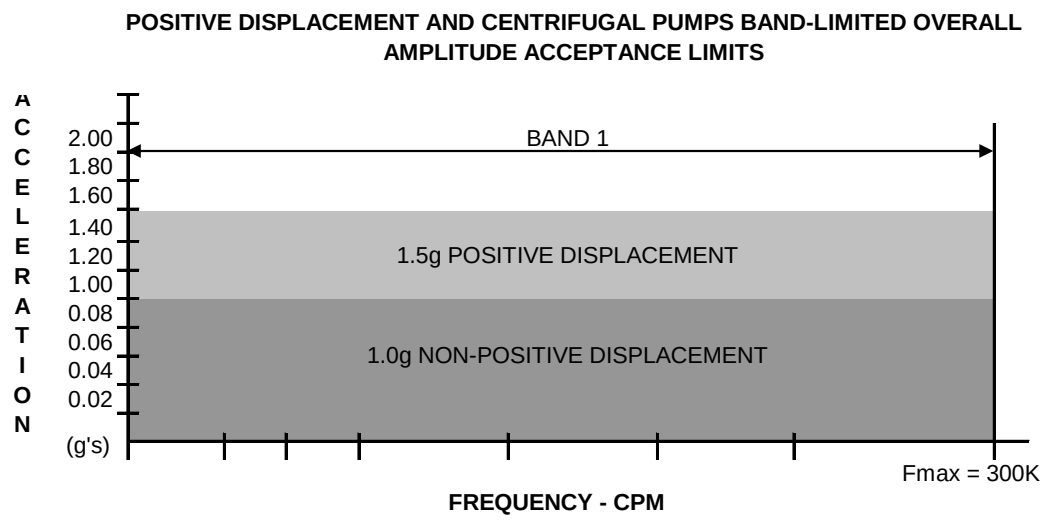


Figure 3.4.2 Band-Limited Overall Amplitude Acceptance Limits for Positive Displacement and Centrifugal Pumps

3.44 VERTICAL MOUNTED PUMPS

A. Vertically mounted pumping systems with a “Vertical Mount Height” greater than 5 feet will have an allowable increase in Velocity Amplitude Acceptance Limit in Bands 1, 2, and 3 of 5% per foot of “Vertical Mount Height” greater than 5 feet. (e.g. A 7 foot Vertical Mount Height would yield a 10% increase [7ft - 5ft) x 5%/ft] in the Table 3.4A Velocity Amplitude Acceptance Limits

specified for Bands 1, 2, and 3. Therefore the limit for Band 1 would be (0.4 Inch/sec + (0.4 Inch/sec x 0.1)] = 0.44 Inch/sec-Peak.

B. Vertical Mount Height is defined as the furthest measurable distance for the machine mounting to the end of the driver or the end of the pump, which ever is greater.

GLOSSARY

ACCELERATION – The time rate of change of velocity. Typical units are ft/sec^2 and g's (1 g = 32.17 ft/sec^2 = 386 in/sec^2 = 9.81 meter/sec^2). Acceleration measurements are made with accelerometers.

Note: By international agreement, the value of 9.80665 m/s^2 = 980,665 cm/s^2 = 386.089 in/s^2 = 32.174 ft/s^2 has been chosen as the standard acceleration due to gravity (g). ISO 2041 (1990)

ACCELEROMETER - Transducer whose output is directly proportional to acceleration. Most commonly used are mass loaded piezoelectric crystals to produce an output proportional to acceleration.

AMPLITUDE – The measure of severity of vibration. Amplitude is expressed in terms of peak-to-peak, zero-to-peak (peak), or rms. For pure sine waves only:

- Peak (P) = 1.414 x RMS
- Peak-to-Peak = 2 x Zero-to-Peak (Peak)

ANTI-ALIASING FILTER – A low-pass filter designed to filter out frequencies higher than ½ the sample rate in order to prevent aliasing.

ANTI-FRICTION BEARING – See ROLLING ELEMENT BEARING.

AVERAGE – The sum of the values of the measurements taken divided by the number of measurements taken.

BALANCE – When the mass centerline and rotational centerline of a rotor are coincident.

BALANCING – A procedure for adjusting the radial mass distribution of a rotor by adding or removing weight, so that the mass centerline approaches the rotor geometric centerline achieving less vibration amplitude at rotational speed.

BAND-LIMITED OVERALL AMPLITUDE – For vibration level limits specified in terms of "BAND-LIMITED OVERALL".

BAND LIMITED OVERALL READING – The vibration severity amplitude measured over a frequency range defined by a F_{min} and a F_{max}.

BEATS – Periodic variations in the amplitude of an oscillation resulting from the combination of two oscillations of slightly different frequencies. The beats occur at the difference frequency. ISO 2041 (1990).

BEAT FREQUENCY – The absolute value of the difference in frequency of two oscillations of slightly different frequencies. ISO 2041 (1990)

BLADE PASS FREQUENCY (PUMPING FREQUENCY) – A potential vibration frequency on any bladed machine (turbine, axial compressor, fan, pump, etc.). It is represented by the number of fan blades or pump vanes times shaft rotating frequency.

COMPLETE MACHINE – A complete machine is defined as the entire assembly of components, sub-components, and structure, which is purchased to perform a specific task(s). On a Complete Machine Assembly with all individual components operating in their normal operating condition, mode, and sequence, the Component Vibration Level Limits for the complete machine acceptance are the same as when the component is tested individually.

CRITICAL SPEED – The speed of a rotating system corresponding to a system resonance frequency.

DECIBEL (dB) – A logarithmic representation of amplitude ratio, defined as 20 times the base tem logarithm of the ratio of the measured amplitude to a reference. dBV readings, for example, are referenced to 1 volt rms. dB amplitude scales are required to display the full dynamic range of an $_F$ Analyzer.

DISPLACEMENT – The distance traveled by a vibrating object. For purposes of this document, displacement represents the total distance traveled by a vibrating part or surface from the maximum position of travel in one direction to the maximum position of travel in the opposite direction (Peak–to–Peak) and is measured in the unit mil (1 mil = 0.001 inch).

DYNAMIC RANGE – The difference between the highest measurable signal level and the lowest measurable signal level that is detectable for a give Amplitude Range setting. Dynamic Range is usually expressed in decibels, typically 60 to 90 dB for modern instruments.

DYNAMIC MASS – To determine if the mass of the transducer is effecting the measurement, perform the following steps:

1. Make the desired measurement with the accelerometer.
2. Place a mass equivalent to the mass of the accelerometer adjacent to the measuring accelerometer.
3. Repeat the measurement.
4. Compare data from 1 and 3.
5. If any differences (i.e. shift in frequencies) between 1 and 3 exist, then a less massive transducer should be used in 1.

FFT ANALYZER – Vibration analyzer that uses the Fast Fourier Transform to display vibration frequency components.

FFT (FAST FOURIER TRANSFORM) – A calculation procedure which produces a mathematical relationship between the time domain and the frequency domain resulting

in discrete frequency components from the sampled time data. (A calculation procedure which converts a time domain into a frequency domain display)

FIELD BALANCING – The process of balancing a rotor in its own bearings and supporting structure rather than in a balancing machine.

FLEXIBLE ROTOR – A rotor that deforms significantly at running speed. This term is used for rotors that operate close to or above their critical speed. A rotor is considered flexible when its speed is more that 75% of its lowest natural frequency in bending.

FORCED VIBRATION – The oscillation of a system under the action of a forcing function. Typically forced vibration occurs at the frequency of the exciting force.

FREE VIBRATION – Vibration of a mechanical system following an initial force – typically at one or more natural frequencies.

FREQUENCY – The repetition rate of a periodic event, usually expressed in cycles per second (Hertz- abr. HZ), cycles per minute (CPM), or multiples of rotation speed (Orders). Orders are commonly referred to as IX for rotational speed, 2X for twice rotational speed, etc. Frequency is the reciprocal of the Period.

- Note: Vibration frequencies are expressed in Hertz (cycles per second) or CPM (cycles per minute). Rotational speed (Running Speed) is expressed in RPM (Revolutions per Minute).

FREQUENCY DOMAIN – Presentation of a signal whose amplitude is measured on the Y-axis, and the frequency is measured on the X-axis.

FREQUENCY RESOLUTION (delta-F) – delta-f = (F_{max} – F_{min})/# Lines of resolution. Delta-f represents the minimum spacing between data points in the spectrum:

F_{max}: Maximum Frequency Limit of the spectrum being evaluated
F_{min}: Minimum Frequency Limit of the spectrum being evaluated

FREQUENCY RESPONSE – Portion of the frequency spectrum which can be covered within specified frequency limits. eg: The value of acceleration produced by the force of gravity. (32.17 ft/sec_2, 386 in/sec_2, 9.91 m/sec_2).

HANNING WINDOW – An i< window function that provides better frequency resolution than the flat top window, but with reduced amplitude accuracy.

HARMONIC – Frequency component at a frequency that is an integer (whole number e.g. 2X, 3X, 4X, etc.) multiple of the fundamental (reference) frequency.

HI BANDPASS FILTER – A device that separates the components of a signal and allows only those components above a selected frequency to be amplified.

HERTZ (Hz) – The unit frequency represented by cycles per second.

IMBALANCE – Unequal radial weight distribution of a rotor system; a shaft condition such that the mass and shaft geometric centerlines do not coincide.

INTEGRATION – A process producing a result that when differentiated, yields the original quantity. Integration of acceleration, for example, yields velocity. Integration is performed in an FFT Analyzer by dividing 2Ilf where f is the frequency of vibration. Integration is also used to convert velocity to displacement.)

LARGE APPARATUS AC/DC MOTORS – Reference NEMA Publication No. MG 1, Motors and Generators, Section III

LINEAR NON-OVERLAPPING AVERAGE – An averaging process where each Time block sample used in the averaging process contains data not contained in other Time blocks (i.e. Non-overlapping) used in the averaging. Linear averaging is performed in the Frequency Domain, and each sample is weighted equally.

LINES - The total number of data points in a spectrum (e.g. 400, 800, 1600, etc.)

LINE AMPLITUDE LIMIT – The maximum amplitude of any line of resolution contained within a band shall not exceed the Line Amplitude Acceptance Limit for the Band.

LINE OF RESOLUTION – A single data point from a spectrum which contains vibration amplitude information. The Line of Resolution amplitude is the Band Overall Amplitude of the frequencies contained in the Af Frequency Resolution.

MICROMETER (MICRON) – One millionth (0.000001) of a meter. (1 micron = 1 x E-6 meters = 0.04 mils)

MIL – One thousandth (0.001) of an inch. (1 mil = 25.4 microns)

NATURAL FREQUENCY – The frequency of free vibration of a system when excited with an impact force (Bump Test).

ORDER – A unit of frequency unique to rotating machinery where the first order is equal to rotational speed. See FREQUENCY

PEAK – Refers to the maximum of the units being measured, i.e., peak velocity, peak acceleration, peak displacement.

PEAK-TO-PEAK – Refers to the displacement from one travel extreme to the other travel extreme. In English units, this is measured in mils (.001 inch) and in metric units it is expressed in micro-meter pM (.000001 meters).

PERIOD – The amount of time, usually expressed in seconds or minutes, required to complete one cycle of motion of a vibrating machine or machine part. The reciprocal of the period is the frequency of the vibration.

PHASE (PHASE ANGLE) – The relative position, measured in degrees, of a vibrating part at any instant in time to a fixed point or another vibrating part. The Phase Angle (usually in degrees) is the angle between the instantaneous position of a vibrating part and the reference position. It represents the portion of the vibration cycle through which the part moved relative to the reference position.

RADIAL MEASUREMENT – Measurements taken perpendicular to the axis of rotation.

RADIAL VIBRATION – Shaft dynamic motion or casing vibration which is in a direction perpendicular to the shaft centerline.

RESONANCE – The condition of vibration amplitude and phase change response caused by a corresponding system sensitivity to a particular forcing frequency. A resonance is typically identified be a substantial amplitude increase and related phase shift.

RIGID ROTOR – A rotor that does not deform significantly at running speed. A rotor whose parts do not take up motion relative to each other, i.e., all points move in the same direction at the same instant of time. A rotor is considered rigid when its speed is less that 75% of its lowest natural frequency in bending.

RMS – (Root Mean Square) Equal to 0.707 times the peak of a sinusoidal signal.

ROLLING ELEMENT BEARING – Bearing whose low friction qualities derive from rolling elements (balls or rollers), with little lubrication.

ROTATIONAL SPEED – The number of times an object completes one complete revolution per unit of time, e.g., 1800 RPM

SIDE BAND – Equals the frequency of interest plus or minus one times the frequency of the exciting force.

SIGNATURE (SPECTRUM) – Term usually applied to the vibration frequency spectrum which is distinctive and special to a machine or component, system or subsystem at a specific point in time, under specific machine operating conditions, etc.

Usually presented as a plot of vibration amplitude (displacement, velocity or acceleration) versus time or versus frequency. When the amplitude is plotted against time it is usually referred to as the TIME WAVE FORM.

SMALL (FRACTRIONAL) AND MEDIUM (INTEGRAL) HORSEPOWER AC/DC MOTORS – Reference NEMA Publication No. MG 1, Section II SMALL

(FRACTIONAL) AND MEDIUM (INTEGRAL) MACHINES. Part 12. Tests and Performance – AC and DC Motors.

TIME DOMAIN - Presentation of a signal whose amplitude is measured on the Y-axis and the time period is measured on the X-axis.

TRANSDUCER (PICKUP) – VIBRATION – A device that converts shock or vibratory motion into an electrical signal that is proportional to a parameter of the vibration measured. Transducer selection is related to the frequencies of vibration which are important to the analysis of the specific machine(s) being evaluated/analyzed.

UNBALANCE – See IMBALANCE

VELOCITY - The time rate of change of displacement with respect to some reference position. For purposes of this document, velocity is measured in the units Inch per second-Peak.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING & EQUIPMENT

PART 1. GENERAL

1.01 This section specifies the products and methods for identification of HVAC systems.

1.02 HVAC identification systems shall be in accordance with ANSI A13.1.

PART 2. PRODUCTS

2.01 All materials used in HVAC identification shall be waterproof and corrosion resistant.

2.02 IDENTIFICATION PRODUCTS

A. Pipe markers - Vinyl, self-adhering; Seton, Emed, or equal.

B. Pipe markers - Snap-on type, preformed, acrylic plastic with clear overlaminate; Seton "Setmark", Emed "Kwik-koil", or equal.

C. Valve tags - Brass or aluminum, 1-1/2 inch minimum diameter, stamped or engraved, attached to the valve with #12 AWG wire (galvanized or stainless steel) or with chain (galvanized or brass).

D. Equipment tags - Engraved laminated plastic, white letters on black, minimum 3 inch x 1 inch tag with 1/4-inch lettering, unless otherwise noted.

E. Equipment Nameplate Data Sheet - To be submitted per Section 01 33 00. Data sheets shall be provided in the following format for each piece of powered equipment and shall contain appropriate data for each item.:

Submittal Information for Every Piece of Operable Equipment					
Contractor		Ref Drawing #			
Work Order #		Equip ID shown on drawing		MAXIMO # (if known)	
Name Plate Data					
Manufacturer		Motor		Max Temp.	
Model #		Drive		Max Pressure	
Serial #		Size		Sheave Size (motor)	
Cat. # / Part #		Motor rpm		Sheave Size (equip.)	
Mfg. Date		Horsepower		Capacity (gpm, cfm, ton, etc.)	
Voltage		Frame		Equipment rpm	
Phase		Duty		Filter Size	
Amps		Service Factor		Filter Qty.	
KVA Rating		NEMA Rating		Belt Size	
Equipment Type (fan, pump, AHU, CRU, etc.)		Motor % Efficiency		Belt Qty.	

F. Underground Warning Tapes:

1. For metallic piping - color coded polyethylene film, 6 inches wide, with legend identifying the utility below; Seton, Emed, or equal.

2. For non-metallic piping - color coded metallic foil tape, 6 inches wide, with legend identifying the utility below; Seton, Emed, or equal.

PART 3. EXECUTION

3.01 PIPING IDENTIFICATION SYSTEMS

A. Identify contents and flow direction of all new piping unless otherwise indicated. Acceptable methods of identification are as follows.

1. Pipe and covering less than 3/4-inch O.D.

a. Vinyl pipe markers adhered to non-ferrous plates. Suspend the plates from the piping with galvanized or stainless steel wire.

b. Paint color bands on the pipe. At each band, provide a non-ferrous plate with a stenciled identifying legend. Suspend plate from piping with galvanized or stainless steel wire.

2. Pipe and covering 3/4-inch O.D. and larger.

a. Snap-on pipe markers.

b. Vinyl pipe markers secured at each end with pressure sensitive tape wrapped completely around the pipe and overlapped.

c. Painted color band with stenciled legend.

B. Minimum dimensions of identification markings shall be as follows.

O.D. of Pipe and Covering	Band Length	Letter Height
3/4" to1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2"to 6"	12"	1-1/4"
8" to 10"	24"	2-1/2"
over 10"	32"	3-1/2"

C. Color coding of identification markings shall be as follows.

Service	Legend	Band Color	Legend Color
Potable water, cold	Potable Water Domestic Cold Water	Green	White
Industrial water	Industrial Water	Green	White
Chilled water	Chilled Water Supply Chilled Water Return	Green	White
Heating water	Hot Water Supply Hot Water Return	Yellow	Black
Cooling tower water	Condensing Water Supply, Condensing Water Return	Green	White
Drain	Drain	Green	White
Sanitary sewer	Sanitary Sewer Sanitary Vent	Green	White
Shop air (<100 psi) (100+psi)	Shop Air or Compressed Air	Blue Yellow	White Black
Steam	Steam	Yellow	Black
Steam condensate	Steam Condensate Condensate	Yellow	Black
Refrigerants	Refrigerant Liquid Refrigerant Suction Refrigerant Hot Gas	Green	White

D. Pipe identification markings shall be located as follows.

1. Adjacent to each valve or group of valves.

2. At each side of wall or floor penetrations.

3. At each equipment connection.

4. On long piping runs, at 20-foot maximum intervals.

E. Provide flow direction markings at each identification point. In addition, indicate maximum system pressure for all steam & air piping.

F. Where pipelines are located more than nine feet above floor level, place the lettering below the horizontal centerline of the pipe.

G. Mark piping which presents a bumping or tripping hazard with black and yellow stripes at the point of hazard.

H. Clean and degrease surfaces to receive adhesive markers. Prior to painting on steel pipe, remove rust and provide one coat of primer.

3.02 VALVE AND EQUIPMENT TAGS

Identification requirements and tag numbers for valves and equipment will be indicated on the drawings, if required.

3.03 WARNING TAPE

A. Place warning tape directly above all buried piping. Note that different warning tapes are required for metallic and non-metallic utilities.

B. Burial depth for polyethylene tape shall be approximately one foot below grade.

C. Burial depth for metallic foil tape shall be 4 to 6 inches below grade.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC (AIR & HYDRONIC)

PART 1 GENERAL

1.01 SUMMARY

This section applies to all testing, adjusting, and balancing (TAB) of HVAC systems.

1.02 STANDARDS

A. TAB work shall be performed in accordance with the following reference standards.

1. Associated Air Balance Council (AABC), "AABC National Standards."

2. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE), "1995 HVAC Applications Handbook", Chapter 34; "Testing, Adjusting and Balancing".

3. National Environmental Balancing Bureau (NEBB), "NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems."

4. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), "HVAC Systems -Testing, Adjusting and Balancing."

5. SMACNA, "HVAC Air Duct Leakage Test Manual."

1.03 CONTRACTOR QUALIFICATIONS

If noted on the drawings, the work shall be performed by an independent firm specializing in TAB work and certified by AABC or NEBB. All work performed by the TAB Contractor shall be under the direct field supervision of a certified test and balance technician, unless otherwise noted.

1.04 CALIBRATION OF INSTRUMENTS

All instruments used for testing and balancing shall have been calibrated within 6 months (or within manufacturer's recommended period if longer), and shall be checked for accuracy prior to start of work. The Government reserves the right to require recalibration of any, or all, instruments in accordance with the frequency recommended by the manufacturer, or when reasonable doubt of accuracy exists.

1.05 SUBMITTALS

A. If the requirements of paragraph 1.03 are noted on the drawings, provide the following submittals.

1. Submit a copy of the firm's AABC or NEBB certificate to show compliance with paragraph 1.03.

2. Submit a list of project experience within the past three years, and provide brief descriptions of system types.

3. Submit a list of personnel, with descriptions of TAB education, certification, and experience.

4. Submit the TAB procedures proposed to be used for each system, and the intended order of TAB work.

B If required by the Schedule of Submittals, the TAB field supervisor shall review the drawings and specifications and submit a Plan Review Report (SD-09). Report shall contain design changes recommended for the proper testing, adjusting and balancing of all systems. Recommendations might include piping or ductwork modifications, and addition or relocation of dampers, balancing valves, P/T test ports, flow measuring devices, gages, and access doors.

C. If required by the Schedule of Submittals, the TAB field supervisor shall submit a Preliminary TAB Report (SD-09). The report shall include single line diagrams of all air systems and piping systems, data reporting forms for all systems and equipment, and a list of all TAB instrumentation with scale ranges and dates of latest calibration. Diagrams and data reporting forms shall include design values and other data to the extent possible.

D. Submit a Final TAB Report (SD-12) as described below.

1. Provide a cover letter signed by the TAB field supervisor. The cover letter shall clearly and specifically note any unresolved deficiencies. Data shall be reported on AABC, NEBB or SMACNA report forms.

2. Provide a complete list of instruments used. Describe instruments, applications and dates of latest calibration. Instrument descriptions shall include manufacturer, model and serial number.

3. If required by the Schedule of Submittals, provide schematic diagrams of all duct systems. Diagrams shall include trunk and branch ducts with sizes, design air flows and velocities, fans, coils, filters, control dampers, manual volume dampers, fire dampers, smoke dampers, louvers, pitot traverse locations, flow measuring stations, duct heaters, air terminal units, and air outlets. Air terminal units shall be labeled with inlet sizes, design air flows and ID numbers. Air outlets shall be labeled with design air flows and ID numbers.

4. If required by the Schedule of Submittals, provide schematic diagrams of all HVAC piping systems. Diagrams shall include main and branch piping with sizes, design flows, pumps, strainers, balancing valves, coils, heat exchangers and flow measuring devices.

PART 2 PRODUCTS (NONE)

PART 3 EXECUTION

3.01 GENERAL

A. Perform all TAB work in accordance with the practices, methods and standards referenced. Final flow rates shall be adjusted to within +/- 10 percent of design flow rates unless noted otherwise.

B. Inspect systems to verify correct installation and proper operation of all balancing devices. Verify access to all balancing devices. Report all deficiencies to the Government Inspector before balancing systems.

C. Except as otherwise specified, do not proceed with TAB work until all systems have been cleaned, flushed, lubricated, and made fully operable. TAB work shall not begin until initial equipment startup and checkout have been successfully completed.

D. All testing shall be witnessed by the Government Inspector. All test reports shall be signed by the Government Inspector.

E. Unless noted on drawings, test and balance of existing ductwork is not the responsibility of the contractor.

3.02 AIR SYSTEMS

A. General Requirements

1. Air systems shall be balanced with all doors in the conditioned area closed.

2. After final balancing of air systems, tighten set screws on all manual balancing dampers and permanently mark settings.

3. Minimum number of outside airflow TAB readings required:

a) In case of a VFD, a constant outside airflow, and no outside air measurement sensor/transmitter installed, the following number of TAB readings are required as a minimum:

i. Fan Speed @ 20%--# readings req'd to determine proper damper setting to maintain desired outside flow.
ii. Fan Speed @ 40%--# readings req'd to determine proper damper setting to maintain desired outside airflow.
iii. Fan Speed @ 60%--# readings req'd to determine proper damper setting to maintain desired outside airflow.
iv. Fan Speed @ 80%-- # readings req'd to determine proper damper setting to maintain desired outside airflow.
v. Fan Speed @ 100%--# readings req'd to determine proper damper setting to maintain desired outside airflow.

b) In the case of a VFD, a constant outside airflow req'd w/an outside airflow measurement sensor/transmitter installed, the following number of TAB readings are required as a minimum:

i. At Fan Speeds of 20%, 40%, 60%, 80%, 100%----Verify outside airflow measurement device is reading accurately and that the outside air damper is modulating as req'd to obtain and maintain the desired airflow.

B. Fans

1. Verify correct direction of rotation for all three phase fan motors.

2. Adjust rpm of fans to provide the design airflow. Measure and record the rpm of fans and fan motors. Measure and record the static pressure at the inlet and outlet of each fan.

3. Measure and record the voltage and amp draw on each phase of all fan motors.

4. Record nameplate data for each fan and fan motor.

C. Heating and Cooling Coils

1. Inspect air system coils to establish that finned surfaces are clean and straight.

2. Measure and record the static pressure upstream and downstream of each coil. Record the number of rows and fins per inch.

3. Measure and record the airflow through each coil. Measure the entering and leaving dry bulb and wet bulb temperatures of all cooling coils. Measure the entering and leaving dry bulb temperatures of all heating coils.

D. Filters

1. Inspect all air filters, verify that all required air filters are installed, clean, and intact.

2. Measure and record the static pressure upstream and downstream of each bank of filters.

E. Duct Systems

1. Total supply and outdoor airflows for air systems handling 3,000 CFM or greater shall be balanced to within five percent of design values.

2. Air systems with economizer cycles shall be balanced at both minimum outdoor air and 100 percent outdoor air conditions.

3. All ductwork constructed to 4" w.g. static pressure class and higher shall be tested for leakage. Ductwork constructed to a lower pressure class shall be tested only if specifically noted on the drawings. Test leakage in accordance with referenced SMACNA standards. Total leakage from any air system shall not exceed 2 percent of the total design airflow in that air system. Ductwork failing the test shall be sealed and retested until a successful test is completed.

4. Provide static pressure profiles of all duct systems.

F. Fire Dampers and Smoke Dampers

1. Test operation of all fire dampers. Remove access doors and fusible links. Verify that fire dampers close smoothly and completely. Reset the fusible links and close access doors.

2. Test operation of all smoke dampers. If possible, smoke damper testing should be performed in conjunction with testing of the fire alarm system. Remove access doors and activate smoke dampers. Verify that smoke dampers close smoothly, quickly, and completely. Reset, and verify that smoke dampers open completely. Close access doors.

G. Flow Measuring Stations

1. Conduct a pitot tube traverse at each flow measuring station. Calculate and record the airflow.

2. Measure and record the pressure signals at the high and low pressure connections of each flow measuring station. Calculate and record the velocity pressures and airflows.

H. Air Terminals

1. Adjust air outlets to provide air distribution patterns and throws required.

2. With all air outlet dampers fully open, airflows to outlets shall be balanced to within 20 percent of design using only dampers in trunk ducts and at branch duct take-offs. Outlets shall then be balanced to within 10 percent of design airflow using outlet dampers. Where dampers are not provided at outlets, outlets shall be balanced with dampers at branch duct take-offs.

I. Fume Hoods

1. Balance fume hoods to provide a minimum average face velocity of 100 feet per minute (fpm) unless otherwise noted. Velocity at any point shall not be less than 90 fpm nor greater than 120 fpm.

2. Fume hood face velocities shall be measured with a hot wire anemometer supported by a rigid stand. Points of measurement shall be evenly spaced, a maximum of 6 inches on center, and a maximum of 3 inches from the edge of the sash opening. Locations of each point of measurement shall be diagrammed, dimensioned, and numbered. The diagram shall include the dimensions of the sash opening. Provide a numbered table of velocity measurements to indicate location of each measurement.

3. Fume hood face velocities shall be measured and recorded with sash openings of 12 inches and 100 percent.

4. Measure and record the static pressure at the fume hood duct connection with sash openings of 12 inches and 100 percent.

3.03 HYDRONIC SYSTEMS

A. General Requirements

1. After final balancing of hydronic systems, adjust and tighten set screws, memory stops, etc. of all balancing valves and permanently mark the setting.

2. Measure and record the concentration of glycol in systems with water/glycol mixtures. Note percent by volume or percent by weight.

B. Pumps

1. Verify correct direction of rotation for each three phase pump.

2. Measure, balance, and record flow through pumps. Measure flow with calibrated flow measurement devices that have been installed per manufacturer's instructions. Pump curves shall not be used to measure flow.

3. Measure and record the voltage and amp draw on each phase of all pump motors.

4. Record the nameplate data for each pump and pump motor.

C. Strainers and Filters

1. Confirm that all strainers, pump suction diffusers, and other hydronic filters have been removed, cleaned, and visually inspected immediately before balancing of any hydronic system.

2. After completion of hydronic TAB work, verify that disposable start-up strainers have been removed from all pump suction diffusers.

D. Coils

1. Vent air from coils. Measure, balance, and record flows through coils. Measure flow with calibrated flow measurement devices. Coil or control valve pressure drops shall not be used to measure flow.

2. Measure and record the coil pressure drop.

3. Measure and record entering and leaving fluid temperatures.

E. Piping Systems

1. Hydronic systems shall be balanced by direct flow measurement with factory calibrated balancing devices. Hydronic systems shall not be balanced by temperature difference or head loss at coils and other heat exchangers.

2. Verify that make-up water pressure regulators are set for a minimum pressure of 12 PSIG above the system static head.

3. Verify that all high points of piping systems are equipped with air vents. Verify that valves at automatic air vents are open. Operate each manual air vent before balancing hydronic systems.

4. Verify the correct water level in plain steel type expansion tanks. Vent excess air or drain excess water as required.

5. Verify the correct air pressure in bladder type expansion tanks. Increase or decrease pressure as required.

6. Verify that all check valves, control valves, and hydronic specialties are properly oriented for direction of flow.

F. Chillers

1. Vent air from evaporators and condensers of all chillers. Measure, balance, and record flows through evaporators and condensers. Measure flow with calibrated flow measurement devices. Evaporator and condenser pressure drops shall not be used to measure flow.

2. Measure and record water pressure drops of all evaporators and condensers.

3. Measure and record entering and leaving fluid temperatures at evaporators and condensers.

4. Measure and record the voltage and amp draw on each phase at full load. Record the nameplate data.

G. Cooling Towers

1. Balance flow to each cell of towers with multiple cells. Measure and record entering and leaving water temperatures.

2. Verify correct operation of water level controls on cooling towers and evaporative condensers.

3. Measure and record voltage and amp draw on each phase of all cooling tower fan motors. Record fan motor nameplate data.

3.04 STEAM SYSTEMS

A. Test the operation of all steam pressure reducing valves. Record valve tag number (if any), valve size, and inlet and outlet pressures.

B. Test steam coils for proper draining of condensate. Measure and record inlet and outlet piping surface temperatures to verify that coils are not waterlogged. Record steam coil number or location.

C. Test the operation of all steam traps. Measure and record inlet and outlet piping surface temperatures at each trap. Record trap type, size, and tag number (if any).

D. Test the operation of condensate return pumps. Test duplex pump alternating controls. Verify correct direction of rotation for all pumps. Measure and record voltage and amp draw on each phase of all pump motors. Record nameplate data for each pump and motor.

3.05 REFRIGERATION SYSTEMS

A. Measure and record voltage and amp draw on each phase of all compressor and condenser fan motors. Record compressor and condenser fan motor nameplate data.

B. Verify that compressor crankcase heaters are operating.

3.06 CONTROL SYSTEMS

A. Test the operation of all high and low limit temperature switches and duct mounted smoke detectors.

B . Test the calibration of at least 10 percent, and a minimum of three, pneumatic thermostats. Record controlled temperature, setpoint, and output pressure of each device.

C. Test the operation of air handling unit economizer cycle controls. Cycle the controls and check the control dampers for binding and loose linkages.

D. Verify that outdoor air dampers close tightly when air handling systems are shut down by any control device.

E. Verify the correct operation and application of direct acting and reverse acting thermostats.

F. Verify proper operation of all interlocks between mechanical equipment.

3.07 TAB VERIFICATION

A. If noted on the drawings, data reported in the Final TAB Report shall be re-checked. Data to be re-checked will not exceed 10 percent of measurements reported in the Final TAB Report.

B. If 20 percent of re-checked values differ from reported values by 5 percent or more, an additional 10 percent of all measurements shall be re-checked at no additional expense to the Government.

C. If 20 percent of the additional re-checked values differ from reported values by 5 percent or more, then systems shall be rebalanced as directed by the A/E, at no additional expense to the Government.

D. All TAB verification work shall be witnessed by the Government Inspector.

END OF SECTION

SECTION 23 07 13

DUCT INSULATION

PART 1 GENERAL

1.01 SUMMARY

This section specifies insulation systems for ductwork, except acoustical ductliner, which is specified in Section 23 30 00, " HVAC Air Distribution ."

PART 2 PRODUCTS

2.01 MATERIAL PROPERTIES AND QUALITY

A. Insulation materials containing asbestos shall not be used.

B. In accordance with Section 01 35 43, contractor shall submit a report for insulating products covered under the EPA regulations for recoverable materials. When such products cannot be provided the contractor shall provide a non-compliance report stating the reason the product cannot be used and the nature of the product to be used. For an all-inclusive list of products and recoverable material contents see the latest EPA web site for Construction products containing recoverable materials.

C. All insulation systems shall be certified in accordance with ASTM E84, and shall have the following surface burning characteristics.

1. Maximum flame spread rating of 25, without evidence of continued progressive combustion.

2. Maximum smoke development rating of 50.

D. Insulation materials and related products shall be as manufactured by Armstrong, Certainteed, Owens-Corning, Knauf, Pabco, Foster Products, or equal.

E. Insulation material "k-values" specified below are given in units of Btu-inch/hr-ft^2-°F, and are rated at 75 degrees F mean temperature unless otherwise noted.

F. All insulation installed interior to the Building, and all HVAC duct lining insulation shall be "Greenguard Certified" in addition to

meeting, or exceeding, the minimum requirements as stated elsewhere in these specifications.

2.02 DUCTWORK INSULATION

A. Rigid fiberglass board: 1" thick, 3 pounds/cubic foot density, maximum k=0.24, with factory applied reinforced foil vapor barrier; Knauf, Certainteed, Owens-Corning, or equal.

B. Duct wrap: 1-1/2" thick flexible fiberglass, 0.75 pounds/cubic ft. density, maximum k=0.30, with factory applied reinforced aluminum foil vapor barrier; Knauf, Certainteed, Owens-Corning, or equal.

C. Spotter pins: Welded, steel; Duro-Dyne PN-250 or equal.

D. Spotter clips: Duro-Dyne PC-1 or equal.

E. Adhesive: Non-flammable, quick-setting, rubber-based; Foster "Spark-Fas" or equal.

F. Tape: Pressure sensitive, reinforced foil vapor barrier material, minimum 3 inches wide.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Install insulation in accordance with the manufacturer's recommendations.

B. Install insulation to provide the full specified thickness on all surfaces.

C. Surfaces shall be clean, dry, and oil-free before insulation is applied.

D. Insulation shall not be applied to ducts, and equipment until all required testing has been completed, and all necessary repairs have been made.

E. Where a vapor barrier jacket is specified, make the vapor barrier continuous. Seal punctures of the barrier with overlapping patches of matching material and adhesive before concealing the insulation.

F. Insulation surface finishes shall be extended to protect all surfaces, ends, and raw edges of insulation.

G. Insulation shall be continuous through wall, floor, or ceiling penetrations unless otherwise noted.

H. Insulation that becomes wet for any reason shall be removed, and new insulation shall be provided at no additional cost to the Government.

I. All new fiberglass and calcium silicate insulation shall be identified as non-asbestos. The identification markings shall be stenciled with black paint on the finished surface, and shall consist of the following:

1. 2"-wide bands at the extremities of the new installation.

2. Arrows indicating the direction of placement

3. The legend "Non-Asbestos" in 1 inch-high letters at each band and at maximum 20-foot intervals.

3.02 DUCTWORK INSULATION

A. Externally insulate all unlined supply, return, and outside air ductwork and plenums. Insulate exhaust ductwork only where it passes through unconditioned spaces.

B. External duct insulation shall be flexible fiberglass wrap or rigid fiberglass board.

C. Attach rigid board insulation with adhesive, and with spotter pins and clips 16 inches on center. Seal all joints, breaks, and punctures in the vapor barrier with pressure sensitive vapor barrier tape.

D. Secure external wrap insulation to ductwork with adhesive applied in 6-inch-wide bands, 24 inches on center. Firmly butt circumferential joints. Remove insulation from longitudinal joints to provide a minimum 2 inch vapor barrier overlap. Secure lap joints with adhesive or outward clinching staples 4 inches on center. Seal all longitudinal and butt joints with pressure sensitive vapor barrier tape.

END OF SECTION

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SUMMARY

This section specifies insulation systems for HVAC piping.

PART 2 PRODUCTS

2.01 MATERIAL PROPERTIES AND QUALITY

A. Insulation materials containing asbestos shall not be used.

B. In accordance with Section 01 35 00, contractor shall submit a report for insulating products covered under the EPA regulations for recoverable materials. When such products cannot be provided the contractor shall provide a non-compliance report stating the reason the product cannot be used and the nature of the product to be used. For an all-inclusive list of products and recoverable material contents see the latest EPA web site for Construction products containing recoverable materials.

C. All insulation systems shall be certified in accordance with ASTM E84, and shall have the following surface burning characteristics.

1. Maximum flame spread rating of 25, without evidence of continued progressive combustion.

2. Maximum smoke development rating of 50.

D. Insulation materials and related products shall be as manufactured by Armstrong, Certainteed, Owens-Corning, Knauf, Pabco, Foster Products, or equal.

E. Insulation material “k-values” specified below are given in units of Btu-inch/hr-ft^2-°F, and are rated at 75 degrees F mean temperature unless otherwise noted.

F. All insulation installed interior to the Building, shall be “Greenguard Certified” in addition to meeting, or exceeding, the minimum requirements as stated elsewhere in these specifications.

2.02 PIPING INSULATION

A. Fiberglass: Preformed, with white reinforced kraft and foil general service jacket, maximum k=0.25; Knauf, Certainteed, Owens-Corning (Vapor Wick) or equal.

B. Calcium Silicate: Fiber-reinforced, preformed, maximum k=0.40 at 200 degrees F, color-coded to indicate asbestos-free; Pabco "Super Cal-Temp Gold," Owens-Corning “Kaylo”, or equal.

C. Closed Cell Foam: Flexible foamed elastomer, maximum k=0.27, maximum water vapor transmission rating of .17 perms; Armstrong "AP Armaflex," Rubatex R-180-FS, Normaco “Normagard,” or equal.

D. Cellular Glass: Rigid closed-cell structure, maximum k=0.35, fabricated per ASTM C585; Pittsburgh Corning "Foamglas" or equal.

E. Fitting Covers: Preformed PVC, 10 mil thickness, UV resistant; CEEL-CO 300 Series, Proto “LoSMOKE,” or equal.

F. Weather Jacket: .016-inch-thick aluminum with moisture barrier; Pabco “Surefit” or equal.

G. Direct-Burial Jacketing: Prefabricated laminate, consisting of an asphalt-impregnated fabric and a 1 mil aluminum foil sandwiched between 3 layers of bituminous mastic; with heat sealable edges; Pittsburgh Corning "Pittwrap" or equal.

H. Gypsum Cement: Water-based, for fabrication of cellular glass; U.S. Gypsum Co. "Hydrocal B-11" or equal.

I. Joint Sealant: Non-hardening butyl sealant for cellular glass; Pittsburgh Corning "Pittseal 444" or equal.

J. Adhesive: For closed cell foam, rubber based, UL listed; Armstrong 520 or equal.

K. Finish: For closed cell foam, white vinyl lacquer based; Armstrong "Armaflex Finish" or equal.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Install insulation in accordance with the manufacturer's recommendations.

B. Install insulation to provide the full specified thickness on all surfaces.

C. Surfaces shall be clean, dry, and oil-free before insulation is applied.

D. Insulation shall not be applied to piping, ducts, and equipment until all required testing has been completed, and all necessary repairs have been made.

E. Where a vapor barrier jacket is specified, make the vapor barrier continuous. Seal punctures of the barrier with overlapping patches of matching material and adhesive before concealing the insulation.

F. Insulation surface finishes shall be extended to protect all surfaces, ends, and raw edges of insulation.

G. Insulation shall be continuous through wall, floor, or ceiling penetrations unless otherwise noted.

H. Insulation that becomes wet for any reason shall be removed, and new insulation shall be provided at no additional cost to the Government.

I. Unless specific insulation types are noted on the drawings, the Contractor may select insulation type for each service from the schedule in 3.02.N. However, only one type shall be used per service.

J. All new fiberglass and calcium silicate insulation shall be identified as non-asbestos. The identification markings shall be stenciled with black paint on the finished surface, and shall consist of the following:

1. 2"-wide bands at the extremities of the new installation.

2. Arrows indicating the direction of placement

3. The legend "Non-Asbestos" in 1 inch-high letters at each band and at maximum 20-foot intervals.

3.02 PIPING INSULATION

A. Install piping insulation in whole sections where possible. Otherwise, minimize the number of splices.

B. Apply insulation with joints tightly butted.

C. When applying closed cell foam insulation, coat both surfaces of butt ends and longitudinal joints with adhesive, allowing it to become tacky before joining the surfaces together.

D. Seal all joints in cellular glass insulation with joint sealant (low temperature services) or gypsum cement (high temperature services).

E. Secure longitudinal flaps on fiberglass insulation jackets with adhesive or outward clinching staples (adhesive is required for cold services to maintain vapor barrier). Seal butt joints with manufacturer's standard tape strips.

F. Valves and fittings shall be insulated with preformed fittings, mitered sections of pipe insulation, or insulating material built up to the required thickness. On fiberglass insulated fittings, provide PVC fitting covers. On cold service piping, seal fitting covers with a vapor retardant mastic and pressure sensitive tape.

G. Do not insulate pipe unions and steam traps. Insulate valves so as not to interfere with their normal operation.

H. Where insulation terminates, it shall be neatly beveled and finished.

I. Where insulation passes through a pipe hanger and cannot support the piping without being crushed, provide wood blocking or a section of rigid insulation in the hanger.

J. Paint closed cell foam insulation with two coats of the manufacturer's approved finish indoors where exposed to view in finished areas.

K. Unless as otherwise noted, all above-ground outdoor piping insulation shall be provided with aluminum jackets, secured with aluminum banding or corrosion resistant screws. Place longitudinal

jacket joints near the bottom of the piping. Seal butt laps with silicone sealant. Deburr all exposed jacket edges.

L. When insulation is applied over electrically heat traced piping, label the outer jacket accordingly. Labels shall be electric heating cable manufacturer's standard warning label, or one of the labeling systems specified in Section 25 05 53.

M. Cover all underground piping insulation with direct-burial jacketing. Heat seal longitudinal overlaps. Heat seal butt joints with a 4"-wide strip of the jacketing material.

N. Piping insulation shall be selected from the following schedule, unless otherwise noted.

SERVICE	CLOSED CELL FOAM	FIBERGLASS	CALCIUM SILICATE	CELLULAR GLASS
CHILLED WATER				
Indoors	X			X
Outdoors	X			X
Underground (see also section 33 61 13; 2.03.0.1)				X
HEATING WATER				
Indoors	X	X	X	X
Outdoors	X		X	X
Underground				X
POTABLE WATER	X	X		
COLD CONDENSATE	X			
INDUSTRIAL WATER				
Indoors	X	X		
Outdoors	X			X
REFRIGERANT	X			
STEAM &CONDENSATE				
Indoors		X	X	X
Outdoors			X	X

O. Minimum insulation thickness for piping shall be according to the following schedule and notes, unless otherwise indicated.

MINIMUM INSULATION THICKNESS, INCHES

Service	Runouts (2)	Nominal Pipe Size, Inches Up to 1	1-1/4 to 2	2-1/2 to 4	5 & 6	8 & Up
Chilled Water (1)	.75	.75	1.0	1.5	1.5	2.0
Heating Water (1)	.5	1.0	1.0	1.5	1.5	2.0
Potable Water: (1)						
Hot	.5	.5	1.0	1.5	1.5	1.5
Cold	.5	.5	.5	.75	.75	.75
Industrial Water (1)	.5	.5	.5	.75	.75	.75
Cold Condensate (3)	.5	.5	.5	-------	-------	-------
Refrigerant:						
Suction	1.0	1.0	1.5	1.5	1.5	1.5
Hot Gas (4)	.5	.5	.5	.5	.5	.5
Steam:						
Up to 15 PSIG	1.0	1.5	2.0	3.0	3.0	3.0
16 to 58 PSIG	1.5	2.0	2.5	3.0	3.0	3.0
Above 58 PSIG	1.5	2.5	3.0	3.0	3.5	3.5
Steam condensate	1.0	1.0	1.5	2.0	2.0	2.0

Schedule Notes:(1) Increase thickness by 1/2 inch for steam condensate and water services outdoors.
(2) Runouts are branch lines, not exceeding 12 feet in length, for individual pieces of equipment.
(3) For cold condensate drains, insulate only the portions of the line that will not drain by gravity.
(4) Insulate hot gas piping only in conditioned spaces.

END OF SECTION

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This section describes the formal commissioning and functional performance testing of HVAC systems. It specifies the additional requirements and procedures with which the Contractor shall comply when noted on the drawings or in the Commissioning Plan.

B. If the Contractor is not required by the drawings and the Schedule of Submittals to perform the formal commissioning and functional performance testing described in this section, the Contractor is not relieved of the testing and acceptance requirements expressly stated elsewhere in this specification.

1.02 SUBMITTALS

If required by the Schedule of Submittals, the Contractor shall submit the following:

A. A list of commissioning team members (SD-01) who will represent the Contractor in performance of the commissioning and functional performance testing at least two (2) weeks prior to start of commissioning and testing. Commissioning team members shall be familiar with the HVAC system being installed and shall also be qualified as required in related sections of this specification.

B. A commissioning and testing schedule (SD-07), at least two (2) weeks prior to the proposed testing start date.

C. A listing of all testing equipment, identifying equipment calibration dates within one year of the testing date.

1.03 SEQUENCING AND SCHEDULING

The work described in this section shall begin only after all work required in related sections, including Section 23 09 00 “INSTRUMENTATION AND CONTROL FOR HVAC,” Section 23 09 23 “DIRECT DIGITAL CONTROLS / UTILITY CONTROL SYSTEM,” and Section 23 05 93 “TESTING, ADJUSTING AND BALANCING FOR HVAC (AIR &

HYDRONIC)" has been successfully completed; and all test and inspection reports and O&M manuals required in these sections have been submitted and approved.

PART 2 PRODUCTS (NONE)

PART 3 EXECUTION

3.01 COMMISSIONING TEAM AND FUNCTIONAL PERFORMANCE TESTS

The Contractor shall designate team members to participate in the commissioning and functional performance testing specified herein. The Contractor shall designate a Mechanical Representative, an Electrical Representative, and a Testing, Adjusting, and Balancing Representative. In addition, the Government will be represented by a Government Construction Management Inspector, a Government UCS representative, a Government Maintenance and Operations Representative, and a Government Commissioning Agent.

Each checklist included in the Commissioning Plan shall be completed by the commissioning team. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

3.02 COMMISSIONING CHECKLISTS

The Commissioning Plan will include a Pre-functional Checklist and a Functional Test List. The Pre-functional Checklist must be completed before Functional Testing begins.

A. Pre-functional Checklists – There will be a Pre-functional Checklist for each HVAC systems and subsystem. The purpose of the pre-functional checklist is to verify that all components of the HVAC system are present, properly installed, and ready for functional testing. The Pre-functional Checklists are YES/NO lists. Any "NO" finding indicates that a component of the system is not properly installed and must be corrected.

B. Functional Test Lists – The purpose of Functional Testing is to demonstrate that the systems perform safely and as intended by the designer during all operating conditions. The lists will be derived from the Sequence of Operation shown on the drawings and will consist of various conditions to be simulated, the procedure

used to simulate the conditions and the expected response of the HVAC system, and an acceptable range of error.

A typical example is to verify that a system responds to a call for cooling. The procedure might be to lower the cooling setpoint temperature. The expected result might be that a VAV damper would modulate open so that the space temperature is kept at the new setpoint temperature ± 2°F. Upon confirmation, the setpoint is returned to its normal value and the damper should reposition so that the space temperature goes back to and maintains the original setpoint ± 2°F.

3.03 TESTS

A. The commissioning and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related sections. Where checking, testing, and inspection methods are not specified in other sections, methods shall be established which will provide the information required. Requirements in related sections are independent from the requirements of this section and shall not be used to satisfy any of the requirements specified in this section.

B. The Contractor shall provide all materials, services, and labor required to perform the commissioning and functional performance tests.

C. A commissioning and functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test.

D. Functional performance tests shall be performed for all items noted in the Commissioning Plan. Tests shall prove all modes of the sequences of operation, and shall verify the integration of UCS, HVAC controls, and HVAC equipment into a complete environmental control system. Fragmented checkout and testing of components by individual sub-contractors, although necessary, shall only be considered as preliminary to the required testing stated in this section. Tests shall begin with equipment or components and shall progress through subsystems to complete

systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

END OF SECTION

SECTION 23 09 00

INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

This section specifies pneumatic and electric control components and systems for HVAC control. Direct Digital Controls (DDC) are specified in Section 23 09 23.

1.02 QUALITY ASSURANCE

A. Controls shall be installed by individuals with a minimum of five years experience in the installation and service of similar controls. If required by the schedule of submittals submit a list of projects, dates and control descriptions as proof of experience installing similar controls. Installers may be employed by the HVAC system installer unless noted otherwise on the drawings.

B. If noted on the drawings, the controls installer shall be an independent company licensed by a controls manufacturer. The company shall employ factory trained installation and service technicians and maintain a stock of service parts. The principal business of the company shall be the design, installation and service of HVAC controls.

PART 2 PRODUCTS

2.01 GENERAL

Products specified on the drawings shall take precedence over products specified herein.

2.02 PNEUMATIC DEVICES

A. Thermostats

Room Thermostats shall be horizontal, surface mounted, proportioning, two-pipe relay type with pneumatic feedback, a volume amplifier and output test connection. Sensing elements shall be bimetallic type. Heating-Cooling thermostats shall have dual elements, dual setpoints and an adjustable deadband. Sensitivity shall be factory set at 2.5 PSI/Degree F and be field

adjustable. Thermostats shall be direct-acting or reverse-acting as required. Setpoint adjustments shall be concealed. Covers shall be blank and be secured with allen head screws. Johnson Controls H-4000 Series or equal.

B. Temperature Transmitters

Room Temperature Transmitters shall be horizontal, surface mounted, proportioning, two-pipe relay type with pneumatic feedback, a volume amplifier and output test connection. Sensing elements shall be bimetallic type. Sensitivity shall be factory calibrated and fixed. Linearity shall be within plus or minus one percent of full span throughout the scale range. Transmitters shall be direct-acting. Covers shall be blank and be secured with allen head screws. Johnson Controls H-5002 Series or equal.

C. Humidistats

Room Humidistats shall be horizontal, surface mounted, proportioning, two-pipe relay type with pneumatic feedback, a volume amplifier and output test connection. Sensing elements shall be cellulose acetate butyrate (CAB). Sensitivity shall be factory set at 2.5 PSI/1% RH and be field adjustable. Humidistats shall be direct-acting or reverse-acting as required. Setpoint adjustments shall be concealed. Covers shall be blank and be secured with allen head screws. Johnson Controls H-4100 Series or equal.

D. Humidity Transmitters

Room Humidity Transmitters shall be horizontal, surface mounted, proportioning, two-pipe relay type with pneumatic feedback, a volume amplifier and output test connection. Sensing elements shall be cellulose acetate butyrate (CAB). Sensitivity shall be factory calibrated and fixed. Linearity shall be within plus or minus one percent of full span throughout the scale range. Transmitters shall be direct-acting. Covers shall be blank and be secured with allen head screws. Johnson Controls H-5100 Series or equal.

E. Receiver - Controllers

Receiver-Controllers shall be single input or dual input type with proportional or proportional plus integral control as indicated on the drawings. Units with proportional plus integral control shall have an adjustable integral time and automatic integral cutout at system startup to prevent control instability. All units shall have adjustable

local setpoint, local/remote setpoint selection, adjustable gain, direct/reversing action selection, multiple pressure test connections and an output pressure gauge. Dual input units shall have direct/reversing readjustment selection and adjustable ratio. Johnson Controls T-5800 Series or equal.

F. STATIC PRESSURE SENSING TIPS AND FITTINGS

1. Angled metal pressure sensing tips with 4 inch insertion depth and four 0.040 inch diameter, radially drilled pressure sensing holes. Tips shall be designed for mounting in a 3/8 inch diameter hole with access to both sides. Dwyer Instruments Model A-301 or equal with compression fitting for 1/4 inch O.D. tubing or Model A-302 or equal with barbed end for 3/16 inch and 1/8 inch I.D. plastic or rubber tubing.

2. Metal fitting for sensing the static pressure at the surface of low velocity systems. Fittings shall be designed for mounting in a 3/8 inch diameter hole with access to both sides per SK-SPP1. Mamac Systems Part # A-520-2-A-1 with ¼" hose barbed end or equal. Dwyer Instruments Model A-307 or equal with compression fitting for 1/4 inch O.D. tubing or Model A-308 or equal with barbed end for 3/16 inch and 1/8 inch I.D. plastic or rubber tubing.

3. Flange for surface mounting static pressure sensing tips and fittings without access to both sides of mounting hole, Dwyer Instruments Model A-345 or equal. Flange shall include gasket and sheetmetal screws. Flange shall accept Dwyer Instruments Models A-301, A-302, A-307, and A-308 static pressure sensing tips, fittings, and pitot tubes.

2.03 ELECTRIC/ELECTRONIC DEVICES

A. Thermostats

1. Duct Mounted Low Limit Thermostats (Freezestats) capillary shall wind horizontally across every sq. ft. of coil face surface area. Thermostats shall have a manual reset, snap-acting, SPDT switch and a thermal capillary. The switch shall open on a drop in temperature. Minimum length of the capillary shall be 20 feet. The lowest temperature across any 12 inches of the capillary shall be sufficient to trip the switch. Invensys Barber Colman Model TC5241 or equal.

2. Duct Mounted High Limit Thermostats (Firestats) shall have a manual reset, snap-acting, SPST switch and a helical, bimetallic sensing element. The switch shall have an adjustable setpoint with a dial range of 75 to 135 degrees F and a fixed differential of 10 degrees F. The switch shall open on a rise in temperature. The switch shall be rated for 16 amps at 120 VAC. Barber-Colman Model TA-3432.

B. Temperature Transmitters

Temperature Transmitters shall be as indicated on the drawings.

C. Humidistats

Duct Mounted High Limit Humidistats shall have nylon sensing elements, 15% to 95% RH range, 5% RH differential and snap-acting SPDT switch. Switch voltage rating shall be as indicated on the drawings. Barber-Colman Model HC-201 or equal.

D. Humidity Transmitters

Humidity Transmitters shall be as indicated on the drawings.

E. Differential Pressure Switches

Differential Pressure Switches for airflow confirmation shall be U.L. approved, diaphragm type with a SPDT snap-acting switch rated for 15 amps at 120-480 VAC, adjustable setpoint, 1/8 inch FNPT pressure connections, mounting bracket, and NEMA 1 switch enclosure. Unit shall be rated for 45 inches W.C. Setpoints available shall range from 0.07 to 20.0 inches W.C. Dwyer Instruments Model 1910 series or equal.

F. Flow Switches

1. Hydronic Flow Switches shall be U.L. listed, vane type with brass body, stainless steel vane, SPDT snap-acting switch and magnetic actuation without mechanical linkage. Size 2" NPS and smaller:
W.E. Anderson Model V6 or equal. Size 2 1/2" and larger:
W.E. Anderson Model V4 or equal.

2. Airflow Switches shall be U.L. listed, sail type with polyester film sail and SPDT snap-acting switch with 75 FPM and 250 FPM make/break points. Honeywell Model S688A or equal..

2.04 CONTROL VALVES

A. Control valves, size 2 inch and smaller, shall have bronze bodies with screwed connections. Control valves, size 2 1/2 inch and larger, shall have cast iron bodies with flanged connections. Valve ratings shall meet all pressure and temperature requirements of the application. Valve trim shall be replaceable. Unless indicated otherwise, stems shall be stainless steel, seats shall be bronze, plugs shall be brass, discs, as applicable, shall be teflon or composition and cages, as applicable, shall be brass. Stems shall be top and bottom guided for size 2 1/2 inch and larger valves. Packing shall be teflon "V" rings, graphite or synthetic elastomer "U" cups. Packing shall be spring loaded or adjustable, manually loaded.

B. Control valves for modulating flow of steam and chilled water shall have linear flow characteristics. Control valves for modulating flow of heating water shall have equal percentage flow characteristics.

C. Control valves shall be two-way, three-way mixing, or three-way diverting type as indicated on the drawings.

D. Two-way control valves for steam and heating water shall be normally open and three-way valves normally open to the heat exchanger. Two-way control valves for chilled water shall be normally closed and three-way valves shall be normally closed to the heat exchanger and open to the bypass connection.

E. Steam control valves with inlet pressures of 50 PSI or higher shall have stainless steel plugs and seats hardened to not less than 500 Brinell.

F. Hydronic control valves for modulating flow through coils shall have a minimum pressure drop of 5 PSI, plus or minus 1 PSI, at the maximum design flow. Steam control valves shall have a minimum pressure drop of 1/2 the inlet steam pressure.

G. Pressure independent control valves shall be utilized in applications where it is deemed that fluctuations in flow due to increased or decreased pressure will be detrimental to system stability.

2.05 CONTROL DAMPERS

A. Control dampers for ductwork shall be as specified below. Control dampers furnished as an integral part of air handling unit mixing boxes shall be as specified in SECTION 23 70 00, CENTRAL HVAC EQUIPMENT.

B. Outside air and relief air control dampers shall be ultra low leakage control dampers. All other control dampers shall be standard control dampers. Two-position control dampers shall be parallel blade or opposed blade type. Modulating control dampers shall be opposed blade type.

C. Ultra low leakage control dampers shall have AMCA certified data showing leakage less than 10 CFM/SF at 4 inches W.C. differential pressure. Frames shall be constructed of 1/8 inch thick extruded aluminum hat channel with staked reinforcing braces at each corner. Blades shall be extruded aluminum, airfoil type with 6 inch maximum width and integral structural reinforcement running full length of each blade. Blade edge seals shall be field replaceable, extruded vinyl, double edge design to enable the air pressure to assist sealing. Jamb seals shall be compression type with flexible aluminum seals. Linkages shall be concealed inside frames. Axles shall be 1/2 inch plated steel hex for a positive connection to blades. Control shaft shall be 1/2 inch diameter and extend 6 inches beyond the frame. Bearings shall be non-corrosive, two piece molded synthetic. Ruskin Model CD-50 or equal.

D. Standard control dampers shall have frames constructed of 16 gage galvanized steel hat channel with corner bracing. Blades shall be constructed of roll-formed, 16 gage galvanized steel with 6 inch maximum width. Blade edge seals shall be polyurethane foam. Linkages shall be concealed inside frames. Axles shall be 1/2 inch plated steel hex for a positive connection to blades without screws or welds. Control shaft shall be 1/2 inch diameter, extend 6 inches beyond the frame and have an additional outboard support bearing. Bearings shall be non-corrosive, two piece molded synthetic. Ruskin Model CD35 or equal.

2.06 CONTROL VALVE & CONTROL DAMPER ACTUATORS

A. Control valve and control damper actuators shall be electric, electronic or pneumatic type as indicated on the drawings and as specified herein. Actuator control method shall be two-position, proportional or proportional with positive positioning as indicated on the drawings and as specified herein. Actuators shall be provided

with mounting brackets, crankarms, pushrods and other components specified herein and as required for a complete working installation.

B. Actuators shall be sized by the controls installer for a minimum of 150 percent of the required force. Actuators for outside air dampers and relief air dampers shall have return springs and motors or pistons sized to provide tight shutoff against system operating pressures. Actuators shall return valves and dampers to the normally open or normally closed position as specified herein or as indicated on the drawings.

C. Control valve actuators shall be supported from and located directly above the valve body. Actuators shall be one of the following types as indicated on the drawings.

1. Pneumatic diaphragm type with concentric pushrod and diaphragm plate or piston.

2. Electric/Electronic type with oil-filled gear box, rotating horizontal shaft, crankarm, and pushrod.

3. Electric/Electronic type with rack and pinion gearing and vertical pushrod.

Actuator pushrods shall be directly connected to valve stems to push and pull along the valve stem axis to fully stroke the valve. Actuators shall have valve position indicators with "Open" and "Closed" labels.

D. Control valve pneumatic actuators shall be provided with positive positioners as listed below.

1. Control valves, all sizes, sequenced for proportional control of heating and cooling.

2. Control valves, size 2 1/2 inch and larger, used for proportional control of hydronics and low pressure steam.

3. Control valves, all sizes, used for proportional control of steam, 60 PSI or greater.

E. Control damper actuators shall be mounted to the duct and located outside the air stream. Actuators shall be one of the following types as indicated on the drawings.

1. Pneumatic diaphragm type with concentric pushrod and piston.

2. Electric/Electronic type with oil-filled gear box, rotating horizontal shaft, crankarm, and pushrod.

3. Electric/Electronic type with slip-on, gear driven socket for damper shaft/duct mounting.

Actuator linkage shall not "bridge" flexible duct connections. Actuators shall have damper position indicators with "Open" and "Closed" labels.

F. Control damper pneumatic actuators shall be provided with positive positioners as listed below.

1. Outside air dampers where control dampers are sequenced for proportional control of outside air and return air.

2. Outside air and relief air dampers where control dampers are sequenced for proportional control of outside air, return air and relief air.

3. Control dampers, size 36 square feet and larger, used for two-position or proportional control of air flow.

4. Large multiple section or single section control dampers with multiple actuators used for two-position or proportional control shall have a positive positioner on one actuator.

2.07 SOLENOID VALVES

Solenoid Valves shall conform to SECTION 23 05 23, “GENERAL-DUTY VALVES FOR HVAC PIPING”, of these specifications.

2.08 DUCT MOUNTED SMOKE DETECTORS

Duct Mounted Smoke Detectors shall be U.L. listed, addressable, ionization type with molded plastic housing, normally open SPST alarm contacts, SPDT auxiliary contacts rated for 10 amps at 120 VAC and metal sampling tube. Sampling tube length shall equal duct width. Provide remote test/reset stations for detectors located more than 7 feet above floors. Detector power voltage shall be as indicated on the drawings. Detector shall be fully compatible with the building fire alarm system.

2.09 ENCLOSURES

Enclosures shall be UL listed, constructed of minimum 14 gage sheet metal with spot welded joints and enamel finish. Doors shall have a full length piano hinge and keyed lock. Doors shall be convertible to right hand or left hand hinge. Windows, when specified, shall be of Lexan polycarbonate. All enclosures shall be keyed alike.

2.10 CONTROL AND INSTRUMENTATION TUBING

A. Copper tubing shall be Type M hard copper with wrought copper fittings with solder joints or Type M soft copper with brass fittings with compression joints. Tool-made bends may be used in lieu of fittings.

B. Polyethylene tubing shall be black, virgin polyethylene meeting stress crack tests per ASTM D-1693 and be self-extinguishing per ASTM D-635. Fittings shall be brass or plastic with barbed connections.

C. Type EMT conduit and fittings shall be in accordance with DIVISION 26, ELECTRICAL, of these specifications.

D. Push-On opaque Nylon tubing. Legris Industries, .180 x ¼” Nylon, part # 128289, 220 psi @ 75Degrees C. or equal.

2.11 CONTROL WIRING

Conduit, wiring and other control wiring products shall conform to the National Electric Code as a minimum standard and DIVISION 26, ELECTRICAL, of these specifications.

2.12 FLOW MEASURING STATIONS (FMS)

Flow measuring stations shall consist of the housing, a straightener/ equalizer and pressure sensors. Housings shall be welded, 14 gage galvanized steel with 1-1/2 inch flanges for duct mounting. Size and shape of housings shall be as noted on the drawings. The airflow straightener/ equalizer shall be an aluminum "honeycomb" with 3/8 x3 inch cells. The maximum pressure drop shall be 0.085 inches w.c. at 2000 FPM. The pressure sensors shall be copper tubes arranged for equal area sensing and symmetrical averaging of total and static pressures. Stations of four square feet and less area shall have sensing ports for every 16 square inches. Larger stations shall have sensing ports for every 36 square inches. Self-generated sound shall be less than NC40. Accuracy shall be two percent from 1000 FPM to 4000 FPM. Stations

shall be equal to "Fan-Evaluator" model by Air Monitor Corporation, Ebtron Corporation or equal.

2.13 Circuit Setter/Balancing Valve

A. Do not use circuit setters as a positive shut off device or with pressure independent control valves.

B. Circuit setter must have integral snifter valves (hose valves), or separately installed snifter valves on either side of the circuit setter to allow attachment of differential pressure gage for flows setting & verification.

C. For larger pipes, a butterfly valve with memory stop is acceptable as a balancing device, but shall have a second butterfly valve as a positive shutoff.

D. Suggested manufacturers: Bell & Gossett, Taco, or Tour & Anderson.

PART 3 EXECUTION

3.01 GENERAL

A. All control products shall be installed in accordance with the manufacturer's instructions.

B. Main air to receiver-controllers shall not be valved. Main air to receiver-controllers shall not be cycled On/Off by the controls.

3.02 CONTROL AND INSTRUMENTATION TUBING

A. The control and instrumentation tubing shall be designed by the controls installer so that the maximum pressure drop at any main or branch is not greater than 0.5 PSI at maximum air consumption.

B. Tubing in concealed, accessible locations may be soft copper or polyethylene.

C. Tubing in concealed, inaccessible locations may be soft copper, or polyethylene in conduit.

D. Tubing in exposed locations may be polyethylene in conduit or hard copper.

E. Hard copper tubing and conduit shall be rigidly supported from the structure at regular intervals. Hard copper tubing and conduit shall not be supported from piping, ductwork or equipment. Multiple runs shall be neatly nested.

F. Polyethylene tubing exiting conduit shall be protected from chafing with smooth, chamfered bushings or plastic strain relief bushings. Polyethylene tubing shall be protected from tight bends and pinching with springs.

G. After installation, all tubing shall be purged of all impurities with dry, oil-free compressed air before making connections to control instruments.

H. The complete tubing system shall be tested at 30 PSI for 2 hours. The pressure loss after 2 hours shall not exceed 2 PSI.

I. Freeze stat capillary tube(s) shall protect entire coil face area.

3.03 CONTROL WIRING

Control wiring shall conform to the National Electric Code as a minimum standard and DIVISION 26, ELECTRICAL, of these specifications.

3.04 CONTROL VALVES

A. Control Valves shall be furnished by the controls installer and installed by the HVAC systems installer in accordance with the requirements specified herein.

B. Control valves shall be installed with the stem in the vertical, upright position. Valves shall be installed with adequate clearance for easy service and replacement of valves and actuators.

3.05 CONTROL DAMPERS

Control dampers specified by this section shall be furnished by the controls installer and installed by the HVAC systems installer. Dampers shall be installed without twisting or binding to allow smooth, free operation through the full range of movement.

3.06 DUCT MOUNTED SMOKE DETECTORS

A. Duct Mounted Smoke Detectors shall be furnished by the controls or fire alarm system installer and installed by the HVAC systems installer. Power and fire alarm interlocks shall be connected by the

electrical installer. Control interlocks shall be connected by the controls installer.

B. Duct Mounted Smoke Detectors shall be located as indicated on the drawings, and be interlocked with fan motor starters and the building fire alarm system, unless otherwise noted.

3.07 ENCLOSURES

Enclosures shall be installed in accordance with the National Electric Code as a minimum standard and DIVISION 26, ELECTRICAL, of these specifications.

3.08 VIBRATION ISOLATION

Controllers and other devices sensitive to vibration shall be isolated by location or by mounting devices to prevent vibration.

3.09 SEQUENCES OF OPERATION

The sequences of operation shall be as indicated on the drawings.

3.10 CONTROL SYSTEM DRAWINGS

A. Provide a control drawing of each control system unless indicated otherwise. Each drawing shall include a system diagram with all components identified, a list of all components with manufacturer and model number, locations of equipment and sequences of operation. Drawings shall also list all spring ranges, pressure switch settings, temperature switch settings, sensor sensitivity settings, control setpoints, minimum and maximum design flows, system design capacities, etc.

B. At completion of the job, the contractor shall furnish copies of as-built wiring diagrams, system schematics and sequences of control. One copy of each shall be enclosed in laminated plastic, suspended at each air handler and/or controlled system and inside each control panel, or as directed by the Contracting Officer's Technical Representative (COTR).

3.11 TESTING, CALIBRATION AND ACCEPTANCE

A. After completion of control systems installation, all control systems shall be tested and adjusted in terms of function and performance in preparation for control systems acceptance tests

(ref: Section 23 09 23). Data showing set points and final adjustments of all controls shall be provided.

B. The controls installer shall conduct a thorough test in the presence of the Government Inspector, demonstrating all system performance features.

C. After control systems have been tested in the presence of the Government Inspector, the systems shall be operated in normal service for two weeks. After two weeks, all instruments and devices shall be checked. Items found to be out of order shall be corrected. When all control systems meet specified operating conditions and when all other pertinent specification requirements have been met, systems will be accepted.

3.12 SPECIAL TOOLS

Special tools shall be provided as required for the operation and adjustment of controllers, instruments, or other control system devices.

3.13 FLOW MEASURING STATIONS

A. Flow measuring stations shall be furnished by the controls installer and installed by the HVAC systems installer in accordance with the manufacturer's instructions.

B. Flow measuring stations shall be externally insulated by the HVAC systems installer with flexible fiberglass blanket insulation per SECTION 23 07 13, DUCT INSULATION, and SECTION 23 07 19 HVAC PIPING INSULATION.

END OF SECTION

SECTION 23 09 23

DIRECT DIGITAL CONTROL / UTILITY CONTROL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This section applies to all Utility Control System instrumentation. Product quality, installation, and operation shall meet the requirements specified herein unless indicated otherwise on the design drawing(s).

B. The existing UCS architecture consists of multiple LAN segments supporting dual servers, operator workstations, printers and Ethernet to MS/TP data routers supporting multiple MS/TP LANs. The MS/TP networks include over 200 point-to-point modems and data converters used to extend each MS/TP LAN segment. Operator workstations are Windows XP based systems running Dorsett's Infoscan, Oracle Client, and other custom applications. Servers are Windows Server 2003 based systems running Dorsett Technologies Inc.'s Infoscan and Oracle Database Manager. The UCS monitors and/or controls more than 3.5 million square feet of conditioned space in excess of 100 buildings, comprising more than 18,000 connected field devices. Due to MSFC's multi-million dollar investment in the large installed UCS product base and to ensure 100% compatibility with the existing hardware and software, all construction, renovation or modification of facilities shall be an extension of the existing UCS architecture. For all modifications and/or additions that include UCS or affect UCS, the design of the UCS control system network and UCS equipment is done by a specialized "in-house" UCS design group at MSFC.

1.2 PRE-CONSTRUCTION MEETING

A. A control system pre-construction meeting shall be held prior to undertaking any control system construction installations at MSFC. The contractor's construction supervisor or field manager must attend this meeting. The following individuals shall attend this meeting:

1. PROJECT ENGINEER
2. CONSTRUCTION INSPECTOR
3. UTILITY CONTROL SYSTEM REPRESENTATIVE
4. UTILITY CONTROL SYSTEM DESIGNER
5. CONTRACTOR CONSTRUCTION SUPERVISOR

B. The purpose of the meeting is to review this specification and discuss the project prior to starting work. Proper construction techniques and expected

results will be discussed. In general this meeting will address questions, or concerns, by any party, so that a clear understanding of the job scope and contractor responsibility is understood.

1.3 QUALITY ASSURANCE

A. The instrumentation installation shall be under the direct supervision of individuals with a minimum of 5 years experience in the installation and service of similar instrumentation. The contractor shall submit a list of projects, dates, and control descriptions as proof of experience installing similar instrumentation.

1.4 GENERAL REQUIREMENTS

A. Section 26 05 00 "Basic Electrical Materials and Methods," applies to work specified in this section.

B. Section 23 09 00 “HVAC Instrumentation and Controls”, for non-DDC control system instrumentation.

1.5 SYSTEM DESCRIPTION

A. A control system consists of: sensors, indicators, final control elements, interface equipment, accessories, software, and other apparatus connected to distributed controllers operating in a multi-user, multitasking environment on Local Area Network(s), and programmed to control specified equipment.

1.6 SUBMITTALS

A. If required by the Schedule of Submittals, prior to beginning work provide the following submittals in accordance with Section 01 33 00, "Submittals." Submittals shall be provided in sufficient detail to show full compliance with the specification.

B. Product Data

1. Data is composed of catalog cut-sheets, specifications, product data, warranty information and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents. A technical submittal must be submitted including specification compliance, technical sheets, and factory representative authorization. The technical submittal shall contain the following:

    a. Specification Compliance: The compliance document shall address each paragraph of the specification by indicating COMPLY,

EXCEED, or EXCEPTION. Do not indicate COMPLY unless the proposed system exactly meets the paragraph requirement. If EXCEED or EXCEPTION is indicated, then provide a clear and concise explanation of the variance from the specifications and the net effect this would have on the proposed system.

b. Technical Sheets: Provide technical sheets on all system components shown on the design drawing(s).

C. Shop Drawings

1. The Contractor shall submit complete schematic drawings of the entire control system to the Government for approval before work begins.

2. Submittals shall graphically show layout and connection of components and include schematic diagrams of systems. Samples of such systems, not all inclusive, shall consist of air handling systems, chilled water, steam, and hot water systems. Communication trunk diagrams shall designate and identify the specific building location of each application-specific or multi-function controller card and the relative position of each card on respective trunks.

3. The Contractor shall provide detailed I/O point summaries indicating each instrumentation point with wire termination identifications for each point and grouped by individual I/O card.

4. The control schematics shall indicate the differential pressure setpoints for all air filters.

5. The contractor shall provide a detailed sequence of operation describing the operation of specified equipment.

6. Four (4) copies of the following as-builts shall be provided in hardcopy and on compact disc (CD) in either Bentley Systems' Microstation or DXF format and shall include Contractor's original, un-translated drawing file.

   a. Wiring diagrams
   b. System schematics
   c. Communication trunk layout
   d. Sequence of Operation

D. Test Reports

1. Thirty days prior to the start of system verification, three (3) copies of written test plans describing control system verification and operational functionality procedures shall be submitted for Government approval. The Contractor is responsible for the development of the test plans. Test plans shall validate the intended purpose and operational effectiveness of the entire system; this includes all hardware devices and software sequences called for on the design drawings.

2. Control system verification procedures describing how the operation of each control loop will be verified shall be submitted by control loop, identifying each sensor, actuator, controller, transducer, and measuring device, as required. The procedures shall describe adjustments in terms of control component positions, input and output signals and ranges, air and water flow rates, temperature and humidity setpoints, and other pertinent control parameters. The contractor shall provide trending charts to verify that all equipment/systems are controlling properly.

3. Control system verification test reports describing test results of each control loop shall be submitted in bound form and shall indicate the final values and settings of each control component in each control loop. Where testing indicates a necessary deviation from the contract drawing sequences of operation and controls submittals, the Government shall be informed immediately. Any deviations shall be made only after Government approval and the test report shall note any changes in the control loop or component settings caused by the deviation. One (1) hardcopy and two (2) electronic copies on CD of the control system verification test report shall be submitted within 30 days after completion of testing.

E. Manufacturer’s Instructions: Contractor shall submit three (3) hardcopies and three (3) electronic copies on CD of manufacturer’s instructions describing installation of a product or system, special notices and material safety data sheets concerning impediment, hazards, safety precautions, startup, shutdown, and emergency operation.

F. Operation and Maintenance Manuals: Operation and maintenance manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Contractor shall submit three (3) hardcopies and three (3) electronic copies on CD of O&M documentation. Operation and maintenance manuals shall be provided for all control system instrumentation products.

1.7 TELECOMMUNICATIONS

A. Telecommunication lines are furnished by the Government. If installation of a communication line to a new field interface device is specified on the design drawing(s), the Contractor shall submit a written request to the BASSCO Contractor 30 days prior to system startup.

The Contractor shall furnish the modems specified below for installation as required on contract drawings.

1. Modems are available from:
   a. Patton Electronics Co. (301) 975-1000
   b. ADC-MegaBit 1-800-366-3891

2. Company websites:
   a. http://www.patton.com
   b. http://www-wsp.adc.com

3. Rack-mount modem:
   a. Patton Electronics P/N 1080ARC

4. Stand-alone modem:
   a. Patton Electronics P/N 1080
   b. ADC-MegaBit DSL P/N MM300S

PART 2 - PRODUCTS

The Controls Contractor shall furnish components required by design and described herein.

2.1 DIRECT DIGITAL CONTROL (DDC) EQUIPMENT

A. Utility Control System (UCS): This work includes all material, equipment, and appurtenant accessories necessary for, or incidental to, the installation of a complete Direct Digital Control (DDC) System as specified in the design package. The appropriately selected DDC configuration shall be capable of controlling processes in the building through configurable electronic controllers. This configurable hardware shall be electronically interfaced via an Interface Card (CPU), X-Talk or UNV-T-E card, manufactured by Dorsett Technologies Inc., http://www.dorsett-tech.com/, through telecommunication data lines to the central computer-based Utility Control System (UCS) located in Room 29 of Building 4250. Complete operational compatibility shall be maintained between the central UCS Infoscan system, both hardware and software, as manufactured by Dorsett Technologies Inc. and the direct digital controllers. The central host computer communicates via Government-furnished telecommunication lines and contractor installed modems to Dorsett's Interface

Panel(s) located in the building(s) where the project is being performed. The Interface Panel communicates with application-specific controllers or multi-function controller cards, which implement direct control of equipment through industry standard electronic signals.

B. The term compatible means that the DDC hardware and software will communicate directly with the central host Infoscan application and that all existing UCS programs will function completely to control and monitor related equipment. It also means that engineering units, values, or parameters utilized within the panels or controllers are compatible with units used within the Infoscan System. The field hardware and the central host computer shall communicate and be fully programmable from the host Infoscan application.

C. Operators shall have the ability to specify within the software and in standard engineering units the amount by which the point must change at the sensor before it is reported as changed to the UCS central servers in Building 4250. This feature provides a system function referred to as "report-by-exception." Interface cards only report to the central computers value changes that exceed the selected delta value. This minimizes data traffic on telecommunication lines to and from the UCS central servers.

D. Each point that is used within the process shall be displayable and accessible through an Infoscan point review. When these points are represented as displayed values on computer graphic displays, operators shall be able to select these values with a point device and retrieve accurate data within 20 seconds.

E. Computer graphic displays shall be developed to represent each HVAC or environmental control component or system. These pictorial displays shall represent a chiller with all support pumps, valves, towers, air handlers, etc. All related analog and status points shall be dynamically represented on the display. If an analog or binary point changes value beyond the delta limit, this condition must be reported to an operator workstation within 20 seconds.

F. The Contractor shall perform all application programming and point configurations through existing operator workstations via Infoscan software. All programming and graphic display generation for a completely operational system shall be provided.

G. Field Interface Device: A Field Interface Device, also called FID, SID, MID, JID, etc., is a solid state electronic device with supporting software that provides an interface and permits communication between field controllers and the UCS servers. This device is the Dorsett's CPU card, X-Talk or UNV-T-E card into which the multi-function or application-specific cards are interfaced. It is connected via Government-furnished telecommunication lines to the UCS central servers in Building 4250. It has hardware and software compatibility with the existing Utility Control System. This card functions on a "report-by-

exception" basis as described earlier in this section. If a new Interface Device is required, it shall be acquired from Dorsett Technologies Inc.

H. Multi-Function Controller Card: Is a solid-state electronic controller with universal input-output channels. All configuration parameters are fully programmable via the UCS central servers. Multifunction controller cards are manufactured by Dorsett Technologies Inc. Examples are:
   1. MS4-UNV-T-E
   2. MS4 xTalk
   3. SCADA Controller
   4. Older MS3 controller cards

I. Application-Specific Controller: An application-specific controller is a solid-state electronic assembly designed to control the functions of a specific type of electrical or mechanical equipment. These programmable cards shall be connected and communicate to the UCS system through the CPU, UNV-T-E cards, or X-Talk. An example is an MS4-VAV controller.

J. Equipment Specific Controller (ESC): An equipment specific controller is any controller that is user programmable such as programmable logic controllers (PLC), PID controllers, etc. An ESC, when allowed by contract drawings and specifications, shall have all pertinent accessories included for the programming, downloading, and documentation of software. Where front panel programming of the ESC is not readily available, the contractor shall provide a Government approved programming device including software, cables, hardware locks, etc. to provide for the physical connection to the ESC and access to the non-volatile memory for programming of the ESC. Programming software shall be provided on factory media with all/any serial numbers, key codes, etc. such that the media can be registered with the manufacturer. For all ESC's, the contractor shall provide two (2) hardcopies of the factory programmed software logic. Owner's manuals and programming manuals shall also be included with all ESC installations. Where UCS control is desired, ESC's must be compatible with accepted UCS communication protocols. Examples of these protocols are:
   1. BACnet – IP
   2. BACnet – MSTP
   3. N2 – (Johnson Controls Inc.)
   4. Modbus RTU.

K. Control Panel (MUX):

   1. A control panel is a completely configured field panel consisting of multi-function controller card(s), power supply(s), and terminal strips, fully contained within a UL listed, NEMA rated enclosure. Control panels manufactured by Dorsett Technologies Inc., are available in several sizes and configurations.

2. All control panels shall have a trough wire-way mounted above and below the enclosure for conduits to enter or exit. Chase nipples or conduits shall be used to connect the trough to the bottom of the control panel enclosure. Only penetrations in the bottom of the UCS control panel shall be made.

2.2 FIELD DEVICES

A. General:

1. The use of interface signal converters is not allowed unless otherwise indicated on design drawings.

2. 24 volt AC power sources shall be 120 volt AC primary input, 4 amp minimum rated secondary, on/off switch, circuit breaker mounted in metal enclosure.

3. Uninterruptible Power Sources (UPS) shall have hot-swappable batteries, automatic voltage regulation and 1 KVA minimum capacity rating.

4. Acceptable industry standard analog voltage and current signals are as follows: 4 to 20mA, 0 to 20mA, 0 to 10VDC and 2 to 10VDC..

B. Temperature Sensor: Temperature sensors shall be 100 Ohm or 1000 Ohm 0.00385 coefficient platinum Resistive Temperature Devices (RTD). All temperature transmitters shall be provided as specified on the design drawings. Temperature sensors shall conform to DIN-IEC-751 class B (+/- 0.12%). As minimum requirements, the repeatability shall be +/- 0.1 degrees C and the stability shall be less then +/- 0.1 degree C drift per year. The transmitter shall be 4-20 mA loop powered having a calibration accuracy of +/- .1% of span and a linearity of 0.1% of span, unless otherwise specified.

1. Duct Temperature Sensor: Probe sensors for supply air and return air shall have rigid averaging elements and be installed horizontally extending two-thirds of the duct width as a minimum. Probe sensors for mixed air shall have bendable averaging elements with a minimum length equivalent to four times duct width. Non-platinum 0.00385 coefficient RTD’s having platinum equivalent accuracy may be used.

2. Room Temperature Sensor: Room sensors shall be provided with a high impact plastic cover. When connected to an application-specific controller the sensor shall include an access-port for communications.

3. Immersion Well Temperature Sensor: Immersion sensors with thermowells shall be installed in liquid and steam applications. Thermowells shall be stainless steel.

C. Pressure Sensor

1. Static Air Pressure Sensor: Pressure sensors shall be 4 to 20 milliamp, loop powered, 1/8-inch brass barb fittings and 1% full-scale accuracy. Static pressure sensors shall have a range approximately twice the setpoint called for in the sequence of operation. Duct static pressure sensors must be located downstream of fan 2/3 of the duct length.

2. Liquid and Gas Pressure Sensor: Pressure sensors shall be Setra Model 209. A snubber and pigtail siphon shall be installed in steam applications. Isolation valves shall be installed on each device port to facilitate removal/replacement. http://www.setra.com

3. Liquid and Gas Differential Pressure Sensor: Differential Pressure sensors used for gas and liquid applications shall be Setra Model 230. Isolation valves shall be installed on each device port to facilitate removal/replacement. http://www.setra.com

4. Low Differential Air Pressure Sensor: Pressure sensor shall be Setra Model 267. http://www.setra.com

5. Space Air Pressure Sensor: Space air pressure sensors shall be bi-directional, 4 to 20 milliamp loop powered unless otherwise specified.

D. Humidity Sensor

1. Relative Humidity Sensor: Humidity sensors shall be plus or minus 2 percent minimum accuracy, unless otherwise specified. Sensor output signal shall be loop powered 4 to 20 milliamps. http://www.gesensing.com/

E. Pressure Switch

1. Air Differential Pressure Switch: Differential pressure switches for airflow confirmation shall be Dwyer Instruments Model 1910 series. http://www.dwyer-inst.com/

2. Liquid Differential Pressure Switch: Differential pressure switches for proving water flow shall be Penn Model P74FA-5. Isolation valves shall be installed on each device port to facilitate removal/replacement.

F. Pneumatic Transducer: Pneumatic transducers shall be analog input, minimum supply pressure shall be 25 PSI, control range shall be 3 to 15 PSI, air connection shall be 1/8 inch brass barb or 1/8 inch FNPT and utilize electronic feedback pressure control. Branch line shall have a 0 to 30 PSI maximum range pressure gauge installed.

G. Actuators: Electronic actuators shall be 24 VAC powered, unless otherwise specified and operated by industry standard process signals. Examples are 4 to 40mA, 0 to 10V, Pulse-Width Modulation and 3-Point Floating.

H. Enclosures: Enclosures shall be UL listed, constructed of minimum 14 gauge sheet metal with spot welded joints, gray enamel finish and suitable for the application. Doors shall have a full-length left-hand piano hinge and slotted-head screw operated latch.

I. Utilities Metering: All programmable utility meters as required on contract drawings shall have all pertinent accessories included for the programming, downloading, and documentation of software. Where front panel programming of the meters is not readily available, the contractor shall provide a Government approved programming device including software, cables, hardware locks, etc. to provide for the physical connection to the meter and access to the non-volatile memory for programming of the meter. For all programmable meters, the contractor shall provide two (2) hardcopies of the factory programmed software logic. Owner's manual and programming manual shall also be included with all installations.

Where discrete connections are specified, meter output(s) shall be directly connected to the Utility Control System DDC hardware. Meter electrical ratings shall be compatible with the Utility Control System DDC hardware. Pulse outputs shall indicate an accumulated quantity. Minimum pulse output duration shall be 0.25 seconds. Pulse output type shall be open-collector/current sinking or form C relay contacts. If specified on the contract drawings, the following utility meter to UCS connections may be required:

1. Pulse output meters:
   a. Condensate
   b. Industrial water
   c. Potable water
   d. Natural and Propane gas
   e. Process make-up water

2. Analog output rate meters:
   a. Chilled water flow
   b. Hot water flow
   c. Process flow

3. Pulse and Analog output meters:
   a. Electrical power
   b. Steam
   c. BTU

J. Voltage/Phase-loss monitor: Device shall be selected per application; automatic reset type with DPDT form C relay outputs, adjustable trip setpoint.

K. Refrigerant/HCFC Monitor: Device shall have, at a minimum; scalable 4 to 20mA analog output indicating refrigerant levels in Parts-Per-Million (PPM) and programmable SPDT alarm relay.

L. Indoor Air Quality (IAQ): Device shall have an analog output corresponding to Carbon Dioxide (CO_2) concentrations ranging from 0 to 2000 ppm.

M. Gas Detection: Gas detection devices, i.e. Oxygen Deficiency, Hydrogen, Fluorine and Carbon Monoxide shall have form C relay alarm output(s).

N. Current Switch: Device shall be capable of switching 150mA continuously. Split core design with adjustable trip point and capable of switching AC or DC circuits. Applicable for VFD applications down to 6Hz and powered by monitored line.

O. Water Level Detection: Device shall have 4 – 20mA output.

P. Moisture Leak Detection: Device shall provide the following features:

1. By-zone form C relay interface capable of 32 alarm outputs
2. ALARM, FAULT, and HORN form C relay outputs
3. 36 hour battery backup
4. Capable of monitoring 32 independent zones
5. Provides subsequent alarming, no matter how many zones go into ALARM or FAULT
6. Identifies location, time & date of all ALARM and FAULT conditions displayed in chronological order via a LCD alphanumeric display
7. ALARM, FAULT and POWER front-panel mounted LED indicators
8. Lineal leak detection tape

Q. Variable Frequency Drive: VFD shall have an analog 4 – 20mA input for speed control, a contact-closure input for start/stop control, and N2 communications.

2.3 LABELING

A. Sensor and Control Devices: Each sensor and each control device shall be labeled at the sensor or device with the Infoscan database point name that identifies it. The point name shall be displayed in print achieved electronically or typographically on permanent adhesive labels. Minimum label size shall be 1 inch by 1/2 inch. Label color shall be white background. Printed text shall be black.

B. Enclosures: UCS control panels, as a minimum, shall be labeled. Labels shall be engraved plastic, beveled edges, black background, white letters. Letter height shall be 1/2 inches minimum. Overall label dimensions shall be 1.25 inches minimum height, length as required. Labels shall be centered along width and located within upper 1/4 area of enclosure door. Minimum distance

from top of enclosure shall be 3 inches. Labels shall be affixed with adhesive cement. Panels shall be labeled consistent with design drawing terminology.

C. Terminations: Each terminated wire shall be clearly labeled with Field Device Infoscan point name (example 4200-AH1-SAF) at the Field Device and at each wire termination. Labeling shall be heat-shrink-type and device or point names shall be displayed in print achieved electronically or typographically. The Government shall approve labeling medium and method before work begins. One source for white non heat-shrinkable plastic sleeves with print-type capability is: Brady Corporation, 800-537-8791, Brady P/N: WMS-117-319, http://www.bradyid.com.

2.4 WIRING

A. Instrumentation and Low Voltage Wiring: All wiring shall be installed in conduit except that plenum-rated wire may be used in low voltage runs in concealed but accessible ceiling areas and computer room sub-floor only. A.C. power wiring shall not be installed in the same conduit, or pathway, with low voltage (24 volt or less) signal wiring. All low voltage UCS control wiring shall be installed in dedicated conduit. Flexible conduit shall not exceed 3 feet. Conduit shall be 3/4 inches minimum diameter. Wiring specifications are as follows:

B. INSTRUMENTATION/SENSOR WIRING:

1. 1-Pair, 22 AWG, stranded (7X30),twisted pair construction, 300 volt, polymer alloy-insulation, maximum O.D. of 0.15 inches, aluminum foil-polyester tape 100% shield, 24 AWG stranded drain wire, and plenum rated-jacket. Gray jacket with one black and one red wire. West Penn part #25291B or approved equal.
2. 2-Pair, 22 AWG, stranded (7X30) twisted pair construction 300, volt, polymer alloy-insulation, maximum O.D. of 0.21 inches, individual aluminum foil-polyester tape shielded pairs, 100% shield coverage, 24 AWG stranded (7X32) tinned copper drain wire, and plenum rated-jacket. Gray jacket with black/red and white/green wire pairs. West Penn part #25510B or approved equal.

C. 24 VOLT POWER WIRING: 2 Conductor, 16 AWG, stranded (19X29) wire for delivering low voltage power to 24 volt UCS connected devices. Plenum rated-jacket, 300 volt, polymer alloy insulation and maximum O.D. of 0.18 inches. Gray jacket with one black and one red-wire. West Penn part #25225B-or approved equal.

D. Wires connecting field devices shall not be spliced or butted together. They shall be "home runs" from the field device to the panel.

E. Control panel instrumentation/sensor-wiring shall have shield/drain wires terminated only at a grounding bar in the wire trough located beneath the MUX panel. A 25 position (minimum) grounding bar shall be mounted and bonded to the wire trough bottom. A maximum of five shield/drain wires shall be terminated at each ground bar position. Shield/drain wires are not permitted in the control panel and shall remain within the wire trough enclosure.

PART 3 - INFOSCAN INTERFACING

A. Equipment described in this section shall interface to the existing InfoScan system using standard interface protocols as shown on contract drawings. Typical industry standard interfaces are Johnson N2, Modbus RTU, BACnet-MSTP and BACnet-IP.

B. The following categories list the minimum required interface protocol read/write properties:

1. Chiller Requirements (dependant upon chiller type)

   a. Read Properties:
      1) Chiller run status
      2) Evaporator leaving water temperature
      3) Evaporator entering water temperature
      4) Condenser leaving water temperature
      5) Condenser entering water temperature
      6) Condenser refrigerant pressure
      7) Evaporator refrigerant pressure
      8) Motor winding temperature
      9) Bearing oil temperature
      10) Oil temperature
      11) Oil pressure
      12) Compressor % RLA.

   b. Write Properties:
      1) Chiller enable
      2) Chiller disable
      3) Evaporator leaving water temperature setpoint
      4) Percent load setpoint

2. Steam Boiler Requirements

   a. Read Properties:
      1) Boiler Run Status
      2) Low water
      3) High water
      4) Boiler Alarm

5) Stack Temperature (fuel-fired only)

b. Write Properties:
1) Boiler Enable
2) Boiler Disable
3) Steam Pressure Setpoint

3. Hot Water Boiler Requirements

a. Read Properties:
1) Boiler Run Status
2) Low water
3) High water
4) Water Supply Temperature
5) Water Return Temperature
6) Boiler Alarm
7) Stack Temperature (fuel-fired only)

b. Write Properties:
1) Leaving/Return Water Temperature Setpoint
2) Boiler Enable
3) Boiler Disable

4. Computer Room Air Handling Units

a. Read Properties:
1) Status
2) General Alarm
3) Filter Alarm
4) Supply Air Temperature (SAT)
5) Return Air Temperature (RAT)
6) Relative Humidity

b. Write Properties:
1) Start/Stop
2) Temp Setpoint
3) Humidify Setpoint
4) De-Humidify Setpoint

5. Variable Frequency Drive Requirements

a. Read Properties:
1) Frequency
2) Power
3) Motor Current
4) Runtime
5) Fault Alarm

b. Write Properties:
   1) Start
   2) Stop
   3) Frequency Setpoint
   4) Minimum Frequency
   5) Maximum Frequency
   6) Ramp Time
   7) Max Current
   8) Max Torque

6. Generator Requirements

   a. Read Properties:
      1) Run Time
      2) Engine Temperature
      3) Coolant Level
      4) Oil Pressure
      5) No AC Output Alarm
      6) Battery Voltmeter
      7) Water Temperature
      8) Ammeter
      9) Voltmeter
      10) Frequency
      11) Overcrank Alarm
      12) Overspeed Alarm

   b. Write Properties:
      1) Start/Stop

7. Transfer Switch Requirements

   a. Read Properties:
      1) Source 1 Power Available Status
      2) Source 2 Power Available Status
      3) Switch Position Status

   b. Write Properties:
      1) N/A

8. Electrical Meter Requirements

   a. Read Properties:
      1) KW*
      2) KW (demand)*
      3) KWH

4) Amps*
5) Volts*
6) Neutral Amps*
7) Power Factor*
8) THD*
9) KVA*
10) KVAR*
11) KVARHR
12) Demand Reset
13) Power Fail Alarm
14) *Include Min/Max parameters

b. Write Properties:
1) Demand Period
2) Number of Demand Periods
3) Reset KWH
4) Reset KVARHR
5) Reset Min/Max Values

9. Steam Metering Requirements

a. Read Properties:
1) Flow Rate
2) Flow Total
3) Temperature
4) Pressure
5) Peak Rate (time stamped)
6) Alarm

b. Write Properties:
1) Reset Flow Total
2) Reset Min/Max Values

10. BTU Meter Requirements

a. Read Properties:
1) Water Flow Rate
2) Water Supply Temperature
3) Water Return Temperature
4) BTU Rate
5) BTU Total

b. Write Properties:
1) Reset BTU Total

11. Un-Interruptible Power-supply (UPS) Requirements

    a. Read properties:
        1) Voltage In / Output
        2) Current In / Output
        3) Battery Voltage
        4) Battery Current
        5) Runtime
        6) Operational Status

12. Lighting Panel Requirements
    a. Read Properties:
        1) Status

    b. Write Properties:
        1) Breaker Control
        2) Zone Control
        3) Powerlink N2 Control

PART 4 - EXECUTION

4.1 GENERAL

A. All products shall be installed in accordance with manufacturer's instructions. Installation of control components shall be performed by qualified control and instrumentation specialists. Only penetrations in the bottom of enclosures shall be made unless otherwise specified on contract drawings.

4.2 AC POWER WIRING

A. The Contractor shall install 120 Volt AC power wiring for control system instrumentation if required by device. The breaker must be dedicated to the device and labeled. All work shall be performed in accordance with applicable sections of Division 26, "Electrical," unless otherwise specified. Contact the COTR before performing any electrical panel modification.

B. The UCS control panel Uninterruptible Power Source (UPS) input voltage shall be supplied by dedicated 120 volt AC duplex receptacle.

C. 120 volt AC input power cord for field panels shall be of sufficient length to allow connection to either UPS output receptacle or 120 volt AC duplex receptacle dedicated for UPS input.

4.3 EQUIPMENT ACCESSIBILITY

A. Enclosures: Enclosures shall be installed in accordance with the National Electrical Code as a minimum standard. Doors shall not be obstructed and shall open a minimum of 90 degrees from its closed position.

B. Instrumentation: All control system instrumentation shall be installed such that each device is accessible and unobstructed to facilitate ease of maintenance. Examples of obstructed equipment typically include piping surrounding valve actuators and covers that protect electronic components in VAV applications.

C. Shelf for Uninterruptible Power Sources (UPS) shall be constructed of corrosion-resistant metal of sufficient gauge to support UPS weight without flexing with a 3/8-inch minimum lip around edge. Shelf shall be mounted beneath field panel and 6 inches minimum above finished floor.

D. A power disconnect switch shall be provided at each VAV used in the control system and located on the high voltage side of the control transformer.

4.4 VIBRATION ISOLATION

A. Controllers and other devices sensitive to vibration shall be isolated by location or utilizing shock absorbing mounting devices.

4.5 SEQUENCE OF OPERATION

A. The sequence of operation shall be as indicated on the design drawing(s).

4.6 CONTROL SYSTEM DRAWINGS

A. At completion of the job, the Contractor shall furnish copies of as-built wiring diagrams, system schematics, and sequences of control. One (1) copy of each shall be enclosed in laminated plastic, suspended at each air handler and/or controlled system and inside each control panel, or as directed by the Contracting Officer's Technical Representative (COTR).

B. Wiring diagrams shall show all instrumentation, interlocks and connection information required for controlling the specified equipment.

4.7 SYSTEM VERIFICATION AND STARTUP

A. Verification testing shall be performed in the presence of the Government Construction Management Inspector and shall be repeated, as necessary, until each system or control loop is successfully verified.

B. The Contractor shall have factory-authorized representatives perform system start-up and adjustment after acceptance of test plans.

C. The Contractor shall demonstrate to the Government through a system verification test that final calibrations and adjustments are accurate and each control loop operates as defined by the sequence of operation. All deficiencies shall be corrected prior to final acceptance. The Government Construction Management Inspector shall witness all verification tests.

D. The Controls Contractor shall perform a complete checkout and verification of the controls and instrumentation before total system commissioning begins. The Controls Contractor shall participate in the total integrated system commissioning. Integrated system commissioning procedures are specified in Section 23 08 00, “Commissioning of HVAC .”

4.8 TRAINING

A. The Contractor shall provide [ ] on-site instruction Session(s) for [ ] personnel. Each session shall consist of a minimum of [ ] hours. Instructors shall be factory-authorized representatives. The Government shall approve course content and format.

END OF SECTION

SECTION 23 12 13

FACILITY FUEL OIL PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Definitions:

1. Capacity: Gallons per minute (GPM) of the fluid pumped.

2. Head: Total dynamic head in feet of the fluid pumped.

3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

1.02 RELATED WORK

A. Section 23 05 00, Common Work Results for HVAC

B. Section 23 05 00.01, Laser Alignment for HVAC Pumps & Rotating Equipment

C. Section 23 05 48, Vibration Controls for HVAC Pumps & Rotating Equipment.

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00, SUBMITTALS.

B. Manufacturer's Literature and Data:

1. Pumps and accessories.
2. Motors and drives.
3. Variable speed motor controllers.

C. Manufacturer's installation, maintenance and operating instructions. Shall include MOD #, Ser. #, & Date Installed.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and

show fluid pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.

PART 2 PRODUCTS

2.01 FUEL OIL PUMPS

A. Electric motor-driven (motors rated NEMA Premium Efficiency), close-coupled, single stage, positive displacement type with built-in pressure relief valves.

B. The pump and its electrical and plumbing connections shall be sized to provide a flow rate of at least 10% higher than the required fuel pumping rate.

C. Pump seals and materials of construction to be compatible with B-80 Bio-diesel fuel.

D. Pump and motor bearings shall be B-10 rated with a minimum life of 250,000 hours. Shop drawings/submittals shall bear manufacturer’s certification of bearing life.

E. Suggested Manufacturers: Viking

PART 3 EXECUTION

3.01 INSTALLATION

A. Pumps shall be stored indoors and protected against dust and moisture. Provide expanded foam on the air inlet and outlet parts of the motor and cover pump suction and discharge flanges to prevent entry of foreign matter.

B. Follow manufacturer's written instructions for pump mounting and start-up. Access/ Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

C. Independently support pumps and piping so that the weight of the piping is not supported by the pumps and the weight of the pumps is not supported by the piping. The first 3 hangers for each pipe shall be spring and neoprene type.

D. Permanently support in-line pumps by the connecting piping only, not from the casing or the motor eye bolt.

E. Sequence of installation for base-mounted pumps:

1. Level and shim the unit base and grout to the concrete pad.
2. Shim the driver and realign the pump and driver. Correct axial, angular or parallel misalignment of the shafts per Section 23 05 00.01,"LASER ALIGNMENT FOR HVAC PUMPS & ROTATING EQUIPMENT."
3. Connect properly aligned and independently supported piping.
4. Recheck alignment.

3.02 START-UP

A. Verify that the piping system has been flushed, cleaned and filled.

B. Lubricate pumps before start-up.

C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition. Mechanical Seal or Packing Flush Water Lines
must be cleaned before pump start-up.

D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

E. Perform field mechanical balancing if necessary to meet specified vibration tolerance.

F. Ensure the disposable strainer is free of debris prior to testing and balancing of the hydronic system.

G. After several days of operation, replace the disposable start-up strainer with a regular strainer in the suction diffuser.

H. Pump and piping flanges shall be aligned so that the connecting bolts will fit freely with no external forces applied to pump or piping.

I. The contractor shall provide laser alignment of the pump and pump motor shafts after setting pump on foundation, grout has been set, foundation bolts have been tightened, and piping connections have

been completed. Other methods of pump alignment will not be accepted. The Government reserves the right to verify pump alignment and to require re-alignment where necessary. Laser alignment shall be per Section 23 05 00.01.

END OF SECTION

SECTION 23 21 13

ABOVE GROUND HYDRONIC PIPING

PART 1 GENERAL

1.01 SUMMARY

Work provided under this section includes the following:

A. Above ground Hydronic Piping and Specialties

B. Coil Condensate Piping and Pumps

1.02 RELATED SECTIONS

A.	Section 23 05 00	Common Work Results for HVAC
B.	Section 23 05 19	Meters & Gages for HVAC Piping
C.	Section 23 05 23	General-Duty Valves for HVAC Piping
D.	Section 23 05 29	Hangers and Supports for HVAC Piping & Equipment
E.	Section 23 05 53	Identification for HVAC Piping & Equipment
F.	Section 23 05 93	Testing, Adjusting and Balancing for HVAC (Air & Hydronic)
G.	Section 23 07 19	HVAC Piping Insulation
H.	Section 13 36 13	Underground Hydronic Energy Distribution Piping

1.03 INSPECTION AND ACCEPTANCE

A. All work performed under this section shall comply with the International Mechanical Code and ANSI B31.9, "Building Services Piping".

B. Work shall not be covered, enclosed, or insulated until it has been inspected, tested, and approved. Any work that is covered, enclosed, or insulated before such inspection and test shall be uncovered and, after it has been inspected and approved, shall be restored to its prior condition at no additional cost to the Government.

C. All testing shall be performed in the presence of the Government Inspector.

PART 2 PRODUCTS

2.01 HYDRONIC PIPING (CHILLED, HOT, AND CONDENSER WATER)

A. Copper: Copper tubing shall be Type L, hard drwn copper per ASTM B75 or ASTM B88. Solder joint fittings shall be wrought copper per ASME/ANSI B16.22 or cast copper alloy per ANSI B16.18. Solder shall be lead free, tin-silver solder. Cast bronze threaded fittings shall be per ANSI/ASME B16.15. Cast copper alloy flanges shall be Class 150 per ASME B16.24. Pressed joint fittings with factory installed EPDM o-ring seals shall be wrought copper per ASME B16.22 or cast copper alloy per ASME B16.18.

B. Steel: Steel piping 10” and smaller shall be Schedule 40 black carbon steel per ASTM A53, Grade B and ANSI B36. 10M. Steel piping 12” and larger shall be Standard weight black carbon steel per ASTM A53, Grade B and ANSI B36. 10M. Fittings 2” NPS and smaller shall be Class 150 black malleable iron, threaded fittings per ASTM A197, ANSI B16.3 and ASME B1.20.1. Fittings 2-1/2” and larger shall be standard weight, forged steel, butt weld fittings shall be Class 150, forged steel, weld neck flanges with raised faces per ASTM A105 and ANSI B16.5.

C. HDPE – See TSRC Section 33 61 13 for underground chilled water piping specifications. All applicable sub-sections of this specification shall apply to HDPE piping used in above-ground applications. HDPE piping may be used above-ground, inside buildings, only if run within a fire-rated wall, or if enclosed is a fire-retardant conduit.

2.02 COOLING COIL CONDENSATE PIPING

A. PVC: Polyvinyl Chloride (PVC) piping shall be white, Schedule 40 PVC piping per ASTM D 1785. Fittings shall be molded, white PVC solvent joint fittings per ASTM 2466.

B. Copper: Copper tubing shall be Type L, hard drawin copper per ASTM B75 or ASTM B88. solder joint fittings shall be wrought copper per ASME/ANSI B16.22 or cast copper alloy per ANSI B16.18. Cast bronze threaded fittings shall be per ANSI/ASME B16.15. Cast copper alloy flanges shall be Class 150 per ASME B16.24. Pressed joint fittings with factory installed EPDM seals shall be wrought copper per ASME B16.22 or cast copper alloy per ASME B16.18.

2.03 HYDRONIC SPECIALTIES

A. Combination ball valve/union/strainer/balance valve may be used in lieu of individual components.

B. Dielectric unions and flanges: Watts, EPCO, Harco, or equal.

C. Threaded and Welded outlet fittings: For branch connections to existing steel mains -carbon steel, ASTM A105, standard weight, butt weld type; Bonney Forge "Thred-O-Let" and “Weld-O-Let,” Anvil Products “Anvilet,” or equal.

D. Strainers: Water service, Y-type, iron body, bronze cap, 20-mesh monel or stainless steel screen with free area equal to five times inlet line, Class 125; Watts 77S Series or equal.

E. Manual Balancing Valves: Bronze body, threaded, Class 125, gage ports with integral check valves, and pre-formed insulation kit; Bell & Gossett "Circuit Setter" or equal.

F. Automatic Balancing Valves: Piston type, 2-32 psid range unless otherwise noted, factory set for flow indicated on the drawings, with stainless steel or nickel-plated brass internals, NPT connections, and dual P/T ports; Autoflow BR Series, Griswold 3500 and 3600 Series, or equal.

G. Hydronic Flow Metering Stations: Low loss venturi type; steel, iron, or brass body; machined venturi (sheet metal inserts not acceptable); +/- 1% accuracy; 250 psi working pressure; end connections as required; differential pressure sensing ports with

valves; Victaulic Style 733, Preso XV Series, or equal. Provide extended dp ports for insulated lines.

H. Automatic Air Vents: Water service, float operated, non-ferrous construction, NPT connections, maximum 150 psig at 240 degrees F; TACO Model 426, Bell & Gossett Model 87, or equal.

I. Pressure and Temperature (P&T) Test Ports: Brass body with dual self-sealing elastomer internal valves, knurled cap, o-ring cap seal, cap retainer, and 1/4" NPT connection. Test ports shall be rated for 500 psig service at 275 degrees F, and shall be designed to receive 0.156-inch O.D. probes. Test ports for insulated piping shall extend beyond insulation; Flow Design Inc. "Super Seal" Models SS25 and SS25L or equal.

J. P&T Test Kit: Compatible with the P&T test ports provided, and consisting of the components specified below.

1. Pressure gage - 3-1/2" dial, aluminum or phenolic case, 0-150 psi range, +/- 3% accuracy.

2. Thermometer - dial type, bimetallic element, 1-3/4" dial, external adjustment, stainless steel case and stem, 25-125°F range
(0-220°F for heating water), +/- 1% accuracy.

3. Adaptor probe for pressure gage, length as required for the P&T ports provided.

4. Silicone lubricant for P&T probes.

5. Form fitting case.

Test kits shall be equal to Flow Systems Inc. Model 300.15.

K. Pump Suction Diffusers: Iron body, permanent and start - up strainers, permanent magnet to capture metallic particles, adjustable pipe support foot, flow straightening vanes, and NPT gage and blowdown ports; connection sizes and types as indicated on the drawings; Bell & Gossett, Armstrong Pump, or equal.

L. Combination Pump Valves: Combination shut - off, flow balancing, and non - slam check valve; iron body, stainless steel stem and spring, soft seated, differential pressure measurement ports; pattern, size, and connection type as indicated on the drawings;

Bell & Gossett “Triple Duty” Valve, Armstrong Pump “Flow - Trex” Valve, or equal.

M. Flexible Pump Connectors

1. Type FPC-1: Rubber spool type - reinforced rubber construction, minimum 150 psig working pressure at 180 degrees F, galvanized steel union or flanges ends (or rubber flanges with galvanized back-up rings); sizes, connection types, and tie rod requirements as indicated on the drawings; MetraFlex, M-G Piping Products “C-Flex,” or equal.

2. Type FPC-2: Corrugated metal hose type - bronze hose and braid, Schedule 40 steel NPT or 150# steel flanged ends, 150 psig working pressure; sizes and connection types as indicated on the drawings; MetraFlex, Anaconda Metal Hose, or equal.

2.04 COOLING COIL CONDENSATE PUMPS

Cooling coil condensate pumps shall be UL listed, suitable for wall, floor, or A/C unit mounting, complete with high impact polystyrene tank, ABS cover and pump, stainless steel shaft, thermally protected motor with 6-foot cord and plug (voltage as specified on the drawings), snap-acting level switch, and integral discharge check valve; minimum capacity of 25 gph at 15 feet of head; Little Giant VCM-20UL Series, Beckett CU19 Series, or equal.

PART 3 EXECUTION

3.01 HYDRONIC PIPING

A. Provide dielectric unions or flanges wherever dissimilar metals subject to galvanic activity are joined together (tank and equipment connections, connections between copper pipe and steel pipe, etc.).

B. Route piping approximately as shown on the drawings, and as field conditions permit. Install piping so as not to interfere with doors and equipment maintenance access.

C. Install unions and flanges to allow servicing and removal of equipment without dismantling piping.

D. Install drain and vent connections and suitable valves at all high and low points in hydronic systems to permit rapid filling and draining for maintenance work. Provide a drain at the base of each riser.

E. Install piping to coils, pumps, and other equipment at full size indicated on the drawings. Make required line size changes at the equipment connections.

F. Hydrostatically test piping at 1-1/2 times maximum operating pressure , but not less than 100 PSI. If pressure does not hold for 4 hours, repair leaks and retest. Conduct tests in the presence of the Government Inspector. Test procedure shall be in accordance with ANSI B31.9. Remove or isolate any equipment which could be damaged by the test pressure. Each system may be tested in sections, or as a whole.

G. The pressure gauge used for hydrostatic testing shall have a range such that at the test pressure is between 40 percent and 60 percent of full range. The minimum dial size shall be 4 ½ inches. The full range rotation of the pointer shall be a minimum 270 degree arc. The accuracy of the gauge shall be one percent or better. The gauge shall have been calibrated by an independent lab within six months of the hydrostatic test date. The Government reserves the right to require recalibration when reasonable doubt of accuracy exists.

H. Remove and repair defects in welded piping in accordance with ANSI B31.9. Drain hydrostatically tested piping with weld leaks to a level below the leak before repairing welds.

I. Use soldering and brazing materials and procedures in accordance with ANSI B31.9. Provide composition of filler metal and flux in accordance with the recommendation of the manufacturer for the metals being joined.

J. Flush hydronic piping systems with potable water to remove dirt and debris prior to making final equipment connections.

3.02 COIL CONDENSATE PIPING

A. Provide coil condensate piping for HVAC units as indicated on the drawings.

B. Provide a p-trap for each HVAC unit, unless otherwise indicated on the drawings or in the manufacturer's installation manual.

C. Pitch horizontal piping to drain a minimum of 1/8 inch per foot of run.

D. Test piping by plugging the outlet and filling with water. Check fittings for leakage after 30 minutes. Repair leaks and retest until all leaks are eliminated.

3.03 HYDRONIC SPECIALTIES

A. Provide hydronic specialties in the sizes, capacities, and locations indicated on the drawings. Install per manufacturer's recommendations.

B. Provide one P&T Test Kit to the Government for each project where P&T test ports are specified.

C. Pipe discharges of all automatic air vents to building drains, or to grade outside the building.

D. Remove start-up strainers from pump suction diffusers after completion of hydronic system balancing (ref. Section 23 05 93).

END OF SECTION

SECTION 23 21 23.16

BASE-MOUNTED CENTRIFUGAL HYDRONIC PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Pumps for Heating, Ventilating and Air Conditioning (Chilled Water, Hot Water)

B. Definitions:

1. Capacity: Gallons per minute (GPM) of the fluid pumped.
2. Head: Total dynamic head in feet of the fluid pumped.
3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

1.02 RELATED WORK

A. Section 23 05 00, Common Work Results for HVAC

B. Section 23 05 00.01, Laser Alignment For HVAC Pumps & Rotating Equipment

C. Section 23 05 48, Vibration Controls for HVAC Pumps & Rotating Equipment

D. Section 23 21 13, Above-Ground Hydronic Piping

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00, SUBMITTALS.

B. Manufacturer's Literature and Data:

1. Pumps and accessories.
2. Motors and drives.
3. Variable speed motor controllers.

C. Manufacturer's installation, maintenance and operating instructions. Shall include MOD #, Ser. #, & Date Installed.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and show fluid pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished

and at least the maximum diameter impeller that can be used with the casing.

PART 2 PRODUCTS

2.01 CENTRIFUGAL PUMPS, BRONZE FITTED (CHILLED WATER, INDUSTRIAL
WATER)—NORMAL DUTY

In-Line Type, Base Mounted End Suction or Double Suction Type:

A. Casing and Bearing Housing: Close-grained cast iron, ASTM A48.

B. Casing Wear Rings: Bronze.

C. Suction or Discharge 2-1/2 inches and Larger: Plain face flange, 125 psig,
ANSI B16.1.

D. Casing Vent: Manual brass cock at high point.

E. Casing Drain and Gage Taps: 1/2-inch plugged connections minimum size.

F. Bearings: Oil lubricated ball or roller type. Provide lip seal and slinger outboard of each bearing. Bearings are to have a B-10 rated life of 250,000hr. Shop drawings/submittal shall bear manufacturer’s certification of bearing life.

G. Impeller: Bronze, ASTM B62, enclosed type, keyed to shaft.

H. Shaft: Steel, AISI Type 1045 or stainless steel.

I. Shaft Seal: Manufacturer's standard mechanical type to suit pressure and temperature and fluid pumped.

J. Shaft Sleeve: Bronze or stainless steel.

K. Motor: Furnish with pump. To be rated NEMA Premium Efficiency.

L. Base Mounted Pumps:

1. Designed for disassembling for service or repair without disturbing the piping or removing the motor.

2. Impeller Wear Rings: Bronze.

3. Shaft Coupling: Non-lubricated steel flexible type or spacer type with coupling guard, ANSI B15.1, bolted to the baseplate. (Woods or Lovejoy couplings are acceptable)

4. Base: Cast iron or fabricated steel for common mounting to a concrete base.

5. Suction Diffuser:

   a. Body: Cast iron with steel inlet vanes and combination diffuser-strainer-orifice cylinder with 3/16-inch diameter openings for pump protection. Provide taps for strainer blowdown and gage connections.

   b. Provide adjustable foot support for suction piping.

   c. Strainer free area: Not less than five times the suction piping.

   d. Provide disposable start-up strainer.

6. Suction Strainer, "Y" Type: Section 23 21 13, “ABOVE-GROUND HYDRONIC PIPING.”

   a. May be furnished in lieu of a suction diffuser at the Contractor's option. Provide equivalent support of pump suction piping.

M. Variable Speed Pumps:

   1. The pumps shall be the type shown on the drawings and specified herein flex coupled to an open drip-proof motor. Provide motors 40 horsepower and larger with thermal overload switches.

   2. Variable Speed Motor Controllers: Refer to Section 26 29 23, “VARIABLE FREQUENCY MOTOR CONTROLLERS.” Furnish controllers with pumps and motors.

   3. Pump operation and speed control shall be as shown on the drawings.

2.02 CENTRIFUGAL PUMPS (ie: MSFC CHILLED WATER SYSTEM PRIMARY AND SECONDARY PUMPS AT BUILDING 4473)

A. GENERAL

1. REFERENCES

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

ANTI-FRICTION BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA 11 Load Ratings and Fatigue Life for Roller Bearings

AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.1 (1998) Cast Iron Pipe Flanges and Flanged Fittings

HYDRAULIC INSTITUTE (HI)

HI-01 Standards for Centrifugal, Rotary and Reciprocating Pumps

2. SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, “Submittals,” in sufficient detail to show full compliance with the specification:

SD-01 Data

Design Analysis and Calculations shall show NPSH (net positive suction head) calculations for Centrifugal Pumps.

SD-01 Data

Equipment and Performance Data consisting of pump curves (gallons per minute versus total head in feet per rpm) shall be provided for each type Centrifugal Pump.

SD-01 Data

Equipment Foundation Data shall be submitted for Centrifugal Pumps.

SD-04 Drawings

Installation Drawings for Centrifugal Pumps shall be submitted in accordance with Part 3, “Execution,” of this section.

SD-09 Reports

Test Reports for pumps shall be submitted on the following tests:

Hydraulic Tests
Efficiency Tests
Vibration Tests
Output Efficiency
Surface Hardness Tests
Deflection Tests

SD-13 Certificates of Compliance shall be submitted for the following items showing conformance with the referenced standards contained in this section.
- Base-mounted pumps
- Accessories

3. GENERAL REQUIREMENTS

Pumps shall be used for chilled water service (39-55 degrees F Water temperature). Pumps shall be bronze fitted Aurora or approved equal.

B. PUMP CONSTRUCTION

B.1 General Pump Requirements

This specification includes design, construction, installation, and performance features of centrifugal water pumps. Pumps provided shall conform to HI-01, and to requirements specified herein.

Pump, frame, motor, and coupling shall be provided as a complete factory assembled unit.

B.2 Pump Capacity

Pump capacity shall be as indicated in the schedules.

B.3 Classification

Class ADS: Axially (horizontally) split-case, single-stage, double-suction, single- or double-volute centrifugal type.

B.4 Casting

Pump castings shall be bronze-fitted seasoned, cast iron with a design working pressure of not less that 185 pounds per square inch gage (psig) at 100 degrees F. Castings shall be single or double volute with flanged piping connections conforming to ASME B16.1, Class 125. The direction of shaft rotation shall be conspicuously indicated. The casting 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. Drain openings in the volute, intake, or other passages capable of retaining trapped water shall be located in the low point of such passages.

B.5 Impellers

Impellers shall be enclosed cast bronze or stainless steel machined and polished. Waterways shall be machine-or hand-finished. Impellers shall meet maximum and minimum diameters requirements.

B.6 Balancing

Pump Impeller assemblies shall be statically and dynamically balanced to within ½ percent of W times R squared, where W equals weight and R equals impeller radius.

Rotating elements shall be dynamically balanced.

B.7 Wearing Rings

Wearing rings shall be dissimilar bronze composition for non-galling service. Wearing rings shall be provided in every pump case and on all impellers larger than 7 inches in diameter.

B.8 Shaft

Shafts for mechanical seal service shall be solid sleeveless AISI 400 series stainless steel hardened to 425 Brinell in packing area, or sleeved type with AISI 304 and AISI 316 series stainless-steel sleeves hardened to 425 Brinell.

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 2.0 mils under shutoff-head operating conditions. Flow from ¼ inch 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 casting interface with a bronze throttling bushing.

B.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 250 degrees F.

Seal pressure rating shall be suitable for maximum system hydraulic conditions. (Maximum system pressure – 125 psig).

Materials of construction shall include AISI 300 series stainless steel, solid tungsten-carbide rotating-seal face, and Buna-N vinylidene-fluoride-hexafluoropropylene, EPT, or tetrafluoroethylene seals.

Mechanical seals shall not be subjected to hydrostatic test pressures in excess of the manufacturer's recommendations.

Mechanical seals shall be manufacturer's standard for the specified and indicated service. 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 necessary to the function shall be provided.

B.10 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 0.005 inch. 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 a B-10 rated life of not less than 250,000 hours. Shop drawings shall bear manufacturer's certification of bearing life.

Bearings shall be oil lubricated and shall be provided with oil supply reservoirs located at top of bearings.

Bearing housings shall be cast iron, self-aligning on metal-to-metal surfaces and shall totally enclose bearings.

B.11 Flexible Coupling

Pump shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape in shear, or a solid-mass serrated-edge disc 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. Woods or Lovejoy Couplings are acceptable.

B.12 Bedplate

Pump and driver shall be mounted on a common bedplate, hollow cast iron, multi-ribbed for maximum rigidity, with adequate number of grout holes and grout air vents, and with drip rim and drain tapping.

The 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 ¼ inch steel plate, and provided with adequate grout holes, grout air vents, drip rim, and drain tapping. Formed or bent steel bedplates are not acceptable.

B.13 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, when so specified. Motors shall be TEFC construction, suitable for variable speed frequency inverter service, dynamically and statically balanced.

Motors shall be rated NEMA Premium Efficiency.

B.14 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.

Provide six machines screw taps of a diameter not to exceed ½ inch and a depth not to exceed ¾ inch shall be provided for each pump/motor assembly. To be performed in the field at locations as directed by the Contracting Officer. Taps will be used for predictive maintenance vibration monitoring.

Installed vibration levels shall not exceed those specified in Section 23 05 48.

2.03 HOT WATER PUMP

A. Centrifugal, single stage, constructed to prevent contact of water with metal other than non-ferrous, except casing.

B. Driver shall be electric motor, close coupled or connected by flexible coupling.

C. Shall be designed for 180 deg.F water service.

D. Mounting shall be either of the following:

-In-line mounted
-Floor mounted set on common bed plate with drip lip

E. Casing: Cast iron, vertically or horizontally split

E. Impeller: High grade, cast brass or bronze, accurately machined and properly balanced

G. Motor: Motor to be rated NEMA Premium Efficiency. Capacity to be such as to operate pump without overloading. In-line pump motors shall not exceed 1800 rpm and shall be provided with spring mountings or other devices to assure quiet operation.

H. Pump and motor bearings shall be B-10 rated with a minimum life of 250,000 hours. Shop drawings/submittals shall bear manufacturer's certification of bearing life.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pumps shall be stored indoors and protected against dust and moisture. Provide expanded foam on the air inlet and outlet parts of the motor and cover pump suction and discharge flanges to prevent entry of foreign matter.

B. Follow manufacturer's written instructions for pump mounting and start-up. Access/ Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

C. Independently support pumps and piping so that the weight of the piping is not supported by the pumps and the weight of the pumps is not supported by the piping. The first 3 hangers for each pipe shall be spring and neoprene type.

D. Sequence of installation for base-mounted pumps:

1. Level and shim the unit base and grout to the concrete pad.
2. Shim the driver and realign the pump and driver. Correct axial, angular or parallel misalignment of the shafts per Section 23 05 00.01, "LASER ALIGNMENT FOR HVAC PUMPS & ROTATING EQUIPMENT."

3. Connect properly aligned and independently supported piping.
4. Recheck alignment.

E. Pad-mounted Condensate Pump: Level, shim, bolt, and grout the Unit base onto the concrete pad.

F. Provide drains for bases and seals for base mounted pumps, piped to and discharging into floor drains.

3.02 START-UP

A. Verify that the piping system has been flushed, cleaned and filled.

B. Lubricate pumps before start-up.

C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition. Mechanical Seal or Packing Flush Water Lines
must be cleaned before pump start-up.

D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

E. Perform field mechanical balancing if necessary to meet specified vibration tolerance.

F. Ensure the disposable strainer is free of debris prior to testing and balancing of the hydronic system, if applicable.

G. After several days of operation, replace the disposable start-up strainer with a regular strainer in the suction diffuser, if applicable.

H. Pump and piping flanges shall be aligned so that the connecting bolts will fit freely with no external forces applied to pump or piping.

I. The contractor shall provide laser alignment of the pump and pump motor shafts after setting pump on foundation, grout has been set, foundation bolts have been tightened, and piping connections have been completed. Other methods of pump alignment will not be accepted. The Government reserves the right to verify pump alignment and to require re-alignment where necessary. Laser alignment shall be per Section 23 05 00.01.

END OF SECTION

SECTION 23 21 23.23

VERTICAL TURBINE HYDRONIC PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Pumps for Cooling Tower Water.

B. Definitions:

1. Capacity: Gallons per minute (GPM) of the fluid pumped.

2. Head: Total dynamic head in feet of the fluid pumped.

3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

1.02 RELATED WORK

A. Section 23 05 00, Common Work Results for HVAC

B. Section 23 21 13, Above Ground Hydronic Piping

C. Section 23 05 00.01, Laser Alignment for HVAC Pumps and Rotating Equipment

D. Section 23 05 48, Vibration Controls for HVAC Pumps and Rotating Equipment

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00, SUBMITTALS.

B. Manufacturer's Literature and Data:

1. Pumps and accessories.

2. Motors and drives.

3. Variable speed motor controllers.

C. Manufacturer's installation, maintenance and operating instructions. Shall include MOD #, Ser. #, & Date Installed.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and show fluid pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.

PART 2 PRODUCTS

2.01 VERTICAL TURBINE PUMP FOR COOLING TOWER SERVICE

A. GENERAL

B. REFERENCES

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

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B16.5	(2003; Errata) Pipe Flanges and] Flanged Fittings

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 105	Standard Specification for Forgings, Carbon Steel, and for Piping Components
ASTM A 283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A 48	Standard Specification for Gray Iron Castings

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA MG 1	(2003) Motors and Generators

C. GENERAL REQUIREMENTS

Section 23 05 00, “COMMON WORK RESULTS FOR HVAC”, applies to work specified in this section.

Vertical Turbine Pump shall be furnished for service in the basin Of a cooling tower sump. The pump motor drive shall be an above-base electric drive.

D. PRODUCTS

1. PERFORMANCE REQUIREMENTS
The operating conditions and performance requirements shall be as indicated.

The driver shall meet speed-torque demand of the pump over the entire operating range at a service factor of unity. Pull-in torque shall not exceed 70 percent of locked rotor value.

Starting shall be across-the-line normal-torque, low-current type.

E. PUMP

1. Pump Capacity
Pump capacity shall be as indicated on the drawings

2. Pump Selection
Pumps shall be designed using hydraulic criteria based upon actual model developmental test data. The manufacturer shall certify that pumps have been hydraulically tested at the factory.

3. 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. Pumps shall be non-overloading at all points of the curve.

4. 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.

5. Pump construction shall be manufacturer’s standard, except as noted below:

E.5.1 Impeller: Cast bronze, statically and dynamically balanced, semi-open or closed.

E.5.2 Column: Steel, ASTM A 283, Grade C, 0.25" minimum wall thickness, with discharge elbow and plain end nozzle. The elbow shall have either long-radius pattern (r/d = 1.5 minimum) or have flow vanes.

E.5.3 Bowls: Cast iron, ASTM A 48, Class 35, flanged and bolted, with flow-rectifying vanes.

E.5.4 Suction Bell: Cast iron, ASTM A 48, Class 30, flanged and bolted, with guide vanes.

E.5.5 Suction Strainer: Mounted on bottom bowl and shall be stainless steel. Strainer open area shall be a minimum of five times throat area of suction bell.

E.5.6 Bearings: Leaded bronze, oil-lubricated.

E.5.7 Pump Shaft: Corrosion-resistant steel, ASTM A 283, Type 410 or 416, ground and polished, with 32 micro-inch finish at bearing surfaces.

E.5.8 Surface Plate: The surface-discharge assembly shall be cast iron or fabricated steel and shall be rigid enough to support the entire weight of the motor, bowl assembly, column pipe, cable, and column of water. The cable outlet shall be designed to prevent the entry of foreign matter into the well. Provide two lifting lugs with capacity to support the weight of the entire pump above, plus column of water.

E.5.9 Base Plate: Steel

E.5.10 Lubrication: Bearings shall be oil or water lubricated as standard with the manufacturer.

E.5.11 Corrosion Protection: Approved vinyl coating sprayed on column, bowl assembly, and all stationary ferrous parts, 6-mil minimum thickness.

E.5.12 Discharge: Flanged, above-base discharge per ASTM A 105. Flange drilling shall conform to ASME B16.5 for Class 150.

F. MOTOR

The motor drive shall be surface-mounted conforming to NEMA MG 1, Design B,1760 rpm, 104 deg.F temperature rise, for 460v, 3 ph, 60 hz power. Insulation shall be NEMA Class B. Motor enclosure to be TEFC. Motor to be rated NEMA Premium Efficiency.

Bearings for surface-mounted motors shall be the antifriction oil-lubricated thrust type. Bearing numbers shall be stamped on motor identification plate. Bearings shall have a B-10 rated life of not less than 250,000 hrs. Shop drawings/submittals shall bear the manufacturer’s certification of bearing life.

G. SUGGESTED MANUFACTURERS:

Aurora, Worthington, Gould, Byron-Jackson, Peabody-Floway, Peerless, Johnston-Sulzer, or approved equal.

H. EXECUTION

The pumping unit shall be installed in accordance with the contract drawings, approved shop drawings, and the manufacturer’s instructions.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pumps shall be stored indoors and protected against dust and moisture. Provide expanded foam on the air inlet and outlet parts of the motor and cover pump suction and discharge flanges to prevent entry of foreign matter.

B. Follow manufacturer's written instructions for pump mounting and start-up. Access/ Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

C. Independently support pumps and piping so that the weight of the piping is not supported by the pumps and the weight of the pumps is not supported by the piping. The first 3 hangers for each pipe shall be spring and neoprene type.

3.02 START-UP

A. Verify that the piping system has been flushed, cleaned and filled.

B. Lubricate pumps before start-up.

C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition. Mechanical Seal or Packing Flush Water Lines
must be cleaned before pump start-up.

D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

E. Perform field mechanical balancing if necessary to meet specified vibration tolerance.

E. Pump and piping flanges shall be aligned so that the connecting bolts will fit freely with no external forces applied to pump or piping.

END OF SECTION

SECTION 23 22 13

ABOVE GROUND STEAM & CONDENSATE HEATING PIPING

PART 1 GENERAL

1.01 SUMMARY

Work provided under this section includes the following:

A. Above ground Steam Piping and Specialties

B. Above ground Steam Condensate Piping, Pumps, and Specialties

1.02 RELATED SECTIONS

A. Section 23 05 00 Common Work Results for HVAC

B. Section 23 05 19 Meters & Gages for HVAC Piping

C. Section 23 05 23 General-Duty Valves for HVAC Piping

D. Section 23 05 29 Hangers and Supports for HVAC Piping & Equipment

E. Section 23 05 53 Identification for HVAC Piping 7 Equipment

F. Section 23 07 19 HVAC Piping Insulation

1.03 INSPECTION AND ACCEPTANCE

A. All work performed under this section shall comply with the International Mechanical Code and ANSI B31.9, "Building Services Piping".

B. Work shall not be covered, enclosed, or insulated until it has been inspected, tested, and approved. Any work that is covered, enclosed, or insulated before such inspection and test shall be uncovered and, after it has been inspected and approved, shall be restored to its prior condition at no additional cost to the Government.

C. All testing shall be performed in the presence of the Government Inspector.

PART 2 PRODUCTS

2.01 STEAM AND STEAM CONDENSATE PIPING

A. Steam, up to 15 psig

Sizes up to 2" NPS - Piping shall be Schedule 80 black carbon steel per ASTM A53, Grade B and ANSI B36.10M. Fittings shall be Class 150, black malleable iron, threaded fittings per ASTM A197, ANSI B16.3 and ANSI/ASME B1.20.1.

Sizes 2 1/2" NPS and larger - Piping shall be Schedule 40 black carbon steel per ASTM A53, Grade B and ANSI B36.10M. Fittings shall be standard weight, forged steel, butt weld fittings per ASTM A234, Grade WPB and ANSI/ASME B16.9. Flanges shall be Class 150, forged steel, weld neck flanges with raised faces per ASTM A105 and ANSI B16.5.

B. Steam, 16 psig to 150 psig

Sizes up to 2" NPS - Piping shall be Schedule 80, black carbon steel per ASTM A106, Grade B and ANSI B36.10M. Welded fittings shall be Class 3000, forged steel, socket weld fittings per ASTM A105 and ANSI B16.11. Threaded fittings shall be Class 300, black malleable iron, threaded fittings per ASTM A197, ANSI B16.3, and ANSI/ASME B1.20.1. Socket weld flanges shall be Class 300, forged steel, socket weld flanges with raised faces per ASTM A105 and ANSI B16.5. Threaded flanges shall be Class 300, forged steel, threaded flanges with raised faces per ASTM A105, ANSI B16.5, and ANSI/ASME B1.20.1.

Sizes 2 1/2" NPS and larger - Piping shall be Schedule 40 black carbon steel per ASTM A106, Grade B and ANSI B36.10M. Fittings shall be standard weight, forged steel, butt weld fittings per ASTM A234, Grade WPB and ASME/ANSI B16.9. Flanges shall be Class 150, forged steel, weld neck flanges with raised faces per ASTM A105 and ANSI B16.5.

C. Steam, 151 psig to 250 psig

Sizes up to 2" NPS - Piping shall be Schedule 80, black carbon steel per ASTM A106, Grade B and ANSI B36.10M. Welded fittings

shall be Class 3000, forged steel, socket weld fittings per ASTM A105 and ANSI B16.11. Socket weld flanges shall be Class 300, forged steel, socket weld flanges with raised faces per ASTM A105 and ANSI B16.5.

Sizes 2 1/2" NPS and larger - Piping shall be Schedule 40 black carbon steel per ASTM A106, Grade B and ANSI B36.10M. Fittings shall be standard weight, forged steel, butt weld fittings per ASTM A234, Grade WPB and ASME/ANSI B16.9. Flanges shall be Class 300, forged steel, weld neck flanges with raised faces per ASTM A105 and ANSI B16.5.

D. Steam Condensate

Sizes up to 2" NPS - Piping shall be Schedule 80, black carbon steel per ASTM A53, Grade B and ANSI B36.10M. Fittings shall be Class 300, black malleable iron, threaded fittings per ASTM A197, ANSI B16.3 and ANSI/ASME B1.20.1.

Sizes 2 1/2" NPS and larger - Piping shall be Schedule 80, black carbon steel per ASTM A53, Grade B and ANSI B36.10M. Fittings shall be extra strong weight, forged steel, butt weld fittings per ASTM A234, Grade WPB and ASME/ANSI B16.9. Flanges shall be Class 300, forged steel, weld neck flanges with raised faces per ASTM A105 and ANSI B16.5.

2.02 STEAM AND STEAM CONDENSATE SPECIALTIES

A. Steam Traps

1. Trap types, sizes, and capacities shall be as indicated on the drawings.

2. Float and Thermostatic Traps: Ductile iron body, mechanical lever ball float, stainless steel valve mechanism, with balanced pressure thermostatic air vent, 232 psig maximum working pressure, 392 degrees F maximum working temperature, NPT connections; Spirax/Sarco Model FT-550 or equal.

3. Inverted Bucket Traps: Cast Iron body, NPT connections, stainless steel internals, 250 psig maximum working pressure, 450 degrees F maximum working temperature; Spirax/Sarco Type B or equal.

4. Thermodynamic Traps: Stainless steel construction, NPT connections, integral seat with hardened disc and seating surfaces, 600 psig maximum working pressure, 800 degrees F maximum working temperature, complete with stainless steel insulating cap; Spirax/Sarco Model TD-52 or equal.

5. Thermostatic Traps: Balanced pressure type, cast iron body, welded stainless steel bellows element, 250 psig maximum working pressure, 425 degrees F maximum working temperature; Nicholson Types B, C, N301, or equal.

6. Orifice Traps, Low Pressure: 25 psig working pressure, brass body, union nut integral strainer, stainless steel modified venturi nozzle; Engineering Resources “Steamgard System” SG-R Series or equal.

7. Orifice Traps, Medium Pressure: 300 Series stainless steel body with machined nozzle, Y-strainer with blowdown, and integral secondary screen strainer; Engineering Resources “Steamgard System” SG-HA (150 psig), SG-HL (250 psig), or equal.

B. Vacuum Breakers: Brass body and cap, stainless steel valve and valve seat, NPT connections, 2 inches w.g. vacuum required to open, 210 psig maximum operating pressure, 500 degrees F maximum operating temperature; Spirax/Sarco Model VB14 or equal.

C. Automatic Air Vent: Balanced pressure thermostatic type, bellows operated, cast iron body, stainless steel element and valve trim, NPT connections, 250 psig maximum operating pressure; Spirax/Sarco Model VS204 or equal.

D. Strainers: Y-type, cast iron body, 20 mesh stainless steel screen with free area equal to five times inlet line size; Spirax/Sarco Type "IT" or equal.

E. Pressure Reducing Valves

1. Direct Acting Type: Bronze, steel or cast iron body; NPT connections, maximum saturated steam pressure 250 psig, 2-25 psig output range unless otherwise specified on drawings, hand wheel or wrench adjustment, stainless steel trim. Spirax/Sarco Model BRV or equal.

2. Pilot Operated Type: Cast iron bronze, or steel body, NPT connections 2 inch and smaller, flanged connections 2-1/2 inch and larger, maximum saturated steam pressure 250 psig, 10-30 psig output range unless otherwise specified on drawings, Electronic or pressure pilot controlled as noted, stainless steel trim. Spence or approved equal.
Electronic pilots shall have same body material as main valve, and shall be suitable for 115 Volt AC 3-Point floating control; Spence Actuator Pilot Type D120 without Servo-amplifier, or approved equal.

F. Suggested Manufacturers: Steam and steam condensate specialties shall be Spirax/Sarco, Armstrong, Yarway, Nicholson, Spence, ITT Hoffman, or equal.

PART 3 EXECUTION

3.01 STEAM, AND STEAM CONDENSATE PIPING

A. Provide dielectric unions or flanges wherever dissimilar metals subject to galvanic activity are joined together (tank and equipment connections, connections between copper pipe and steel pipe, etc.).

B. Route piping approximately as shown on the drawings, and as field conditions permit. Install piping so as not to interfere with doors and equipment maintenance access.

C. Install unions and flanges to allow servicing and removal of equipment without dismantling piping.

D. Install drain and vent connections and suitable valves at all high and low points in steam systems to permit venting and draining for maintenance work. Provide a drain at the base of each riser.

E. Install piping to coils, pumps, converters and other equipment at full size indicated on the drawings. Make required line size changes at the equipment connections.

F. Hydrostatically test piping at 1-1/2 times maximum operating pressure , but not less than 100 PSI. If pressure does not hold for 4 hours, repair leaks and retest. Conduct tests in the presence of the Government Inspector. Test procedure shall be in accordance with ANSI B31.9. Remove or isolate any equipment which could be

damaged by the test pressure. Each system may be tested in sections, or as a whole.

G. The pressure gauge used for hydrostatic testing shall have a range such that at the test pressure is between 40 percent and 60 percent of full range. The minimum dial size shall be 4 ½ inches. The full range rotation of the pointer shall be a minimum 270 degree arc. The accuracy of the gauge shall be one percent or better. The gauge shall have been calibrated by an independent lab within six months of the hydrostatic test date. The Government reserves the right to require recalibration when reasonable doubt of accuracy exists.

H. Remove and repair defects in welded piping in accordance with ANSI B31.9. Drain hydrostatically tested piping with weld leaks to a level below the leak before repairing welds.

I. Flush steam & steam condensate, and hydronic piping systems with potable water to remove dirt and debris prior to making final equipment connections.

END OF SECTION

SECTION 23 22 23

STEAM CONDENSATE PUMPS

PART 1 GENERAL

1.01 DESCRIPTION

A. Pumps for Steam Condensate Return.

B. Definitions:

1. Capacity: Gallons per minute (GPM) of the fluid pumped.

2. Head: Total dynamic head in feet of the fluid pumped.

3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

1.02 RELATED WORK

A. Section 23 05 00, Common Work Results for HVAC

B. Section 23 22 13, Above-Ground Steam Condensate Heating Piping

1.03 SUBMITTALS

A. Submit in accordance with Section 01 33 00, SUBMITTALS.

B. Manufacturer's Literature and Data:

1. Pumps and accessories.

2. Motors and drives.

C. Manufacturer's installation, maintenance and operating instructions. Shall include MOD #, Ser. #, & Date Installed.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity. Identify pump and show fluid pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.

PART 2 PRODUCTS

2.01 STEAM CONDENSATE PUMP, SUMP TYPE

A. General: Factory assembled unit consisting of motor-driven pump(s) mounted on a horizontal cover plate bolted to a vented sump-type receiver, interconnecting wiring and piping, motor controls and accessories, designed to receive, store, and pump steam condensate.

B. Receiver Tank: Vertical, cylindrical, cast iron sides and bottom, designed for service underground or below the floor. Inlet connection shall be located nine inches below the cover plate. Provide floor mounting gasket.

C. Receiver Cover Plate: Heavy gage steel designed to support weight of pumps, motors, and accessories and support foot traffic with no deflection. Provide for mounting of pumps, motor and accessories by bolting to the cover. Provide threaded openings for piping connections and a bolted inspection plate for viewing interior of receiver. All bolted connections to cover plate, and between cover plate and receiver, shall be gasketed so that no vapor will escape into the room.

D. Furnish seals for condensate pump with a minimum temperature rating of 250 degrees F.

D. Pumps: Centrifugal or turbine type, vertical extended shaft, bronze fitted, flexible-coupled (Wood or Lovejoy are acceptable), designed for submerged operation.

1. Shaft: Stainless steel, AISI Type 416.

2. Shaft bearings: Bronze, water lubricated.

3. Shaft seal at cover plate: Packed type with bronze packing gland.

4. Thrust bearings: Oil lubricated ball type located above the cover plate. Bearings shall have a B-10 rated life of not less than 250,000 hours. Shop drawings/submittals shall bear manufacturer’s certification of bearing life.

5. Discharge pipes: Terminate above the cover plate.

6. Pump-motor mounting: Bolted to brackets bolted to the cover plate. Removal of one pump shall not affect operation of the second pump.

7. When turbine type pumps are furnished, provide relief valves, set at 100 psig, on pump discharge lines ahead of gate valves. Pipe relief vents to the receiver tank. Relief valve capacity shall equal or exceed pump capacity at set pressure.

F. Motors: To be rated NEMA Premium Efficiency.

G. Pump Operation:

1. Float Switches: NEMA 1, mounted on receiver tank, to start and stop pumps in response to changes in the water level in the receiver, and adjustable to permit the controlled water levels to be changed. Floats and connecting rods shall be copper, bronze or stainless steel.

2. Alternator: Provide for duplex units to automatically start the second pump when the first pump fails in keeping the receiver water level from rising and to alternate the order of starting the pumps. For units 1/3 horsepower and smaller, the alternator may be the mechanical type for use in lieu of float switches.

H. Electric Wiring: Suitable for 200 degrees F service; enclosed in liquid-tight flexible metal conduit where located outside of control cabinet.

2.02 PRESSURE POWERED PUMPS

A. Cast iron body with lift type inlet and outlet check valves: Float-Operated, snap-acting mechanism with stainless steel trim and no external seals or packing; steam operated to 125 PSIG; NPT inlet, outlet, and vent connections; digital cycle counted with isolated set of “dry” contacts to connect to UCS; sizes and capacities as specified on the drawings; Spirax/ Sarco Model PPC, Armstrong Series PT-200 or equal.

B. Follow manufacturer's written instructions for pump mounting and start-up. Access/ Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

C. Independently support pumps and piping so that the weight of the piping is not supported by the pumps and the weight of the pumps is not supported by the piping. The first 3 hangers for each pipe shall be spring and neoprene type.

D. Pad-mounted Condensate Pump: Level, shim, bolt, and grout the unit base onto the concrete pad.

3.02 START-UP

A. Verify that the piping system has been flushed, cleaned and filled.

B. Lubricate pumps before start-up.

C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition. Mechanical Seal or Packing Flush Water Lines must be cleaned before pump start-up.

D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

E. Perform field mechanical balancing if necessary to meet specified vibration tolerance.

F. Ensure the disposable strainer is free of debris prior to testing and balancing of the hydronic system.

G. After several days of operation, replace the disposable start-up strainer with a regular strainer in the suction diffuser.

H. Where applicable. Pump and piping flanges shall be aligned so that the connecting bolts will
fit freely with no external forces applied to pump or piping.

3.03 STEAM AND STEAM CONDENSATE PUMPS & SPECIALITES

A. Provide steam & stema condensate specialities and pumps in the sizes, capacities, and locations indicated on the drawings. Install per the manufacturers recommendations.

B. Unless otherwise indicated, pipe relief valve and air vent discharges & condensate pump vents to a safe location outside the building.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.01 SUMMARY

Work provided under this section includes the following:

A. Refrigerant Piping and Specialties

1.02 RELATED SECTIONS

A. Section 23 05 00 Common Work Results for HVAC

B. Section 23 05 23 General Duty Valves for HVAC Piping

C. Section 23 05 29 Hangers and Supports for HVAC Piping & Equipment

D. Section 23 05 53 Identification for HVAC Piping & Equipment

E. Section 23 07 19 HVAC Piping Insulation

1.03 INSPECTION AND ACCEPTANCE

A. All work performed under this section shall comply with the International Mechanical Code and ANSI B31.9, "Building Services Piping".

B. Work shall not be covered, enclosed, or insulated until it has been inspected, tested, and approved. Any work that is covered, enclosed, or insulated before such inspection and test shall be uncovered and, after it has been inspected and approved, shall be restored to its prior condition at no additional cost to the Government.

C. All testing shall be performed in the presence of the Government Inspector.

PART 2 PRODUCTS

2.01 REFRIGERANT PIPING

A. Up to 1/2" O.D.: Same as specified in part B below, or annealed Type K copper tubing per ASTM B88 with flared-type fittings conforming to SAE J513F. Interior of tubing shall be cleaned equal to purity requirements of ASTM B280 and capped prior to installation.

B. Larger than 1/2" O.D.: Type L or ACR hard-drawn, seamless copper tubing, manufactured per ASTM B88, cleaned, dehydrated, and sealed per ASTM B280, with wrought-copper socket-joint fittings and silver solder.

2.02 REFRIGERANT SPECIALTIES

A. Thermostatic Expansion Valves: Brass or cast bronze body, brass and stainless steel internal parts, replaceable power element, stainless steel diaphragm and power element housing, external equalizer tube, remote bulb sensor, solder or brazing connections, balanced port construction for precise control over wide variations in load and/or condensing pressure, sized for coil capacity requirements; Parker, Alco, Sporlan, or equal.

B. Filter-Driers: Sealed type, flared or soldered connections as required, properly sized for compressor capacity at 2 psid; capacities certified in accordance with ARI Standards 710 (liquid line) or 730 (suction line); Parker, Alco, Sporlan, or equal.

C. Sight Glasses: Flared or soldered connections, replaceable moisture indicator element, full view sight glass. Sporlan Type "SA" or equal.

PART 3 EXECUTION

3.01 REFRIGERANT PIPING

A. Install refrigerant piping per ANSI B31.5. Provide a low flow nitrogen gas purge during brazing and soldering to prevent formation of oxide scale inside the pipe. Copper to copper joints shall use Sil-fos. Copper to brass and copper to steel joints shall

use silver solder. Immediately after the joint has set, all flux residue shall be removed.

B. Clean, dehydrate, test, and charge lines per A/C manufacturer's installation specifications and the following procedure.

1. Charge piping to 150 psig (250 psig for R-22 liquid and hot gas lines) with dry nitrogen. Bubble test all joints. Repair leaks and retest until pressure holds for one hour. Bleed off test pressure.

2. Charge piping with refrigerant to 10 psig. Pressurize piping to the test pressure (as specified above) with dry nitrogen. Check for leaks with an electronic halogen leak detector. Repair leaks and retest until leaks are eliminated.

3. Evacuate the system to 500 microns. Equalize the system with dry nitrogen.

4. Evacuate system to 500 microns. If there is appreciable vacuum loss after 12 hours, return to step 2. If vacuum is retained, charge system with refrigerant per the A/C manufacturer's instructions.

3.02 REFRIGERANT SPECIALTIES

A. Provide refrigerant specialties as indicated on the drawings. Install per the manufacturer's recommendations.

B. Unless otherwise indicated on the drawings, consult the A/C equipment manufacturer's literature for required sizes and capacities.

END OF SECTION

SECTION 23 30 00

HVAC AIR DISTRIBUTION

PART 1 GENERAL

1.01 SUMMARY

This section specifies rigid and flexible ductwork for HVAC and industrial exhaust systems.

1.02 RELATED SECTIONS

A. Section 23 07 13 Duct Insulation

B. Section 23 33 00 Air Duct Accessories

C. Section 23 37 00 Air Outlets and Inlets

1.03 STANDARDS

Ductwork materials, construction, and installation shall comply with all applicable provisions of the following standards, except where more stringent requirements are specified.

A. SMACNA "HVAC Duct Construction Standards, Metal And Flexible"

B. SMACNA "Round Industrial Duct Construction Standard"

C. SMACNA "Rectangular Industrial Duct Construction Standard"

D. SMACNA "Thermoplastic Duct (PVC) Construction Manual"

E. ACGIH "Industrial Ventilation, A Manual Of Recommended Practice"

F. NAIMA “Fibrous Glass Duct Liner Standard”

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. With the exception of PVC ductwork, all ductwork products and materials shall have maximum flame spread and smoke development ratings of 25 and 50, respectively. Ratings shall be certified in accordance with ASTM E84.

B. HVAC ductwork products and materials shall meet all applicable requirements of NFPA 90A and 90B.

2.02 HVAC SHEET METAL DUCTWORK

A. HVAC ductwork shall be fabricated from lock-forming quality galvanized steel sheet per ASTM A653, G90 coating designation. Ductwork noted on the drawings to be painted shall have a paintable galvanized finish.

B. Single wall round duct smaller than 12 inch diameter may be either shop fabricated longitudinal seam type, or factory fabricated spiral type as specified below.

C. Single wall round duct, 12 inch diameter and larger, shall be factory fabricated with spiral lockseams; United McGill “Uni-Seal” or equal.

D. Double wall round duct shall be factory fabricated, consisting of a spiral seam outer wall, 1 inch thick fiberglass insulation, and a perforated spiral seam inner wall.

1. The maximum thermal conductance of the duct shall be 0.27 Btu/hr./sq. ft./degree F.

2. The acoustical properties of the duct shall be published by the manufacturer.

3. The duct shall be rated for an airflow velocity of 4000 fpm per U.L. Standard 181.

4. Ductwork shall be United McGill “ACOUSTI-K27” or equal.

2.03 DUCT LINER AND ASSOCIATED PRODUCTS

A. Duct liner shall be 1 inch thick, 1.5 pounds/cubic foot, bonded fiberglass blanket; maximum "k" value = 0.28 at 75 degrees F; factory coated to prevent fiber erosion, and rated for air velocities up to 6000 fpm; Certainteed, Knauf, Owens-Corning, or equal.

B. Spotter pins shall be welded steel equal to Duro-Dyne PN-250, with spotter clips equal to Duro-Dyne PC-1.

C. Duct liner adhesive shall be non-flammable, quick-setting, rubber-based; Foster "Spark-Fas" or equal.

D. Duct liner shall be “Greenguard Certified” & all adhesives used shall meet or exceed “Greenseal” Requirements.

2.04 PREFAB JOINT SYSTEMS FOR GALVANIZED STEEL DUCTWORK

A. Joint System for Rectangular Ductwork

1. Joint system shall consist of flanges, corner pieces, gaskets, cleats, and corner clips, and shall be similar to SMACNA Type T-24, Formed Flange.

2. Flanges shall be roll formed galvanized steel with integral, non-hardening, mastic sealant.

3. Flanges shall be 26 gage, comparable to SMACNA Class F joints, or 20 gage, comparable to SMACNA Class J joints.

4. Corner pieces shall be minimum 16 gage galvanized steel, and shall permit connection with bolts or corner clips.

5. Gaskets shall be extruded butyl, unless otherwise noted.

6. Cleats shall be minimum 20 gage roll formed galvanized steel.

7. Corner clips shall be minimum 16 gage galvanized steel.

8. System shall be Ductmate Industries “Ductmate 25”, “Ductmate 35”, “DM Ripple 25”, “DM Ripple 35”, or equal.

B. Joint System for Round Duct

1. Joint system shall consist of inner ring flanges, gasket, and a closure ring.

2. Inner ring flanges shall be minimum 24 gage roll formed galvanized steel with integral, non-hardening, mastic sealant.

3. Gaskets shall be extruded butyl, unless otherwise noted.

4. Closure rings shall be minimum 24 gage roll formed galvanized steel, with brackets and tightening bolt.

5. Joint system shall be Ductmate Industries “Spiralmate”, or equal.

2.05 DUCT SEALANTS

A. Duct sealants shall be U. L. classified and labeled, and shall contain no asbestos or PCB's. Solids content of sealants shall be between 65 and 80 percent. Sealants are to meet or exceed “Greenseal” requirements.

B. Sealants shall be approved by the manufacturer for use on round and rectangular ductwork, SMACNA Pressure Classes 1/2 to 10 inches w. c., and SMACNA Seal Classes A, B and C.

C. Duct sealant for indoor ductwork shall be a water based, polyvinyl acrylic sealant, and shall be non-flammable wet or dry; United McGill “Uni-Grip” or equal.

D. Duct sealant for outdoor ductwork shall be a rubber and solvent based sealant, with a service temperature range which includes - 20 to 150 degrees F; United McGill “United Duct Sealer” or equal.

2.06 INSULATED FLEXIBLE HVAC DUCT

A. Insulated flexible HVAC duct shall be U.L. Listed, Class 1 air duct per U.L. Standard 181.

B. Inner duct shall be constructed of CPE permanently bonded to a coated spring steel wire helix, and shall be rated for -1/2 to +6 inches w.c. Service temperature range shall be 0 to 200 degrees F. Velocity rating shall be 4000 FPM.

C. Duct shall be insulated with a fiberglass blanket for a maximum thermal conductance, "C", of 0.23 BTU/hr./sq. ft./ degree F at 75 degrees F mean temperature.

D. Unless otherwise noted, the outer vapor barrier shall be polyethylene with a maximum permeance of 0.2 perm per ASTM E96.

E. Insulated flexible HVAC duct shall be Flexible Technologies “Thermaflex G-KM,” Owens-Corning “Valuflex,” or equal.

2.07 INDUSTRIAL SHEET METAL EXHAUST DUCTWORK

A. The minimum standard for industrial sheet metal exhaust ductwork shall be SMACNA Material Handling Class 2 (a.k.a. Class B), and 0 to -10 inches w. c. negative pressure, unless otherwise noted.

B. Ductwork shall be factory fabricated, round, with spiral lockseams or continuously welded longitudinal seams. Unless otherwise noted, duct and fitting material shall be galvanized steel. Galvanized ductwork noted on the drawings to be painted shall have a paintable galvanized finish.

C. Sheet metal gages for spiral lockseam ductwork shall be equal to United McGill “Uni-Seal” Industrial Duct for the applicable material handling class and negative pressure.

D. Sheet metal gages for continuously welded longitudinal seam ductwork shall be as required by the SMACNA Round Industrial Duct Standard.

E. Sheet metal gages for fittings shall be one even gage number heavier than the downstream duct section.

F. Duct connections for dust collection systems shall be made with material handling couplings or Van Stone flanges. Connections for fume and vapor exhaust systems may be made with slip couplings, unless otherwise noted.

G. Elbows shall be factory fabricated, with multiple gores and continuously welded joints. The minimum centerline radius shall be 1.5 times the duct diameter.

H. Laterals shall be factory fabricated, with 30 degree angle between main duct and branch duct centerlines. Tapered body laterals shall be used for duct size transitions.

I. Blast gates shall have minimum 18 gage fabricated frames, minimum 16 gage blades, and steel set screws; United McGill “GS” or equal.

J. Material handling cut-offs shall be half-frame type with cast aluminum bodies, minimum 16 gage slide gates, and steel set screws; United McGill “COH” or equal.

K. Floor sweep fittings shall be factory fabricated, with hinged door and duct connection as indicated; United McGill “FS” or equal.

L. Exhaust duct access doors shall be hinged type with quick-release latches or clasps, and shall, as a minimum, be fabricated from the same gage material as the ductwork; United McGill “ASHXFSDC” or equal.

M. Vertical stackhead fittings shall be factory fabricated, with discharge stack one inch larger than duct diameter, and stack height above duct outlet equal to four duct diameters; United McGill “WV” or equal.

N. Suggested manufacturers: United McGill, Kirk & Blum, Steelcraft, Semco, or equal.

2.08 FLEXIBLE EXHAUST DUCT

A. Type FH-1: Dust exhaust and similar applications - double ply, triple overlap construction of neoprene impregnated nylon fabric, with enclosed steel wire helix; Flexaust Type CWY or equal.

B. Type FH-2: Wood chip and metal exhaust and similar applications - four ply, triple overlap construction of neoprene impregnated nylon fabric, with enclosed steel wire helix; Flexaust Type LN or equal.

C. Type FH-3: Fume exhaust and similar applications - chemical resistant PVC wall, reinforced with fully enclosed spring steel wire helix. Minimum wall thickness shall be as follows:

Duct Diameter	Min Wall Thickness
1-1/4" to 3-3/4"	0.045"
4" to 5-1/2"	0.050"
6" to 8"	0.057"
9" to 16"	0.074"

Type FH-3 duct shall be Flexaust “Flexadux R-3” or equal.

D. Type FH-4: Extreme temperature or corrosive fume exhaust service - single ply, helically corrugated, with four ply seams folded flat and crimped, semi-rigid, self-supporting, bendable by hand; aluminum or 304 stainless steel as indicated; Flexaust “Bendway” Type A (aluminum), Type S (stainless steel), or equal.

E. Suggested Manufacturers: Flexaust, Hi-Tech Hose, U-Nova Hose, or equal.

2.09 POLYVINYL CHLORIDE (PVC) EXHAUST DUCTWORK

A. The basic plastic compounds for PVC duct, fittings and accessories shall be Class 12454-B or Class 12454-C per ASTM D1784-90 (formerly Type I, Grade 1 and Type I, Grade 2 respectively per ASTM D1784-65T).

B. Rigid PVC sheets used in the fabrication of duct, fittings and accessories shall be manufactured from basic plastic compounds noted above, and shall meet the requirements of ASTM D1927-81.

C. Duct may be either extruded, or thermally formed with butt welded longitudinal seams. The minimum nominal wall thickness shall be per SMACNA standards for the specified pressure class.

D. Fittings for round duct shall be factory fabricated and shall have flanged, butt welding, or bell & spigot end connections. Wall thickness of fittings shall be same as ductwork, as a minimum.

E The minimum centerline radius of round elbows shall be 1.5 times the duct diameter, unless otherwise noted.

F. PVC solvent cement shall be the heavier grade formulated for Schedule 40, 80 and 120 pipe.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Ductwork shall be fabricated, installed, and supported in accordance with applicable SMACNA duct construction standards.

B. If noted on the Schedule Of Submittals, the Contractor shall submit ductwork shop drawings for approval.

C. Ductwork shall be supported from the building structure; not from piping, conduit, or other ductwork. Double nuts and lock washers shall be used on threaded rod supports.

D. Where obstructions prohibit installation of ductwork as designed, the Contractor shall notify the Government Inspector and request direction from the A/E.

E. Ductwork shall be isolated from vibrating equipment with flexible connections.

F. Supplemental reinforcement shall be provided as required to prevent sagging and drumming of ductwork.

3.02 HVAC SHEET METAL DUCTWORK

A. Ductwork pressure/velocity classification shall be + 1 inch w.g. static pressure at 2500 fpm, unless otherwise indicated.

B. Duct systems shall be sealed to meet SMACNA seal Class C unless otherwise noted. Use SMACNA recommended methods with duct sealant or duct sealant plus tape and gasketing, as appropriate.

C. Rectangular ductwork shall be fabricated with cross-breaks in each side over 10 inches in width.

D. Rectangular branch duct connections to rectangular trunk ducts shall be made with 45 degree branch tees.

E. Round branch duct connections to rectangular trunk ducts shall be made with round takeoff fittings per Section 23 33 00.

F. When installing branch connections, provide at least one branch duct width or diameter clearance downstream of elbows.

G. Elbows for rectangular ductwork shall be one of the following types:

1. Curved elbow without vanes, centerline radius equal to 1.5 times the duct width.

2. Curved elbow with 6 inch throat radius and two splitter vanes per SMACNA duct construction standards.

3. Square, mitered elbow with double thickness turning vanes per Section 23 33 00.

H. Elbows for round ductwork shall be constructed with a minimum centerline radius equal to the duct diameter.

I. The angle between opposite sides of concentric transitions shall not exceed 45 degrees for diverging transitions or 60 degrees for converging transitions. The angle between opposite sides of eccentric transitions shall not exceed 30 degrees.

3.03 LINED DUCTWORK

A. Duct liner shall conform to NAIMA Fibrous Glass Duct Liner Standard.

B. Duct dimensions shown on the drawings are inside clear dimensions, unless otherwise noted. Lined ductwork shall be fabricated with allowance for the liner thickness to maintain inside clear dimensions indicated.

C. Liner shall be attached to ductwork with welded spotter pins and a continuous coating of adhesive. Maximum spacing of spotter pins shall be 18 inches longitudinally and 12 inches laterally. Secure liner to spotter pins with clips.

D. Seal all edges of duct liner with adhesive. Provide metal nosing at upstream edges where air velocity exceeds 4000 FPM.

3.04 INSULATED FLEXIBLE HVAC DUCT

A. Flexible duct shall be cut to the correct length to prevent sagging between supports, yet allow a full radius bend at diffuser connections. Duct that is too long shall be shortened.

B. Duct that is too short shall be replaced with longer duct, or a sheet metal elbow shall be provided at the diffuser.

C. The maximum length of insulated flexible duct shall be 8 feet, unless otherwise noted.

D. Flexible duct shall be connected to takeoff fittings and diffusers with steel worm gear type hose clamps. After making the duct connection, secure the insulation with a plastic strap and seal the vapor barrier with duct tape.

E. Support flexible duct with duct straps at a maximum spacing of 6 feet on center.

F. Where possible, support horizontal flexible duct branches to diffusers and grilles a minimum of 18 inches above ceilings. Flexible duct shall never be supported by laying directly on suspended ceiling tiles.

3.05 INDUSTRIAL SHEET METAL EXHAUST DUCTWORK

A. Transverse duct joints shall be secured with sheet metal screws at a maximum 6 inches on center, minimum of three screws per joint. Seal with duct sealant specified herein.

B. Provide blast gates or cutoffs for flow balancing of each branch duct unless otherwise indicated. Ductwork shall be rigidly supported at blast gates and cutoffs to withstand opening and closing forces.

C. Ductwork shall be beaded at connections to flexible duct.

3.06 FLEXIBLE EXHAUST DUCT

Flexible exhaust duct connections shall be secured with stainless steel worm drive clamps and sealed air-tight.

3.07 POLYVINYL CHLORIDE (PVC) EXHAUST DUCTWORK

A. Transverse joints for round duct, 12 inch diameter and smaller, shall be one of the following types:

1. Solvent welded bell & spigot joint.

2. Solvent welded sleeve joint.

3. Butt welded joint.

4. Flanged joint.

B. Solvent welded joints required to be liquid tight shall be hot gas/filler rod back welded.

C. Transverse joints for rectangular duct, and for round duct larger than 12 inch diameter, shall be one of the following types:

1. Hot gas/filler rod welded bell & spigot joint.

2. Hot gas/ filler rod welded sleeve joint.

3. Butt welded joint.

4. Flanged joint.

Solvent cement shall not be used.

D. Elbows for rectangular ductwork shall be fabricated from sheet stock with hot gas/filler rod welded joints. Square mitered elbows shall have turning vanes. The minimum centerline radius of curved elbows shall be 1.5 times the duct width.

E. Reinforcement of ductwork shall be constructed with hot gas/ filler rod welded joints.

F. Submit the following for approval:

1. Details of all hot gas/filler rod welded joint configurations and filler rod materials.

2. Qualifications and experience record of PVC welders.

G. Butt weld joints of any type shall <u>not</u> be solvent welded.

H. Provide expansion joints as required to prevent excessive duct movement or damage to ductwork and supports.

I. Provide drains at all low points of ductwork, as indicated on the drawings.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

This section specifies ductwork accessories for HVAC duct systems with the exception of control dampers, which are specified in Section 23 09 00.

1.02 RELATED SECTIONS

A. Section 23 05 93 Testing, Adjusting, and Balancing for HVAC (Air & Hydronic)

B. Section 23 30 00 HVAC Air Distribution

PART 2 PRODUCTS

2.01 STEEL SHEET

Steel sheet for fabrication and installation of duct accessories shall be flat prime quality, galvanized both sides, gages as indicated.

2.02 ROUND TAKEOFF FITTINGS

Round takeoff fittings shall be factory fabricated, galvanized steel, riveted construction, with mounting flange, adhesive backed neoprene gasket, beaded connection for flexible branch duct, crimped connection for sheet metal branch duct, and locking damper (if indicated on the drawings); Rainaire products "Air Tite" models 84AT and 84ATD or equal.

2.03 DUCT ACCESS DOORS

Duct access doors shall be U.L. labeled, galvanized steel, double panel construction, internally insulated with minimum 1-inch-thick fiberglass insulation, removable; complete with gaskets and quick-opening locking devices; Ductmate, Duro-Dyne Model IAD, Nailor-Hart Series 0800, or equal.

2.04 FLEXIBLE DUCT CONNECTORS

A. Flexible duct connectors shall be U.L. listed, and shall comply with NFPA 90A.

B. Flex connector shall be constructed of fire retardant, neoprene coated, woven glass fiber fabric (minimum density 20 oz. per square yard), secured to galvanized steel edging strips (24-gage minimum) with ship locks.

C. Suggested Manufacturers: Duro-Dyne, Vent Fabrics, U.S. Rubber, or equal.

2.05 TURNING VANES

Turning vanes shall be galvanized steel, double thickness, air-foil shape, with side rails, and shall be fabricated as recommended in the SMACNA HVAC Duct Construction Standards; Duro-Dyne, Barber-Colman, Titus, Airturns, or equal.

2.06 EXTRACTORS

Extractors shall be fabricated from galvanized steel with curved parallel blades, and factory installed screw driver operator; Carnes Model RXVA, Barber Coleman, Titus, or equal.

2.07 DAMPER QUADRANTS

Damper quadrants shall be locking type, with indicator markings showing damper position, and shall be as manufactured by Duro-Dyne, Vent Fabrics, or equal.

2.08 SPLITTER DAMPERS

Splitter dampers shall be fabricated from minimum 16-gage galvanized steel with a hemmed leading edge. Trailing edge shall be pivoted on a rod or hinges. Secure adjustment rod to leading edge of damper and extend rod through side of ductwork using a ball joint bracket with set screw (Ventlok #603 or equal).

2.09 MANUAL VOLUME DAMPERS

A. Dampers in rectangular ductwork of 12 inch depth or less shall be single blade type with extended shaft.

B. Dampers in rectangular ductwork of greater than 12 inch depth shall be opposed blade type, with tie rods and extended shaft. Blades shall be 6 inch width, maximum.

C. Dampers in round ductwork shall be single blade type, with 20 gage X 10 inch long galvanized steel frames and 14 gage galvanized steel blades. Frames shall be flanged or beaded on each end. Blades shall have full circumference neoprene or urethane edge seals. Shafts shall be 1/2 inch diameter, mounted with bearings, and extending 6 inches beyond frame.

D. Suggested Manufacturers: Ruskin, Louvers and Dampers, Arrow, or equal.

2.10 FIRE DAMPERS

A. Fire dampers shall be factory assembled, and shall bear the U.L. label for the fire resistance rating required at each location.

B. Fire dampers shall be curtain type, with interlocking galvanized steel blades folded out of the airstream.

C. Dampers intended for horizontal mounting shall have stainless steel negator springs for positive closure, and a latch mechanism to maintain the closed position until manually reset.

D. Fusible links shall separate at 160 degrees F, unless otherwise indicated.

E. Provide Type C low resistance frames, with free area equal to, or exceeding, that of the connecting ductwork. Frame style shall be as required for duct shape and system velocity.

F. Suggested Manufacturers: Ruskin, Louvers and Dampers, Vent Products, Prefco, or equal.

2.11 BACKDRAFT AND RELIEF DAMPERS

A. Type BD-1: Galvanized steel frame (minimum 16 gage) and linked parallel blades of galvanized steel or aluminum construction (minimum 22 gage) with felt blade edge seals; Airline Products Type FBD-12 or approved equal.

B. Type BD-2: Same construction as type BD-1, with adjustable closure spring or counterweights; Airline Products Type CBD-19 or equal.

C. Type BD-3: Galvanized steel frame, neoprene coated fiberglass fabric blades, aluminum or galvanized expanded metal rear grille, 60% free area; Ruskin NMS-2, Louvers & Dampers FRD, or equal.

D. Type BD-4: For very low pressure relief-extruded aluminum frame, formed aluminum blades with extruded vinyl edge seals, concealed linkage, adjustable counterbalance with a minimum relief setting of 0.01 inches w.g.; Ruskin CBD-2 or equal.

E. Suggested manufacturers: Airline Products, Arrow, Louvers and Dampers, Penn, Ruskin, Vent Products, or approved equal.

2.12 VARIABLE VOLUME ZONE AND BYPASS DAMPERS

A. Dampers shall consist of a short section of rigid round duct and an aerodynamic damper blade, galvanized or aluminized steel construction, with metal-to-metal shutoff seal, and actuator as specified below.

B. Damper actuators shall have positive positioning worm gear drive with end switches to prevent stalled motor operation, 90 degree rotation, approximate one minute drive time, and DDC control module (24 volts A.C.).

C. When specified, provide a wall mounted DDC zone temperature sensor with external set-point indication and adjustment.

D. When specified, provide a damper mounted duct temperature sensor for automatic heating/cooling changeover capability.

E. Variable volume zone and bypass dampers shall be Trane “VariTrac” or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Provide duct accessories as indicated on the drawings, and as specified herein.

B. Install duct accessories in accordance with the manufacturer's recommendations, drawing details, and applicable requirements of the following standards.

1. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

2. SMACNA HVAC Duct Construction Standards for Metal and Flexible Duct.

3. SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.

3.02 ROUND TAKEOFF FITTINGS

Provide duct takeoff fittings for all round branch duct connections (rigid and flexible) to rectangular ducts.

3.03 DUCT ACCESS DOORS

Provide access doors of suitable size and shape for maintenance access to all fire dampers, coils, humidifiers, and other equipment installed in ducts, and not readily accessible through other openings.

3.04 FLEXIBLE DUCT CONNECTORS

Provide flexible duct connectors for all fan and air handler duct connections.

3.05 TURNING VANES

A. Install turning vanes in all square mitered elbows and tees, and where otherwise indicated on the drawings.

B. Vanes shall extend across the full diagonal dimension of the turn, and be securely attached to the side rails.

C. Rivet the turning vane assembly to the ductwork, and install to be permanently rattle-proof.

3.06 EXTRACTORS AND SPLITTER DAMPERS

Provide where indicated on the drawings, and as otherwise required for proper air balancing.

3.07 MANUAL VOLUME DAMPERS

A. Provide where indicated on the drawings, and as otherwise required for proper air balancing.

B. Provide locking damper quadrants for all manual volume dampers.

3.08 FIRE DAMPERS

A. Provide duct access doors where fire damper fusible links are not accessible through other openings. Location and size shall be sufficient for resetting fire dampers and replacing fusible links.

B. Gap between fire damper & opening in wall to be caulked with fire resistant material on entire perimeter.

3.09 BACKDRAFT AND RELIEF DAMPERS

Adjust Type BD-2 and BD-4 dampers to relieve at the pressures indicated on the drawings.

3.10 VARIABLE VOLUME ZONE AND BYPASS DAMPERS

A. Provide zone and bypass dampers with control accessories as indicated on the drawings.

B. Provide a 24 volt A.C. control transformer for damper control power.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.01 SUMMARY

Work specified in this section includes propeller fans, centrifugal fans, and fan accessories for exhaust and ventilation applications.

1.02 RELATED SECTIONS

A. Section 23 05 00.01 Laser Alignment for HVAC Pumps & Rotaing Equipment

B. Section 23 05 48 Vibration Controls for HVAC Pumps & Rotating Equipment

C. Section 23 05 93 Testing, Adjusting , and Balancing for HVAC (Air & Hydronic)

D. Section 23 30 00 HVAC Air Distribution

E. Section 23 33 00 Air Duct Accessories

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Fan types, sizes, performance, horsepower, and electrical requirements shall be as scheduled on the drawings.

B. Fan air performance ratings shall be certified in accordance with AMCA Standard 211, and shall be based on standard sea level conditions.

C. Fan sound performance ratings shall be certified in accordance with AMCA Standard 311. Sound levels shall not exceed specified level at specified air delivery conditions.

D. Fans shall be U.L. listed and bear the AMCA seal for air and sound performance.

E. Fan wheels, housings, and supports not of aluminum or stainless steel shall be factory primed inside and outside for corrosion protection.

F. Fans shall be capable of accommodating static pressure variations of plus or minus 10 percent from the design value.

G. Fans shall be statically and dynamically balanced to minimize vibration and noise generation.

H. Fan motors shall have internal thermal overload protection and permanently lubricated, sealed ball bearings.

I. Belt driven fans shall have heavy duty, permanently lubricated, sealed ball bearings and fixed pitch cast iron sheaves. Belt drives shall be designed for a minimum 150% of input power (120% for fractional horsepower motors). Contractor is to provide final set of sheaves required to meet final system TAB requirements (whether VFD or not).

J. Bearings shall be self aligning, with oil reservoir, rated B10 with bearing life of not less than 250,000 hrs. Shop drawings shall bear manufacturer's certification of bearing life.

K. Provide belt guards on belt driven fans with exposed drives. Provide safety screens or guards where fan inlets or outlets are exposed.

L. Provide all fans with unit-mounted electrical disconnects, unless otherwise noted.

M. Motors shall be "Premium Efficiency" as defined in the most recent NEMA Premium Efficiency Motor Program.

N. Installed vibration levels shall not exceed those specified in Section 23 05 48, "Vibration Controls HVAC Equipment.

O. Units to be Energy Star/FEMP-designated (if applicable) unless otherwise noted.

P. All belt driven fans are to be laser aligned per Section 23 05 00.01, "Laser Alignment for HVAC Pumps & Rotating Equipment."

2.02 PROPELLER WALL FANS

A. Fan mounting panels shall be constructed of heavy gage steel with prepunched mounting holes, factory formed flanges, and deep spun venturi inlet.

B. Motors and drives of fans 24 inch diameter and larger shall be supported by steel angle or formed structural shapes.

C. Steel panels and framing shall be factory primed and painted.

D. Propeller fan blades shall be constructed of die formed aluminum or steel. Steel fan blades shall be welded to steel hubs.

E. Propeller wall fans shall be Penn “Breezeway” or “Breezebuilder” Series or equal.

2.03 CENTRIFUGAL FANS

A. Type CF-1: In-line Centrifugal Fans

1. Housings shall be constructed of galvanized steel panels with structural framing for rigidity. Housings shall have inlet and outlet duct connection flanges, deep spun venturi inlet, and access panels for full access to all internal components.

2. Direct drive fans shall have motor, fan wheel, and inlet venturi mounted on a swing-out panel for easy access.

3. Belt drive fans shall have drive components isolated from the airstream, with externally mounted motors.

4. Fan wheels shall be constructed of aluminum, statically and dynamically balanced, and shall be backward curved, non-overloading type.

5. Provide fan manufacturer’s standard vibration isolators for the type of installation indicated on the drawings.

6. Type CF-1 fans shall be Penn “Centrex In-Liner,” Greenheck SQ and BSQ Series, or equal.

B. Type CF-2: Room Exhaust/Cabinet Fans

1. Housings shall be constructed of galvanized steel panels with structural framing for rigidity. Housings shall have inlet and outlet

duct connection flanges, acoustical insulation, and access panels for full access to all internal components.

2. Room exhaust fans shall be field convertible for either ceiling or wall mounting, and shall be furnished with white eggcrate intake grille, resiliently mounted motor, and integral backdraft damper.

3. Cabinet fans shall be field convertible for either in-line or right angle configurations.

4. Provide manufacturer's standard mounting hardware and vibration isolators for the type of installation indicated on the drawings.

5. Type CF-2 fans shall be Penn "Zephyr" Series or equal.

C. Type CF-3: Utility Fan Sets

1. Scroll housings shall be constructed of heavy gage galvanized or painted carbon steel sheet, with spun venturi inlet, steel angle bracing and base, inlet duct collar, and slip joint or flanged outlet. Housings shall be field adjustable for rotation to eight standard discharge positions.

2. Fan motor and drive components shall be mounted on a structural steel frame, rigidly attached to the scroll housing.

3. Fan motors for outdoor installations shall be TEFC type, or shall be provided with vented weatherproof housings.

4. Fan wheels shall be forward curved, non-overloading backward inclined, or airfoil type, as specified on the drawings. Fan wheels shall be constructed of welded steel or aluminum unless otherwise noted.

5. Provide fan manufacturer's standard spring or rubber-in-shear vibration isolators for the type of installation indicated on the drawings.

6. Type CF-3 fans shall be Trane, Penn "Dynamo" Series, or equal.

D. Wall and Roof Mounted Centrifugal Exhausters

1. Type CF-4: General Purpose Exhausters

a. Housings shall be constructed of heavy gage, spun aluminum with a rolled bead and removable motor/drive cover.

b. Curb caps (roof models) and mounting rings (wall models) shall be one-piece aluminum with integral, deep spun venturi inlet.

c. Fan wheels shall be of non-sparking aluminum construction, and shall be backward curved, non-overloading type.

d. Motor/drive mounting plates shall be isolated from fan housings with rubber vibration isolators.

e. Motor/drive compartments shall be isolated from the exhaust air stream and force cooled with fresh air.

f. Type CF-4 fans shall be Penn “Domex” Series or equal.

2. Type CF-5: Exhausters for Heavily Contaminated Air

a. Fans shall be top discharge type, designed to project the exhaust airstream away from the building for effective contaminant dispersal.

b. Fan housings shall be constructed of heavy gage spun aluminum with a rolled bead, removable motor/drive housing, and integral water drains.

c. Base plates shall be one-piece galvanized steel or aluminum, with integral deep spun venturi inlet. Note: Base plates of spark-proof fans shall be aluminum.

d. Fan wheels shall be of non-sparking aluminum construction, backward curved, non-overloading type, with integral cooling fan.

e. Motor/drive mounting plates shall be isolated from fan housings with rubber vibration isolators.

f. Motor/drive compartments shall be isolated from exhaust air stream, and shall be force cooled with fresh air drawn from outside the fan housing through breather tubes.

g. Type CF-5 fans shall be Penn “Fumex” or equal.

E. Type CF-6: Laboratory Fume Hood Exhaust Fans

1. Type CF-6 fans shall be modular, roof mounted, constant volume, direct drive, vertical discharge; designed for fresh air entrainment in the exhaust plume to produce an effective stack height as specified on the drawings.

2. Modules shall have flanged joints with PTFE gaskets and 316 stainless steel hardware.

3. All steel and aluminum components shall be blasted or chemically etched, then protected with an 8 to 10 mil epoxy coating.

4. The complete fan assembly shall be designed to mount on a conventional roof curb without requiring guy wires.

5. The fan manufacturer shall provide certification that fan performance data includes adjustment for system effects caused by the specified accessories.

6. Base/Impeller Shroud Module

   a. Base/impeller shroud module shall be constructed of continuously welded steel, with a bolted access door for impeller inspection.

   b. Impeller inlet bell shall be aluminum, and shall meet AMCA “C” sparkproof requirements.

7. Motor/Impeller Module

   a. Motor/impeller module shall be constructed of continuously welded steel, with internal lifting lugs and internal drains to prevent rain water entry into ductwork.

   b. Module shall include the motor, impeller, and stationary discharge guide vanes.

   c. Fan motor shall be TEFC mill and chemical duty type, with 1.15 service factor and L-50 bearing life of 200,000 hours. Motor horsepower and voltage shall be as indicated on the drawings. Motor shall be "premium efficiency" as defined in the most recent NEMA premium efficiency motor program.

d. Motor shall be isolated from the exhaust air stream, and shall be visible and accessible from the fan exterior for inspection and maintenance.

e. Module shall include an externally mounted, factory wired, NEMA 3R non-fused disconnect.

f. Impeller shall be a combination of axial and backward curved blades, of welded steel construction, and shall be directly mounted to the motor shaft.

g. Impeller shall be dynamically balanced, with a maximum 0.5 mil peak-to-peak vibration at operating speed.

h. Impeller shall have non-stall and non-overloading characteristics for stable operation at any point on the fan curve.

8. Discharge Nozzle/Windband Module

a. Module shall have twin venturi nozzles with motor access between. Nozzles shall be constructed of chemical and UV resistant FRP. Windband shall be steel.

b. Module shall be designed to provide secondary induction of outdoor air into the exhaust air stream. Outdoor air induction shall be approximately 160% of exhaust airflow.

9. Mixing Box Plenum Module

a. When specified on the drawings, the manufacturer shall provide a mixing box plenum module. Module shall be constructed of continuously welded steel, suitable for roof curb mounting, and designed to support the exhaust fan without guy wires or external supports.

b. Plenum shall have hinged access doors, internal drains, and safety screens over air inlets.

c. Air inlet sizes and orientations shall be as shown on the drawings.

d. Air inlets shall be equipped with manual, adjustable barometric, or low leakage control dampers as indicated. Outdoor air intakes shall be equipped with rain hoods.

10. Type CF-6 fans shall be Strobic Air “Tri-Stack” or equal.

2.04 FAN ACCESSORIES

A. Unless otherwise indicated, all accessories shall be provided by the fan manufacturer.

B. Roof Curbs: Curbs shall be fabricated from aluminum or galvanized steel with mitered and welded corners, pressure treated wood nailer, integral cant, and rigid fiberglass insulation; suitable for roof type and slope; curb size and height as specified on the drawings.

C. Backdraft Dampers and Shutters: Aluminum or galvanized steel construction, equal to Type BD-1 per Section 23 33 00.

D. Wall Sleeves: For propeller wall fans - fabricated from galvanized or painted steel sheet, with reinforced corners and mounting flanges for fan guards and shutters.

2.05 SUGGESTED MANUFACTURER’S

Fans and accessories shall be Acme, Aerovent, Buffalo Forge, Carnes, Greenheck, Loren Cook, Penn, Trane, or equal.

PART 3 EXECUTION

3.01 GENERAL

Provide fans and fan accessories as indicated on the drawings, and in accordance with the manufacturer’s recommendations.

3.02 VENTILATING AND EXHAUST FANS

A. Install fans so that all components are readily accessible for inspection and maintenance.

B. Provide flexible connectors on inlet and outlet duct connections of all ducted fans, unless otherwise indicated.

C. Verify correct direction of rotation for all fans upon initial start-up.

3.03 FAN ACCESSORIES

A. Install roof mounted fans on roof curbs, unless otherwise indicated.

B. Install wall mounted propeller fans in wall sleeves, unless otherwise indicated.

C. Provide flashing for roof curbs and wall sleeves as indicated, and as otherwise required for a weather-tight installation.

D. Use cadmium plated (or other corrosion resistant) hardware for exterior fan mounting.

END OF SECTION

SECTION 23 37 00

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SUMMARY

This section specifies air distribution devices for HVAC systems, and includes grilles, registers, diffusers, and louvers.

1.02 RELATED SECTIONS

A. Section 23 05 93 Testing, Adjusting, and Balancing for HVAC (Air & Hydronic)

B. Section 23 30 00 HVAC Air Distribution

C. Section 23 33 00 Air Duct Accessories

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Air outlet and inlet types, face and neck sizes, throw patterns, mounting types, and performance requirements shall be as indicated on the drawings.

B. Performance of grilles, registers, and diffusers shall be certified in accordance with ADC 1062 or ASHRAE Standards 70 and 113. Louver performance ratings shall be AMCA (Air Movement and Control Association) certified.

C. Construction and mounting of air distribution devices shall preclude flutter, rattle, and vibration.

D. Provide all modifications, accessories, and hardware necessary to mount devices in specified or indicated surface construction.

2.02 SUPPLY DIFFUSERS

A. Unless otherwise noted, all supply diffusers shall be of steel construction with white enamel finish.

B. Unless otherwise noted, provide face operable opposed blade dampers for all supply diffusers. Dampers shall be equal to Carnes Model KXKA (square and rectangular neck) or Model KXMB (round neck).

C. Type SD-1: Louvered face, fixed pattern, surface mounting frame; Carnes Model SKSA or equal.

D. Type SD-2: Louvered face, fixed pattern, exposed duct mounting frame; Carnes Model SKEA or equal.

E. Type SD-3: Louvered face, fixed pattern, T-bar mounting frame; Carnes Model SKTA or equal.

F. Type SD-4: Louvered face, adjustable 4-way pattern, surface mounting frame; Carnes Model SKBA-40 or equal.

G. Type SD-5: Louvered face, adjustable 4-way pattern, exposed duct mounting frame; Carnes Model SKPA-40 or equal.

H. Type SD-6: Louvered face, adjustable 4-way pattern, T-bar mounting frame; Carnes Model SKCA-40 or equal.

I. Type SD-7: Hinged perforated face, 4-way fixed pattern, round neck, surface mounting frame; Carnes Model SPCB, with Style 2 frame, or equal.

J. Type SD-8: Hinged perforated face, 4-way fixed pattern, round neck, T-bar mounting frame; Carnes Model SPCB, with Style 4 frame, or equal.

K. Type SD-9: Hinged perforated face, adjustable pattern, surface mounting frame; Carnes Model SPAB (round neck) or SPDB (square or rectangular neck) with Style 2 frame, or equal.

L. Type SD-10: Hinged perforated face, adjustable pattern, T-bar mounting frame; Carnes Model SPAB (round neck) or SPDB (square or rectangular neck) with Style 4 frame, or equal.

2.03 SUPPLY GRILLES AND REGISTERS

A. Unless otherwise noted, supply grilles and registers shall be of steel construction, with white finish and flanged frame for wall or ceiling mounting.

B. Supply Grilles

1. TYPE SG-1: Single deflection, adjustable vertical front bars (unless otherwise noted); Carnes Model RSSA or equal.

2. TYPE SG-2: Double deflection, adjustable vertical front bars and horizontal rear bars (unless otherwise noted); Carnes Model RSDA or equal.

C. Supply Registers

1. TYPE SR-1: Type SG-1 grille with opposed blade damper; Carnes Model RTSA or equal.

2. TYPE SR-2: Type SG-2 grille with opposed blade damper; Carnes Model RTDA or equal.

3. TYPE SR-3: Computer room floor register - aluminum construction, satin brushed aluminum finish, load bearing, 8 X 12 inch neck, 15 degree louver deflection, with opposed blade damper; Carnes Model CCKBD or equal.

2.04 RETURN AND EXHAUST GRILLES AND REGISTERS

A. Unless otherwise noted, grilles and registers shall have a white finish.

B. Return and Exhaust Grilles

1. TYPE RG-1: Steel, hinged perforated face, T-bar mounting frame; Carnes Type SPRB (round neck) or SPJB (square neck) with Style 4 frame, or equal.

2. TYPE RG-2: Steel, hinged perforated face, surface or exposed duct mounting, flanged frame; Carnes Type SPRB (round neck) or SPJB (square neck) with Style 2 frame, or equal.

3. Type RG-3: Aluminum, 1/2 X 1/2 X 1/2-inch eggcrate face, T-bar mounting frame; Metalaire Model CC5-TB or equal.

4. Type RG-4: Aluminum, 1/2 X 1/2 X1/2-inch eggcrate face, flanged surface mounting frame; Metalaire Model CC5-PF or equal.

5. TYPE RG-5: Steel, fixed horizontal curved face blades, flanged surface mounting frame; Carnes Model RSLA or equal.

6. Type RG-6: Steel, perforated face, non-ducted panel, T-bar mounting; Carnes Model SPHB or equal.

7. Type RG-7: Aluminum, 1/2 X 1/2 X 1/2-inch eggcrate face, non-ducted panel, channel frame for T-bar mounting; Metalaire Model CC5-TB-Core Only, or equal.

8. Type RG-8: Filter/grille - Aluminum, 1/2 X 1/2 X 1/2-inch hinged eggcrate face, flanged surface mounting frame, holding frame for 1-inch disposable fiberglass filter; Titus Model 50FF with Type 1 border, or equal.

9. Type RG-9: Filter/grille - Aluminum, 1/2 X 1/2 X 1/2-inch hinged eggcrate face, T-bar mounting frame, holding frame for 1-inch disposable fiberglass filter; Titus Model 50FF with Type 3 border, or equal.

10. Type RG-10: Filter/grille - Aluminum, horizontal face louvers, 40 degree deflection, surface mounting frame, holding frame for 1-inch disposable fiberglass filter; Tuttle & Bailey Model A70DFB or equal.

C. Return and Exhaust Registers

1. Type RR-1: Type RG-1 grille with opposed blade damper.

2. Type RR-2: Type RG-2 grille with opposed blade damper.

3. Type RR-3: Type RG-3 grille with opposed blade damper; Metalaire Model CC5D-TB or equal.

4. Type RR-4: Type RG-4 grille with opposed blade damper; Metalaire Model CC5D-PF or equal.

5. Type RR-5: Type RG-5 grille with opposed blade damper; Carnes Model RTLAH or equal.

2.05 DOOR GRILLES

Door grilles (a.k.a. door louvers) shall be of aluminum construction, satin brushed aluminum finish, double flange frame, chevron blade, "sight-tight", 80% free area; Carnes Model RFJAD or equal.

2.06 WALL LOUVERS

A. All louvers shall have flanged frames unless otherwise indicated.

B. Unless otherwise noted on the drawings, provide louvers with standard mill finish. When other than mill finish is specified, provide manufacturer's standard color charts for color selection.

C. Type WL-1: Stationary, 4-inch frame depth, minimum 20 gage galvanized steel frame and blades, riveted or welded construction, drainable blades, dual downspouts, removable 1/2 inch galvanized mesh bird screen; water penetration and air performance certified per AMCA Publication 511; Louvers and Dampers Model FL-47 or equal.

D. Type WL-2: Same as WL-1 except fully adjustable, with neoprene blade seals, self-lubricating sintered bronze bearings, and concealed linkage; Louvers and Dampers Model FL-47A or equal.

E. Type WL-3: Stationary, 4-inch frame depth, minimum .081 inch thick aluminum frame and blades, welded construction, drainable blades, dual downspouts, removable 1/2 inch galvanized mesh bird screen; water penetration and air performance certified per AMCA Publication 511; Louvers and Dampers Model EL-47 or equal.

F. Type WL-4: Same as WL-3 except fully adjustable, with neoprene blade seals, self-lubricating sintered bronze bearings, and concealed linkage; Louvers and Dampers Model EL-47A or equal.

2.07 SUGGESTED MANUFACTURERS

A. Diffusers, grilles, and registers shall be Carnes, Hart and Cooley, Krueger, Metalaire, Titus, Tuttle and Bailey, or equal.

B. Wall louvers shall be Arrow, Carnes, Louvers and Dampers, Ruskin,Vent Products, or equal.

PART 3 EXECUTION

3.01 Install air distribution devices where indicated on the drawings, and in accordance with manufacturer's installation instructions.

3.02 Provide manufacturer’s standard round neck adapters for connection of insulated flex duct to square neck diffusers.

3.03 Flash and seal around wall louvers per the drawing details, and as otherwise required to provide a weather-tight installation.

3.04 Provide one box of replacement filters for each return air filter/grille installed.

END OF SECTION

SECTION 23 70 00

CENTRAL-STATION AIR HANDLING UNITS

PART 1 GENERAL

1.01 SUMMARY

Work specified in this section includes the following:

A. Central Station Air Handling Units

B. Fan-Coil and Blower Coil Units

1.02 RELATED SECTIONS

A.	Section 03 03 00	Cast-in-Place Concrete
B.	Section 23 05 00.01	Laser Alignment for HVAC Pumps & Rotating Equipment
C.	Section 23 05 48	Vibration Controls for HVAC Pumps & Rotating Equipment
D.	Section 23 05 93	Testing, Adjusting, and Balancing for HVAC (Air & Hyronic)
E.	Section 23 09 00	Instrumentation and Control for HVAC
F.	Section 23 21 13	Above-Ground Hydronic Piping
G.	Section 23 22 13	Above-Ground Steam & Condensate Piping
H.	Section 23 23 00	Refrigerant Piping
I.	Section 23 30 00	HVAC Air Distribution
J.	Section 23 33 00	Duct Accessories

PART 2 PRODUCTS

2.01 CENTRAL STATION AIR HANDLING UNITS

A. General

1. The terms “air handling unit” and “air handler” are used interchangeably in this specification.

2. Provide central station type air handling units as scheduled on the drawings and specified herein.

3. Air handling unit performance shall be certified in accordance with ARI Standards 430 and 410, and units shall bear the ARI label.

4. Units shall be factory fabricated and shipped fully assembled, or in major sections for field assembly.

5. Unless otherwise noted, provide air handling units with double-wall construction with 2-inch thick, 1.5 pcf density insulation. Fan sections shall have perforated liner unless otherwise indicated. All other sections shall have solid liners.

6. Refrigerant containing equipment shall be designed to use non-ozone depleting substances (ODS) such as R-134a and R-410a.
   *Until further notice (as of 6/26/08 per MSFC), refrigerants HCFC- 22 and HCFC-123 are acceptable.

B. Casing

1. Air handling unit casings shall be factory fabricated from mill-galvanized or primed and painted carbon steel. Mill-galvanized sheet metal shall conform to ASTM A653, and shall be coated with not less than 1.25 ounces of zinc per square foot of two-sided surface. Mill-rolled structural steel shall be hot-dip galvanized or primed and painted. Cut edges, burns and scratches in galvanized surfaces shall be corrosion protected. All interior and exterior surfaces, including lapped contacting surfaces of black carbon steel, shall be primed and painted for corrosion protection.

2. Casings shall have air-tight joints, closures, penetrations and access openings.

3. Coil sections shall contain full size integral drain pans, double-sloped for complete drainage. Drain pans shall be insulated with foamed-in-place insulation to prevent sweating. Coil sections for horizontally split coils shall have intermediate drain pans.

4. Casing construction shall permit removal of section panels for complete access to interior of unit. Casings shall provide for use of fan tachometers without disassembly. Provide hinged, gasketed doors to permit access for maintenance of drive components and cleaning of coils. Filter access doors shall be considered adequate only for filter replacement.

C. Coils

1. General

a. Coils shall be sized for the scheduled capacities and conditions.

b. Coils shall have galvanized steel casings and corrugated aluminum plate fins with integral spacing collars covering copper tubes. Tubes shall be expanded to form a tight, mechanical bond with fin spacing collars. Joints shall be brazed and factory tested underwater at minimum 300 psig

c. All coil connections shall be located on the same side of the air handler,unless otherwise indicated on the drawings.

d. Coil performance shall be certified in accordance with ARI Standard 410.

e. Coils shall have a minimum of 24 inches separation between coils and a minimum of 24 inches separation between coils and other system components, such as filters.

2. DX Coils

a. DX coils shall be matched to the corresponding refrigeration equipment, and shall be by the same

manufacturer. Coils shall be factory dehydrated and sealed.

b. DX coils shall be counterflow design, staggered tube arrangement, with factory mounted brass distributors, and shall be designed for similar pressure drop across each circuit.

c. Coil design shall allow gravity drainage of oil to suction connection.

d. Circuit arrangements for multiple stages of cooling shall be as scheduled on the drawings.

e. DX coils shall be U.L. listed.

3. Hydronic (Water) Coils

a. Water Coils shall be counterflow design with staggered tube arrangement.

b. Coils shall be self-venting, or provided with vent connections and manual vent valves, including drain tubing to drain pan.

c. Coils shall be self-draining, or provided with drain plugs. Coils shall drain completely by gravity, piped to floor drain or drain pan.

d. Minimum wall thickness for coil tubes shall be 0.025” for 1/2”
tubes, and 0.035” for 5/8” tubes.

4. Steam Coils

a. Steam Coils shall be non-freeze, distributing tube type with concentric steam supply and condensate return tubes. Inner steam supply tube shall have orifices for even distribution of steam.

b. Coils shall drain completely by gravity.

c. Steam coils to have automatic air vent at coil outlet and a vacuum breaker at coil inlet.

D. Fans

1. Fan wheels shall be double width, double inlet, centrifugal type. Fans shall be forward curved (FC), airfoil (AF), or backward inclined (BI) type as scheduled on the drawings.

2. Fans shall be statically and dynamically balanced after mounting on shafts. Maximum fan shaft rpm shall be well below the first critical speed. Bearings shall be self-aligning, oil lubricated, with reservoir, rated B10 with bearing life of not less than 250,000 hrs. Shop drawings shall bear manufacturer's certification of bearing life.

3. Fan drives shall be fixed sheave, V-belt type sized for 150 percent of motor horsepower. Contractor is to provide final set of sheaves required to meet final system TAB requirements (whether VFD or not).

4. Fan motors shall be 1750 rpm, open drip proof or totally enclosed type, with horsepower and electrical requirements as specified on the drawings. Motors shall be "premium efficiency" as defined in the most recent NEMA premium efficiency motor program.

5. Provide belt guards where fan motors and drives are externally mounted.

6. Fans shall be internally isolated.

7. Installed vibration levels shall not exceed those specified in Section 23 05 48, "Vibration Controls for HVAC Pumps& Rotating Equipment.

E. Filters

1. Filter sections shall be factory fabricated, with hinged access doors, and shall connect directly to the air handler.

2. Filter types, thicknesses, and minimum filter area shall be as indicated on the drawings. Final Filters are to be rated MERV 13.

F. Mixing Boxes

1. Mixing box sections shall be factory fabricated complete with control dampers and linkages, and shall connect directly to the air handler or filter section.

2. Control dampers shall be airfoil blade, opposed blade, low leakage type, with blade edge and jamb seals. 2-way (shut-off) dampers shall be parallel acting, galvanized steel with nylon bushings.

3. Top and back mounted dampers shall deflect air toward each other for maximum mixing. Top and bottom mounted dampers shall deflect air away from coils for maximum mixing.

4. Mixing box sections shall have hinged access doors for inspection and maintenance of dampers.

G. Filter/Mixing Boxes

Combination filter/mixing box sections shall meet all requirements of individual filter and mixing box sections specified above.

H. Vibration Isolators

1. Provide manufacturer's recommended vibration isolators, appropriate for the installation shown on the drawings.

2. Isolators shall be spring or rubber-in-shear type.

I. Suggested Manufacturers

Air handling units shall be Carrier, Trane, McQuay, York, or equal.

2.02 FAN-COIL AND BLOWER COIL UNITS

A. General

1. Provide fan-coil and blower coil units with configurations, coils, and capacities as scheduled on the drawings.

2. All units shall be U.L. listed. Unit performance shall be rated in accordance with ARI Standard 440, and units shall bear the ARI label.

B. Cabinets

1. Unit cabinets shall be constructed of minimum 18-gage galvanized steel. Cabinets of exposed and recessed units shall have a baked enamel finish.

2. Cabinets shall be insulated, and shall have removable, gasketed panels which provide complete access to all parts requiring repair, periodic maintenance, or replacement

3. Provide cabinets complete with duct collars and/or grilles as indicated on the drawings.

C. Coils

1. All coils shall be constructed of aluminum fins mechanically bonded to seamless copper tubing. All tubing joints shall be brazed with high temperature alloy.
2. All coils shall be provided with manual air vents, and shall be designed to drain completely when installed in accordance with the manufacturer's recommendations. Vents shall be piped to drain pan (tubing acceptable).

3. Coils and condensate drain pans shall be field reversible for right or left side connections.

4. Coils shall be factory leak tested underwater with air at 300 psig.

5. Coil performance shall be certified in accordance with ARI Standard 410.

D. Fans

1. Fans shall be double width, double inlet, forward curved type, dynamically balanced.

2. Fan wheels and housings shall be constructed of aluminum or galvanized steel.

3. Fan shall be statically & dynamically balanced after mounting on shaft. Maximum fan shaft RPM shall be well below the first critical speed. Bearings shall be self aligning, oil lubricated with reservoir, ball bearing type rated B10 with bearing life of not less than 250,000 hrs. Shop drawings shall bear manufacturer's certification of bearing life.

4. Fan drive shall be fixed sheave, V-belt type sized for 150 percent of motor horse power. Contractor is to provide final set of sheaves required to meet final system TAB requirements (whether VFD or not).

5. Installed vibration levels shall not exceed those specified in Section 23 05 48 “ Vibration Controls for HVAC Pumps and Rotating Equipment.

E. Motors

1. Fan motors shall be permanent split capacitor type with built-in automatic reset thermal overload protection.

2. Motors shall have extended shafts for mounting of fans, with permanently lubricated bearings, or sleeve bearings with automatic lubrication requiring only seasonal maintenance.

3. Motors shall be resiliently mounted, located in the air stream, and be easily removable.

4. Fan motor horsepower and electrical requirements shall be as scheduled on the drawings. Motors shall be "premium efficiency" as defined in the most recent NEMA premium efficiency motor program.

F. Drain Pans

1. Units shall have thermoplastic insulated or galvanized steel drain pans with primary and auxiliary drain connections, removable for cleaning, and pitched for positive drainage when unit is level.

2. Drain pans shall project under the entire length of cooling coils including headers, return bends, and internal piping accessories subject to condensation.

3. Provide secondary drain pans under valves and piping subject to condensation, where required by fan coil unit design.

G. Plenums

1. Provide plenums for concealed fan-coil units where indicated on drawings.

2. Plenums shall be constructed of minimum 18 gage galvanized steel, internally lined with a minimum 1/2 inch of fiberglass, and shall have duct collars as required for the configuration shown on the drawings.

H. Filter/Mixing Boxes

1. Filter/Mixing Boxes shall be of the same construction as the base
unit and shall be complete with filter frames for the specified filters and two low leak parallel blade dampers.

2. Control dampers shall be airfoil blade, opposed blade, low leakage type, with blade edge & jamb seals. 2-way (shut off) dampers shall be parallel acting, galvanized steel with nylon bushings.

2. Dampers shall be factory linked to a common drive linkage to allow both dampers to be driven by a single actuator.

I. Electric Resistance Heating Coils

Electric Heating Coils shall be open coil resistance type, UL labeled, with automatic reset thermal cutout, capacities and number of stages per the drawing schedules.

J. Blower Coil Unit Controls

1. Unit controls shall be contained in a unit mounted control box and
shall include a single point power connection, line fusing and disconnect switch, motor and heating contactors, control transformer, and terminal strip for input and output wiring from a remote control system.

2. Provide control and devices per the drawing schedule. Devices
shall be factory mounted and wired.

K. Suggested Manufacturers

Fan-coil and blower coil units shall be Carrier, Trane, McQuay, York, or equal.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Install air handling, fan-coil, and blower coil units as shown on the drawings, and in accordance with the manufacturer's recommendations.

B. Check all fans for proper direction of rotation upon initial start-up.

C. Fan & Motor shafts are to be laser aligned per Section 23 05 00.01, "Laser Alignment for HVAC Pumps & Rotating Equipment".

3.02 CENTRAL STATION AIR HANDLING UNITS

A. Required field assembly of air handling units shall be accomplished with factory-provided hardware, gaskets, and sealants.

B. Make all ductwork connections to air handling units with flexible duct connectors, unless otherwise indicated.

3.03 FAN-COIL AND BLOWER COIL UNITS

Hydronic specialties for fan-coil and blower coil units may be either field provided or factory installed.

END OF SECTION

SECTION 23 81 00

DECENTRALIZED UNITARY HVAC EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

This section specifies unitary (packaged) air conditioners and heat pumps for general purpose and computer room applications. It includes both self-contained and split systems.

1.02 RELATED SECTIONS

A. Section 03 30 00 Cast-in-Place Concrete

B. Section 23 05 48 Vibration Controls for HVAC Pumps & Rotating Equipment

C. Section 23 05 93 Testing, Adjusting and Balancing for HVAC (Air Hydronic)

D. Section 23 21 13 Above-Ground Hydronic Piping

E. Section 23 22 13 Above-Ground Steam & Condensate Piping

F. Section 23 23 00 Refrigerant Piping

G. Section 23 30 00 HVAC Air Distribution

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. System types, configurations, capacities, accessories, and electrical requirements shall be as indicated on the drawings.

B. Self-contained systems shall be factory assembled, charged, and run tested; requiring field connection of power, ductwork, and remote thermostats only.

C. Split system component units shall be factory assembled complete with all internal wiring and piping, a holding charge of refrigerant, and unit control panels with terminal strips. Units shall be shipped

ready for field connection of power, ductwork, and interconnecting control wiring and refrigerant piping.

D. All unitary air conditioners and heat pumps shall be UL listed and have a minimum SEER rating of 12.

E. Units to be Energy Star or FEMP-designated unless otherwise noted.

F. Equipment capacities shall be certified in accordance with applicable portions of ARI Standards 210/240, 340, 360, and 365; and each unit shall bear the appropriate ARI label.

G. Refrigerant containing equipment shall be designed to use non-ozone depleting substances (ODS) such as R134a and R-410a. *Until further notice (as of 6/26/08 per MSFC) refrigerants HCFC-22 and HCFC-123 are acceptable.

2.02 GENERAL PURPOSE AIR CONDITIONERS AND HEAT PUMPS

A. System Types

1. Unless otherwise indicated, all systems shall be air-to-air direct expansion (DX) type.

2. Systems shall be either self-contained (single package) or split system (separate air handling and condensing units) as indicated on the drawings.

B. Equipment Casings and Construction

1. Air conditioner and heat pump casings shall be fabricated from galvanized steel sheet with baked enamel finish, structural steel framing, maintenance access panels, and condenser fan and coil guards.

2. Unit evaporator sections shall be internally insulated, with insulated coil condensate drain pans, filter rails, and disposable fiberglass filters.

C. Fans

1. Evaporator (supply air) fans shall be centrifugal type, statically and dynamically balanced, with fixed sheave belt drive. V-Belts to be sized for 150 percent of motor horse power. Contractor is

to provide final set of sheaves required to meet final system TAB requirements (whether VFD or not).

2. Condenser fans shall be direct drive propeller type, statically and dynamically balanced.

3. Fan motors shall have internal thermal overload protection and permanently lubricated sealed bearings. Motors shall be "premium efficiency" as defined in the most recent NEMA premium efficiency motor program.

4. Fan bearings shall be self aligning, oil lubricating with reservoir, ball bearing type, rated B10 with bearing life of not less than 250,000 hrs. Shop drawings shall bear manufacturer's certification of bearing life.

5. Installed vibration levels shall not exceed those specified in Section 23 05 48, "Vibration Controls for HVAC Pumps & Rotating Equipment".

D. Refrigerant Coils

1. DX evaporator and condenser coils shall have aluminum fins mechanically bonded to seamless copper tubing.

2. Condenser coils shall have integral sub-cooling circuits.

3. Evaporator coils shall be factory leak tested at 300 psig.

4. Condenser coils shall be factory leak tested at 425 psig.

E. Electric Heating Coils

1. Electric resistance heating coils shall have nickel-chromium elements, with automatic reset high limit thermal protection.

2. Coils shall be UL listed.

F. Compressors

1. Compressors shall be direct drive, hermetic or semi-hermetic, reciprocating or scroll type.

2. Compressors shall be equipped with internal thermal overloads, vibration isolators, crankcase heaters, and oil sight glasses.

3. Compressor motors shall be refrigerant suction cooled. Motors shall be "premium efficiency" as defined in the most recent NEMA premium efficiency motor program.

4. Compressors shall carry a five year manufacturer’s warranty.

G. Refrigerant Circuits

1. Each refrigerant circuit shall have a fixed orifice or thermostatic expansion device, service valves, service pressure ports, sight glass with moisture indicator, and liquid line filter/drier.

2. In addition, each heat pump refrigerant circuit shall have a solenoid heating/cooling changeover valve.

3. If specified refrigerant specialties are not factory installed in split system units, they shall be field provided per Section 23 23 00. Locate sight glasses and filter/driers near the outdoor unit.

H. Controls and Safeties

1. All systems shall be provided with the following factory installed controls and safeties.

a. Part winding full voltage or across-the-line starters with overload relays.

b. UL listed control transformer suitable for the specified primary voltage.

c. High and low pressure compressor cutouts.

d. Low oil pressure cutout.

e. Low temperature cutout.

f. Anti-short-cycle timer for each compressor.

2. Unless otherwise specified, provide each system with a remote heating/cooling thermostat with heat-off-cool and fan on-auto selector switches.

I. Electrical Requirements

1. All units shall be factory wired with a unit mounted fusible disconnect, dual element time delay fuses, and single point power connection.

2. Unit voltages shall be as indicated on the drawings.

J. Accessories

1. Provide system accessories as indicated on the drawings, and as specified herein.

2. Outdoor Air Accessories

a. Provide each self-contained unit with a manual outdoor air damper unless an economizer is specified. Damper shall be adjustable up to 25% outdoor air, and shall be equipped with a rain hood, bird screen, and locking quadrant.

b. Economizer modules shall be complete with low leakage outdoor air and return air dampers, barometric relief damper, rain hood, bird screen, and modulating solid state dry bulb controls as specified below.

1. Economizer controls shall have an adjustable potentiometer for setting minimum outdoor airflow.
2. Controls shall enable the economizer when the outdoor ambient temperature is55 degrees F or below, and the space requires cooling.

3. Controls shall modulate the return and outdoor air dampers to maintain the conditioned space at design temperature.

3. Low ambient head pressure controls shall enable systems to provide DX cooling down to 0 degrees F, unless otherwise noted.

4. Vibration isolators shall be spring or rubber-in-shear type, provided by the equipment manufacturer for the specified installation.

K. Suggested Manufacturers

General purpose air conditioners and heat pumps shall be Carrier, McQuay, Rheem, Trane, York, or approved equal.

2.03 COMPUTER ROOM AIR CONDITIONERS

A. Indoor Units (Self-Contained and Split System)

1. Indoor unit cabinets shall be galvanized steel with baked enamel finish, tubular steel framing, 1-inch fiberglass insulation, removable service access panels, stainless steel drain pan, and integral filter holding frames.

2. Supply fans shall be double inlet, double width centrifugal type, statically and dynamically balanced, with fixed sheave belt drive and premium efficiency motors as defined in the most recent NEMA premium efficiency motor program with thermal overload protection. V-Belt drive to be sized for 150 percent of motor horse power. Contractor is to provide final set of sheaves required to meet final system TAB requirements (whether VFD or not).

3. Air filters shall be disposable pleated type, 20% ASHRAE efficiency, unless otherwise indicated.

4. Unit shall have a minimum SEER rating of 12.

5. Bearings shall be self-aligning, oil lubricated with reservoir, ball bearing type rated B10 with bearing life of not less than 250,000 hrs. Shop drawings shall bear manufacturer's certification of bearing life.

6. Installed vibration levels shall not exceed those specified in Section 23 05 48, "Vibration Controls for HVAC Pumps & Rotating Equipment".

7. Cooling Coils

a. Cooling coils shall be copper tube/aluminum fin, A-frame configuration.

b. Chilled water cooling coils shall be provided with modulating 2-way control valves, unless otherwise indicated.

c. DX coils shall be provided with a thermostatic expansion valve for each circuit.

d. DX coils shall have interwoven refrigerant circuits to utilize the full coil surface during single compressor operation.

8. Reheat Coils

a. Unless otherwise noted, DX systems 3 tons and larger shall be equipped with hot gas reheat coils with 3-way solenoid control.

b. Electric reheat coils shall be fin tubular type, low watt density, multi-stage, with thermal safety switches.

9. Humidifiers

a. Humidifiers shall be either infrared or steam generator type.

b. Humidifier functions shall be controlled by the unit microprocessor controls.

c. Infrared humidifiers shall have high intensity quartz lamps, stainless steel pan, and adjustable water supply overfeed to prevent mineral build-up.

d. Steam generator humidifiers shall have disposable canisters, supply and drain valves, steam distributor, and canister change alarm on the unit control panel.

10. Controls and Alarms

a. Unit controls shall be microprocessor based, and shall have the following features:

1. Temperature anticipation.

2. Moisture level humidity control.

3. Compressor sequencing and short cycle controls (DX units only).

4. Auto restart with sequential load activation.

5. Self-diagnostics

6. Auto shutdown by smoke detector signal.

b. Audible/Visual Alarms

1. High and low temperature.

2. High and low humidity.

3. Loss of airflow.

4. Humidifier malfunction.

5. Smoke detected in airstream.

6. Filter change needed.

7. Loss of power.

8 High compressor head (DX only)

9. Low suction pressure (DX only).

c. Each unit shall have a front mounted display panel for indication of room conditions, set points, diagnostics, and alarm conditions.

d. Unless otherwise noted, dual source system controls shall be factory set to utilize chilled water as the primary cooling source, and to activate DX cooling only when chilled water is unavailable or insufficient to meet demand.

11. Accessories

a. Unless otherwise noted, all units shall have the following accessories;

1. Non-locking electrical disconnect switch.

2. Ionization type smoke detector.

b. When specified on the drawings provide:

1. Floor stand - welded tubular steel construction with adjustable legs and vibration pads; height to match specified raised floor height.

2. Turning vane - galvanized steel construction, factory fabricated, designed for field installation under the floor stand.

3. Coil condensate pump - unit mounted, with integral reservoir and float switch; approximate capacity of 145 gph at 20 feet of head.

B. DX Cooling Systems

1. Systems up to 5 tons shall have high efficiency scroll or hermetic reciprocating compressors with vibration isolators, thermal overloads, crankcase heaters, and high and low pressure compressor cutout switches.

2. Systems larger than 5 tons shall have dual semi-hermetic compressors with vibration isolators, thermal overloads, oil sight glass, high and low compressor cutouts switches, suction line strainers, and forced lubrication.

3. Each refrigerant circuit shall have a liquid line filter/drier, sight glass with moisture indicator, externally equalized thermostatic expansion valve, liquid line solenoid valve, and service valves.

4. If split system component units do not have the specified refrigerant specialties factory installed, they shall be field provided per Section 23 23 00.

5. Single compressor systems shall have hot gas bypass or other means to accommodate low load conditions.

6. When specified on the drawings, dual compressor systems shall have unloading valves and controls to provide 4-step capacity control.

7. Motors shall be "premium efficiency" as defined in the most recent NEMA premium efficiency motor program.

C. Air Cooled Condensers and Condensing Units

1. Units shall be fabricated from aluminum or painted galvanized steel, with maintenance access panels and condenser fan guards.

2. Condenser coils shall be copper tube/aluminum fin with integral sub-cooling circuits, and shall be factory leak tested at 300 psig.

3. Unless otherwise indicated, condenser fans shall be vertical discharge, direct drive, propeller type.

4. Units larger than 5 tons shall have multiple fans with full width separation baffles.

5. Condenser fans shall have variable speed controls to provide cooling down to -20 degrees F ambient temperature.

6. Each unit shall have a factory installed disconnect switch and single point power connection.

7. Motors shall be "premium efficiency" as defined in the most recent NEMA premium efficiency motor program.

D. Suggested Manufacturers

Computer room air conditioning equipment shall be Liebert, Airflow, or approved equal.

PART 3 EXECUTION

3.01 Follow manufacturer’s installation instructions.

3.02 Provide clearances as specified by the manufacturer for maintenance access and proper air circulation.

3.03 Mount packaged air conditioners and air cooled condensing units (except roof mounted units) on concrete pads.

3.04 Adjust system controls to maintain design conditions as specified on the drawings.

3.05 Computer room unit start-up and warranty inspection shall be performed by a factory trained manufacturer's representative.

END OF SECTION

SECTION 23 83 00

RADIANT HEATING UNITS/ ELECTRIC DUCT HEATERS

PART 1 GENERAL

1.01 SUMMARY

This section specifies electrical resistance heating coils for mounting in HVAC ductwork.

PART 2 PRODUCTS

2.01 GENERAL

A. Electric duct heaters shall be UL-listed for zero clearance to combustible surfaces, and shall meet all applicable provisions of the National Electrical Code (NEC).

B. Duct heater capacities, types, configurations, sizes, and electrical power requirements shall be as specified on the drawings.

C. Units to be Energy Star/FEMP-Designated unless otherwise noted.

2.02 DUCT HEATER CONSTRUCTION

A. Heaters shall be suitable for mounting in both unlined duct and duct with 1"-thick ductliner.

B. Duct heater frames shall be fabricated from aluminized steel, reinforced with corner braces.

C. Open coil heating elements shall be 80/20 nickel/chromium resistance wire.

D. Finned tubular elements shall consist of 80/20 nickel/chromium wire encased in a steel tube with magnesium oxide filler and copper-plated steel fins.

E. Heating elements shall be supported with corrosion-resistant steel supports and ceramic bushings as required to prevent sagging and deflection.

F. The duct side of heater terminal boxes shall be factory-insulated.

G. Heaters for round duct installation shall be UL listed for that purpose, and shall have an integral round duct adaptor plate.

2.03 CONTROLS, INTERLOCKS, AND SAFETIES

A. Capacity control shall be of the type specified on the drawings.

B. Provide each duct heater complete with the following control, interlock, and safety devices, unless otherwise noted.

1. 2 automatic reset thermal cutouts.

2. 1 manual reset thermal cutout.

3. Differential pressure airflow switch.

4. Magnetic contactors.

5. Locking disconnect.

6. 24-volt control transformer.

7. Power and control circuit fusing per the NEC.

8. Pilot lights to indicate power on, each stage on, airflow loss, and over-temperature alarm.

C. When duct heaters with remote control panels are specified, the thermal cutouts and airflow switch shall be mounted in the heater terminal box. All other control, interlock, and safety components shall be mounted in the control panel.

2.04 SUGGESTED MANUFACTURERS

Electric duct heaters shall be Indeeco, Brasch, Valley Industries, Electric Heaters, Inc., or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install electric duct heaters per the design drawings and the manufacturer's recommendations.

B. Install ductwork as required to provide the minimum airflow velocity and upstream and downstream clearances recommended by the duct heater manufacturer.

C. When installing heaters in existing lined ductwork, remove ductliner as required to provide the manufacturer’s required upstream and downstream clearances from combustibles. Secure cut edges of liner to duct with adhesive. Provide metal nosing on leading edge of liner downstream of the heater.

D. Provide a duct access door on the downstream side of each duct heater per Section 23 33 00, "Duct Accessories".

E. Provide electrical disconnecting means at, or within sight of, the heater control panel.

END OF SECTION

SECTION 23 84 00

HUMIDITY CONTROL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

This section specifies duct mounted and area type humidifiers.

1.02 RELATED SECTIONS

A. Section 22 11 16 Domestic Water Piping

B. Section 22 30 00 Plumbing Equipment

C. Section 23 09 00 Instrumentation and Control for HVAC

D. Section 23 21 13 Above-Ground Hydronic Piping

E. Section 23 22 13 Above-Ground Steam & Condensate Piping

F. Section 23 30 00 HVAC Air Distribution

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Humidifier types, capacities, accessories, controls, and electrical requirements shall be as indicated on the drawings.

B. Humidifiers shall be UL listed.

C. Units to be Energy Star FEMP-Designated unless otherwise noted.

2.02 ELECTRONIC STEAM GENERATOR HUMIDIFIERS

A. Steam generator humidifiers shall have the following components and features.

1. Shall be “Ionic Bed” type.

2. Wall or floor mounted locking steel cabinet with a baked enamel finish.

3. Disposable steam generator cylinders, or reusable cylinders with replaceable electrodes.

4. Water supply connection with integral air gap.

5. Drain connection.

6. Fill and drain solenoid valves.

7 Single point power connection with power disconnect switch.

8. Unit mounted controls as specified below.

   a. Controls shall be microprocessor based, with proportional plus integral functions which optimize water level and conductivity, while maintaining 90 percent of steam output capacity during drain and fill cycles.

   b. Controls shall accept input signals from on/off humidistats or modulating humidity controllers with remote setpoint adjustment.

   c. Control system shall include an alphanumeric display, built-in diagnostics, and status lights.

B. Humidifier steam output capacities shall be field adjustable from 20 to 100 percent of full output.

C. Duct mounted steam distributors shall be designed to separate steam and condensate, distribute the steam evenly across the duct section, and drain the condensate back to the humidifier. Provide flexible steam hose of sufficient length to connect the steam distributor to the humidifier.

D. Area type humidifiers shall be provided with a remote or unit mounted blower assembly with integral steam distributor.

E. Provide one set of spare replacement cylinders or electrodes for each humidifier.

F. Electronic steam generator humidifiers shall be, Armstrong Humidiclean HC 4000 or equal.

G. Verify with factory that “Ionic Bed” type humidifier is suitable for humidification load specified.

2.03 STEAM-TO-STEAM HUMIDIFIERS

A. Steam-to-steam humidifiers shall include the following components and features.

1. Evaporation chamber - welded 18 gage 304 stainless steel construction with removable covers, quick-release latches, and 3/4 inch rigid foam insulation with foil facing.

2. Steam heat exchanger - constructed of 304 stainless steel tubing welded to box type stainless steel headers. Exterior of heat exchangers shall be Teflon coated to shed scale.

3. Drain Valves

   a. Unless otherwise noted, provide a brass or stainless steel manual drain valve.

   b. If noted on the drawings, provide automatic controls for an adjustable, timed, drain/flush cycle to reduce the frequency of cleaning.

4. Steam control valves - Modulating type with electric, electronic, or pneumatic actuator (as specified on the drawings) and inlet strainer.

5. Steam traps - float and thermostatic or inverted bucket type.

6. Water Level Controls

   a. Unless otherwise noted, provide a solid-state control module with teflon coated stainless steel water conductivity probe and solenoid actuated fill valve.

   b. If noted on the drawings, provide a stainless steel, float operated, water make-up valve and low water cut off switch in lieu of electronic level controls.

7. Steam dispersion tubes - duct-mounted, full-width, with flexible steam supply hose. Dispersion tubes shall be designed to separate the steam and condensate, distribute steam evenly across the duct section, and drain condensate back to the humidifier. Dispersion tubes shall have removable nylon inserts with calibrated orifices for proper steam distribution and rapid absorption.

B. Steam-to-steam humidifiers shall be Dri-Steem Model STS, Armstrong Series CS-10, or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Install humidifiers in accordance with drawing details and the manufacturer's instructions. Installation shall allow adequate clearances for maintenance and repair.

B. Interlock duct mounted humidifiers with high limit humidistats and airflow switches to prevent excessive humidification of the supply air stream.

C. Placement of duct mounted steam distribution/dispersion tubes shall be in accordance with the manufacturer's recommendations for proper steam absorption and condensate drainage.

D. Support flexible steam supply hoses to prevent trapping of condensate.

E. Provide an access door downstream of each duct mounted steam distributor per Section 23 33 00.

3.02 ELECTRONIC STEAM HUMIDIFIERS

A. Adjust capacity controls to provide the humidification capacity indicated on the drawings.

B. Drain lines from Humidifier to drain shall be copper.

3.03 STEAM-TO-STEAM HUMIDIFIERS

A. Install humidifier evaporation chamber level and rigidly supported to assure correct operation of water level controls.

B. The humidifier drain shall be trapped to the depth specified by the manufacturer for the humidifier capacity and duct static pressure.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

A. This section applies to basic requirements of electrical work included in the Contract. The contract shall include furnishing of all labor, equipment and materials necessary to install and make ready for use a complete Electrical System as indicated on the drawings and/or specified herein.

B. All provisions of the contract apply to work specified in each section of Division 26.

C. Drawings and general provisions of contract, including general and supplementary conditions of the contract shall apply to work of this section.

D. All work shall be done by electricians properly qualified to perform the work required.

E. All work shall be done in accordance with manufacturer's instructions and recommendations, except where the drawings, or these specifications, specifically indicate other instructions.

F. The provisions of specification sections in Division 01 (those beginning with the number 01 XX XX) shall apply to and form a part of the specifications.

1.02 ELECTRICAL DRAWINGS

A. The electrical drawings are intended to be diagrammatic and are based on one manufacturer's equipment. They are not intended to show every detail in its exact location, the exact dimensions, or all the details of the equipment. The Contractor shall verify the actual dimensions of the equipment proposed to assure himself that the equipment will fit in the available space.

B. Installation shall be within the limitations imposed by architectural, structural, and mechanical requirements, with adequate space for maintenance.

C. The Contractor shall field coordinate the planned location of all equipment before roughing-in as the final location may differ from that shown on the drawings. Device outlets, panelboards, disconnect switches, fixtures, etc. improperly placed because of failure to obtain this information shall be relocated and reinstalled at no additional cost to the Government.

D. Mounting heights, as shown on the drawings, shall be from finished floor to centerline of device boxes unless noted otherwise.

E. The Government reserves the right to change without additional cost, the location of any outlet shown on the drawings provided such change in location is not greater than 6' - 0" and is ordered changed before the rough-in work is installed.

F. Riser and other diagrams are schematic only and do not necessarily show the physical arrangement of the equipment. They shall not be used to obtain quantities or lineal runs of conduits.

1.03 JOB-SITE COPY OF DOCUMENTS

A. Maintain at the site, one copy of all drawings, specifications, addenda, approved shop drawings, change orders and other modifications, in good order.

B. As work progresses, maintain a complete and separate set of blackline prints of contract drawings to record work completed and changes from contract documents.

C. At completion of all electrical work, (whether from design drawings or written instructions) the Contractor shall furnish to the government marked prints showing an accurate record of as-built condition for acceptance.

1.04 EXISTING EQUIPMENT AND MATERIALS

A. Existing equipment, conduit runs and wiring are shown only as a guide, and may vary from that shown on the drawings.

1.05 INSPECTION

A. All work and materials shall be subject to the inspection of the Government Inspector or Engineer at any and all times.

B. The Contractor shall give the inspectors all necessary assistance.

PART 2 PRODUCTS

2.01 MATERIALS

A. All materials and equipment used on this project shall be new, in an unused condition when delivered to the site, and be approved for use by the Engineer.

B. All equipment and materials are required to bear the U.L. label. If UL approved equipment is not available, equipment shall be used which has been manufactured to recognized standards such as those of the National Electrical Manufacturer’s Association (NEMA). If neither UL nor other recognized equipment is available, the equipment used must be approved by the Engineer.

C. All electrical distribution and control equipment which are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.02 GOVERNMENT FURNISHED EQUIPMENT (GFE)

A. Receive and install the government-furnished equipment, if any, in accordance with the contract drawings, specifications and manufacturer's installation manual.

B. Connect all designated equipment, motor and control equipment furnished by the Government requiring an electric power supply. The Contractor shall provide all interconnecting control and annunciation circuits as indicated on the equipment vendor shop drawings and installation instructions.

C. Government-furnished equipment will be delivered to the Contractor at proper time as per construction schedule. Installation drawings shall be provided with the equipment, but the Contractor shall arrange with the manufacturer of the government furnished equipment for installation guidance, start-up and instructional services. These are required to validate the manufacturer's warranty.

PART 3 EXECUTION

3.01 SITE INSPECTION

A. Before making his bid, the bidder shall examine the site of work and ascertain for himself all physical conditions in relation to the work.

3.02 REMOVAL AND RELOCATION

A. The contractor shall remove or relocate electrical items as shown on the drawings. Contracting Officer or his/her authorized representative shall be contacted for disposal of all electrical items removed.

B. All existing wirings and exposed portion of raceways associated with electrical items to be removed or relocated shall be removed.

C. All existing embedded raceways associated with electrical items to be removed or relocated shall be abandoned in places, and capped at both ends. Wiring from the abandoned raceways shall be removed.

D. All the remaining circuits and raceways associated with electrical Items not to be removed or relocated shall be restored to its original configuration unless otherwise shown on the drawing.

3.03 CUTTING AND PATCHING

A. The Contractor shall do all cutting, drilling and patching that must be done in order that his work is properly installed. All work of this nature is subject to the following conditions.

1. All disturbed construction or finish must be repaired to original condition.

2. Structural work shall not be disturbed, except on approval of the Engineer.

3. In general, cutting through floors, walls and partitions is to be avoided and only where absolutely necessary will be permitted. When necessary, it shall be done by the Contractor in a careful manner and the opening filled around conduits as directed by the Engineer. Holes through concrete or masonry shall be made only with a core drill.

4. All masonry or other finish damaged or cut into during the installation of this work shall be replaced or repaired with materials of like kind and quality as the original materials by skilled labor experienced in that particular building trade.

3.04 PAINTING

A. Paint all exposed conduits, raceways, multi-outlet assemblies and panelboard trim as specified in Section 09 90 00, Architectural Painting.

B. Painting shall be done by a qualified licensed Painting Contractor.

C. Conduits, raceways, multi-outlet assemblies and panelboards in electrical equipment rooms, electrical closets and other "authorized personnel only" areas shall not be considered as exposed for the purpose of the above paragraph A.

D. Paint shall not cover nameplates or other identifying markers on equipment.

3.05 TESTS

A. All work shall be complete in every respect, tested and approved satisfactory to the Engineer with the regulations governing the installation.

B. The Contractor shall be responsible for making any and all tests necessary to insure against concealment of defective materials and/or workmanship.

C. The Contractor shall determine, by test, that all wiring and connections are free from shorts between wires and shorts to ground and that all circuits have proper continuity.

D. All defects shall be corrected and retested before installation of fixtures and equipment.

E. All miscellaneous systems shall be tested for conformity to specifications and for proper operation.

F. The Contractor shall test all three phase wiring systems for proper phase rotation.

G. The Contractor shall provide all equipment, materials and labor for the tests and shall make all tests determined necessary by the Engineer.

H. The Contractor shall provide a resistance test of the ground source and all cables and bus work to ground.

I. All feeders and branch circuits over 30A rated below 600 volts, shall be megger-tested between phase conductors and between phase conductors and ground, using a 1000 V megger. Tests shall be made upon completion of all connections and splices and insertion of all overcurrent devices. Tests shall indicate freedom from short circuits and ground.

J. All circuits, which under any circumstances could be paralleled, shall be tested for proposed phasing using hot-phasing or other approved techniques.

K. The full load running current of all motors shall be recorded. Overload heaters shall be inspected to verify that they are properly sized.

L. Full load current of all feeders serving single-phase loads shall be measured. If necessary, branch circuits shall be reconnected to achieve a good load balance on each phase.

M. Proper operation of all control and alarm circuits shall be demonstrated.

N. All protective devices shall be set, tested and calibrated in accordance with the approved coordination study.

3.06 DEMONSTRATION AND INSTRUCTION

A. The Contractor shall place the entire electrical system, including lighting, power, and miscellaneous systems in initial operation.

B. The Contractor shall demonstrate, by actual usage, the proper operation of each and all portions of the various systems to the User or his appointed representative. Follow-up instructional periods shall be provided as required in individual system's specifications.

3.07 RECORDS AND OPERATIONS DATA

A. Prepare one set of as-built (red-line) drawings specified in 1.03.C.

B. Furnish panel schedules on new panels and existing panels for which modifications are made per Section 26 24 16, para. 3.01 F&G.

C. Submit copies of the above data to the Engineer before final inspection is requested.

3.08 OPERATING AND MAINTENANCE MANUALS

A. Following completion of the Contract and prior to the instructional period and final acceptance of the Contract, the Contractor shall prepare Operation and Maintenance Manuals describing the electrical systems and equipment supplied by him, including the government-furnished equipment, if any.

B. Data included in the manuals shall include, but not be limited to, the following:

1. Copies of all data submitted under “Shop Drawings and Product Data."

2. Copies of all data required by "Records and Operational Data."

3, Test results for all testing conducted.

C. Manuals shall be of the loose-leaf type, in heavy-duty binders with a master index and plastic tab sheets indicating system or equipment described.

D. Manuals shall be submitted to the A/E prior to the project acceptance for his approval.

3.09 GUARANTEE

A. The Contractor shall guarantee the satisfactory operation of all material and equipment installed under the Contract, except as stated herein, and shall repair or replace, to the satisfaction of the Engineer, any defective material, equipment or workmanship, which may become evident within one year from the date of final acceptance. This shall include fluorescent and high-intensity lamps. Exception: Incandescent lamps shall be guaranteed for a period of two months from the above date.

3.10 ELECTRICAL POWER SHUTDOWN

A. The Contractor shall plan work in such a way that shut-down of electrical power is kept to a minimum. The Contractor shall coordinate with the Government Inspector for shut-down of electrical power.

END OF SECTION

SECTION 26 05 13

MEDIUM VOLTAGE CABLE

PART 1 GENERAL

1.01 SUMMARY

This section covers medium voltage cables, including shielded single conductor power cables, cable splices and terminations in manholes.

1.02 REFERENCES

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

A. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 3	Standard Specification for Soft or Annealed Copper Wire
ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

B. ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS1	Impregnated-Paper-Insulated, Metallic Sheathed Cable, Solid Type

C. FEDERAL STANDARDS (FED-STD)

FED-STD 228	Cable and Wire, Insulated; Methods of Testing

D. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 383	Standard for Type Test Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations

E. NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA WC 7	Cross-linked Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-66-524)

NEMA WC 8	Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-68-516)

F. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70-2008	National Electrical Code

1.03 DEFINITIONS

Medium voltage power cables shall mean all cables rated above 600 to 35,000 volts.

1.04 GENERAL REQUIREMENTS

Section 26 05 00, "Common Work for Electrical," applies to work specified in this section.

Certificates shall be provided showing that the cable manufacturer has made factory-conducted tests on each shipping length of cable. Certified copies of test data shall show conformance with the referenced standards and shall be approved prior to delivery of cable.

1.05 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, "Submittals," in sufficient detail to show full compliance with the specification:

SD-03 Product Data

Equipment and performance data and manufacturer's catalog data shall be provided for the following item:

Single-Conductor Shielded Cables

SD-06 Test Reports

Test reports for the following shall be in accordance with the paragraph entitled, "Field Testing," of this section.

Dielectric Absorption Tests
High-Voltage Tests

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be provided showing the recommended sequence and method of installation for the following:

Medium-Voltage Power Cables

1.06 CABLE VOLTAGE RATINGS

A. Medium-voltage power cables shall include single-conductor cables rated as follows, phase-to-phase, for grounded and ungrounded neutral systems.

B. Cables rated 15,000 volts, ungrounded neutral, shall be used on 12,470-Y / 7200 volt, three-phase, 60-hertz distribution systems.

1.07 SHIPMENT

A. Cable shall be shipped on reels such that the cable will be protected from mechanical injury. Each end of each length of cable shall be hermetically sealed and securely attached to the reel.

B. Minimum reel drum diameter shall be 14 times the overall diameter of the cable, unless otherwise specified.

PART 2 PRODUCTS

2.01 CONDUCTORS

Conductors shall be solid copper conforming to ASTM B 3.

2.02 CABLE IDENTIFICATION

Cables shall have a tape placed immediately under the outer jacket showing the name of the manufacturer, the year in which the cable was manufactured, and a unique number for identification purposes. Information shall be closely grouped on the tape at 1-foot intervals to permit complete identification.

2.03 SINGLE-CONDUCTOR SHIELDED CABLES

A. Single-conductor, ethylene-propylene-rubber-insulated, polyvinylchloride-jacketed, shielded cable shall be used for 12,470-volt phase to phase circuits.

B. Single conductor 15KV cable assemblies shall consist of: Class B stranded copper conductors, an extruded semiconducting shield over the conductors, 220 mils of ethylene propylene rubber insulation, an extruded semiconducting shield, a stranded copper neutral wrapped helically and a PVC jacket.

C. Single-conductor, ethylene-propylene-insulated, PVC-jacketed shielded cable shall conform to NEMA WC 8.

PART 3 EXECUTION

3.01 INSTALLATION

A. Medium-voltage cables shall be installed in accordance with NFPA 70.

B. Cable shall be installed in underground duct banks, and in conduit above and below grade as shown on the contract drawings.

C. Contractor shall ensure that radii of bends, potheads, fittings, cable risers, and other conditions are suitable for the cable and conform with the recommendations of the cable manufacturer.

D. Blowers shall be provided to force fresh air into manholes or confined areas where free movement or circulation of air is obstructed. Waterproof protective coverings shall be available on the work site to provide protection against moisture while a splice is being made. Pumps shall be used to keep manholes dry during splicing operations. Under no conditions shall a splice or termination be made with the interior of a cable exposed to moisture. A manhole ring at least 6-inches above ground shall be used around the manhole entrance to keep surface water from entering the manhole. Unused ducts shall be plugged and water seepage through ducts in use shall be stopped before the splice is started.

E. Duct Cleaning. Ducts shall be thoroughly cleaned before installation of power cables. A standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material in the line. Mandrel length shall be not less than 12-inches long and shall have a diameter 1/2 inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. Brush diameter shall be the same as or slightly larger than the diameter of the duct.

F. Pulling Cables in Ducts and Manholes.

1. Medium-voltage cables shall be pulled into ducts with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, cable grips, and lubricants. A sufficient number of trained personnel and equipment shall be employed to ensure the careful and proper installation of the cable.

2. Cable reel shall be set up at the side of the manhole hatch opening and above the duct or hatch level, allowing the cable to enter through the opening without reverse bending. Flexible tube guide shall be installed through the opening in a manner that will prevent the cable from rubbing on the edges of any structural member.

3. Pulling force for a cable grip on lead-sheathed cable shall not exceed 1,500 pounds per square inch of sheath cross-sectional area. A dynamometer shall be used in the pulling line to ensure that the pulling force is not exceeded. Pulling force for a nonmetallic-sheathed cable shall not exceed the smaller of 1,000 pounds or a value computed from the following equation:

   TM = 0.008 X N X CM

   Where: TM = maximum allowable pulling tension in pounds

   N = number of conductors in the cable

   CM = cross-sectional area of each conductor in circular mils

4. Cable shall be unreeled from the top of the reel. Payout shall be carefully controlled. Cable to be pulled shall be attached through a swivel to the main pulling wire by means of a pulling eye. Suitable cable grip permitted only on cables less than 200-feet long and less than 2 inches in diameter.

5. Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.

6. Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure.

7. Pulling eyes and cable grips shall be used together for nonmetallic sheathed cables to prevent damage to the cable structure.
   Minimum bending radius shall be eight (8) times the cable diameter unless indicated otherwise on drawings.

8. Cables shall be liberally coated with a suitable cable-pulling lubricant as it enters the tube guide or duct. Grease and oil lubricants shall be used only on lead-sheathed cables. Nonmetallic sheathed cables shall be covered with wire-pulling compounds when required which have no deleterious effects on the cable. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.

9. Cables shall be pulled into ducts at a speed not to exceed 50 feet per minute and not in excess of maximum permissible pulling tension specified by the cable manufacturer. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately with any indication of binding or obstruction and shall not be resumed until such difficulty is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.

10. Cable splices made up in manholes shall be firmly supported on cable racks as indicated. No cable splices shall be pulled in ducts. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing. Cables to be spliced in manholes shall overlap the centerline of the proposed joint by not less than 2 feet.

11. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture. Nonleaded cables shall be sealed with rubber tape wrapped down to 3 inches from the cable end. Rubber tape shall be cover-wrapped with polyvinylchloride tape.

G. Splices and Terminations.

1. Splices shall be made in manholes except where cable terminations are specifically indicated. Splicing and terminating of cables shall be expedited to minimize exposure and cable deterioration.

2. Cables shall be terminated using dry terminations with medium voltage pennants, preformed, or hand wrapped stress cones may be used for terminating cables.

3. Installation shall include built-up or prefabricated heat or cold shrink stress-relief cones at the terminals of all shielded cables rated 15 kV and above.

4. Cable splices shall be field fabricated from splicing kits supplied by and in accordance with the cable manufacturer's recommendations for the type, size, and electrical characteristics of the cable specified. Cable splices in manholes shall be located midway between cable racks on walls of manholes and supported with cable arms at approximately the same elevation as the enclosing duct.

3.02 FIELD TESTING

A. Each cable shall be subjected to dielectric-absorption tests and high-voltage tests after the installation of high-voltage power cables has been completed, including splices, joints, and terminations, and before the cable is energized.

B. Test equipment, labor, and technical personnel shall be provided as necessary to perform the electrical acceptance tests.

C. Arrangements shall be made to have tests witnessed and approved by the Contracting Officer.

D. Each power-cable installation shall be completely isolated from extraneous electrical connections at cable terminations and joints. Safety precautions shall be observed.

E. Each power cable shall first be given a full dielectric-absorption test with 2,500-volt insulation-resistance test set. Test shall be applied for a long enough time to fully charge the cable. Readings shall be recorded every 15 seconds during the first 3 minutes of test and at 1 minute intervals thereafter. Test shall continue until three equal readings, 1 minute apart, are obtained. Minimum reading shall be 200 megohms at an ambient temperature of 60 degrees F. Readings taken at other than 60 degrees F ambient temperatures shall be corrected accordingly.

F. Upon successful completion of the dielectric absorption tests, the cable shall be subjected to a direct-current high-potential test for 5 minutes with test voltages applied in accordance with NEMA WC 7 for cross-linked, polyethylene-insulated cable; and NEMA WC 8 for other cable types.

G. Leakage current readings shall be recorded every 30 seconds during the first 2 minutes and every minute thereafter for the remainder of the test. When the leakage current continues to increase after the first minute, the test shall be immediately terminated and steps taken to find and correct the fault. When a second test becomes necessary, this test procedure shall be repeated.

H. Upon satisfactory completion of the high-potential test, the cable shall be given a second dielectric-absorption test as before. Results of the second dielectric-absorption test shall agree with the first test and shall indicate no evidence of permanent injury to the cable caused by the high-potential test.

I. Test data shall be recorded and shall include identification of cable and location, megohm readings versus time, leakage current readings versus time, and cable temperature versus time.

J. Final acceptance shall depend upon the satisfactory performance of the cable under test. No cable shall be energized until recorded test data have been approved by the Contracting Officer.

END OF SECTION

SECTION 26 05 19

CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUMMARY

This section applies to wires and cables as indicated on the drawings for applications not exceeding 600 volts.

1.02 REFERENCES

The latest editions of the publications listed below form a part of this specification to the extent referenced and have the same force and effect as if bound into the contract documents.

A. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B173	Standard specification for rope-lay-stranded copper conductors having concentric-standard members for electrical conductors.
ASTM B3	Standard specification for soft or annealed copper wire.

B. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA	WC 5	Thermoplastic - Insulated wire and cable for transmission and distribution of electrical energy

C. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA	70-2008	National Electrical Code (NEC)

D. UNDERWRITERS LABORATORIES, INC. (UL)

UL	1581	UL Standard for Safety - Reference standard for electrical wires, cables, and flexible cords.
UL	83	UL Standard for Safety - Thermoplastic-Insulated wires and cables

E. FEDERAL SPECIFICATION (FS)

FS	J-C-30A	Cables and wire, electrical (power, fixed installation)

PART 2 PRODUCTS

2.01 WIRES AND CABLES

A. All wires and cables shall be copper unless specifically noted otherwise. All wires and cables shall conform to NFPA 70, UL 1581 and FS J-C-30A.

B. Building Wires: Building wires for use in conduits, raceways, and wireways shall be single conductor, 600 volt, heat and moisture resistant, and suitable for use in wet and dry locations. Building wires shall be selected as follows:

1. Wires of size 10 AWG or smaller shall be type THHN or THWN solid or stranded. Size 8 AWG and larger wires shall be stranded conductor type THWN or XHHW.

2. Minimum wire size shall be 12 AWG for power wiring, and 14 AWG for control wiring, unless noted otherwise.

C. Luminaire Wiring

Luminaire wire for outlet-box connection to incandescent-fixture lamp-holders shall be flexible seven-strand copper wire with insulation conforming to NFPA 70.

Luminaire wire for use in fluorescent fixture wiring channels shall be flexible seven-strand or solid copper wire conforming to NFPA 70.

D. Switchboard Wire

Switchboard wire used for instrument and control wiring on the back of switchboards and hinged-front instrument panels shall be single-conductor, 600 volt, flame and heat resistant insulated wire not smaller than No. 14 with a minimum temperature rating of 90 degrees C.

Conductor rigidly mounted on the back of switchboards and instrument panels shall be solid round, soft or annealed, copper wire conforming to ASTM B3. Hinge connections shall be rope-lay-stranded copper conductors, Class H, conforming to ASTM B173. All wires shall conform to ASTM B3 for soft or annealed copper wire, before stranding.

Switchboard wire shall be Type SIS with cross-linked thermosetting polyethylene insulation.

E. 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.

F. Standard Flexible Cable

Flexible multi-conductor cable shall conform to UL 1581 for control and power below 600 volts, non-instrumentation type. Cable shall contain one (green) grounding conductor and shall utilize a thermosetting or thermoplastic overall jacket (Type SJ, SJO, SO, STO, etc.), as specified in 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 WC5.

PART 3 EXECUTION

3.01 INSTALLATION

A. Wires shall be pulled in such a manner as to avoid kinking or abrasion to the insulation. Only approved lubricants shall be used. Oil or grease shall not be used to lubricate wire.

B. Make sure that all couplings and conduit connectors have pre-insulated bushings in place before pulling wires.

C. Where more than three current carrying conductors are installed in a single raceway, the minimum wire size shall be increased to comply with NEC Table 310-15 (B)(2)(a). Where the distance from the overcurrent device to the first outlet exceeds 100 feet, the minimum wire size shall be 10 AWG (120 volt circuits only).

D. Wiring shall be arranged as shown on the drawings. Combining of homeruns will not be allowed except as shown.

E. Use pulling means, including fish tape, cable or rope, which cannot damage, raceways or cables. Where pulling machines are used, use tension gages. Do not exceed manufacturer's conductor tension allowances.

F. Install exposed cable parallel and perpendicular to surfaces or exposed structural members and follow surface contours, where possible.

G. Keep conductor splices to a minimum. All circuit conductors for feeders shall be installed without splices.

H. Molded connectors (wire nuts) may be used for splicing size 10 AWG or smaller wires on lighting and receptacle circuits only. All other wiring shall be spliced only with lugs and terminal blocks.

I. Terminal lugs shall be mechanical clamp or compression type unless part of a circuit breaker or switch assembly. Set-screw type lugs in which the set-screw bears directly on the conductor shall not be used.

J. Install splices and tapes which have mechanical strengths and insulation ratings which are equivalent, or better than, those of conductors.

K. Use splices and tape connectors which are compatible with conductor material. Copper-to-copper wire splices shall use copper connectors.

L. Size all branch circuit and subdistribution circuits according to equipment nameplate rating and NEC.

M. The maximum voltage drop on any branch circuit shall not exceed 3% of the circuit supply voltage when measured at the load termination of the circuit.

N. Provide a separate ground bonding conductor inside of all flexible conduit (and liquid tight flexible conduit) in addition to integral bonding tape. Bonding conductor should run full length of flexible conduit.

O. Except where conductor sizes are indicated on the drawings, the following schedule shall be adhered to:

CIRCUIT OVERCURRENT DEVICE RATING	CONDUCTOR SIZE
20 amperes or less	12
30 amperes	10
40 amperes	8
50 amperes	6
60 amperes	6
70 amperes	4
80 amperes	4
90 amperes	2
100 amperes	2

P. Conductor length, size and type for parallel feeders, shall be identical.

Q. Color code the entire power wiring system as follows:

208Y/120 Volt System	480Y/277 Volt System
Phase A - Black	Phase A - Brown
Phase B - Red	Phase B - Orange
Phase C - Blue	Phase C - Yellow
Neutral - White	Netural - White
Ground - Green	Ground - Green

Isolated Ground – Green with yellow stripe.

3.02 FIELD QUALITY CONTROL

A. Prior to energization, test cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.

B. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

This section applies to low-voltage equipment grounding as indicated on the drawings and specified herein.

1.02 CODES AND STANDARDS

Comply with the latest edition of the provisions of the following codes, specifications, and standards, except where more stringent requirements are specified:

A. National Fire Protection Association (NFPA) Standard:

70-2008	National Electrical Code (NEC)

B. Institute of Electrical and Electronics Engineers (IEEE):

IEEE Std 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.03 QUALITY ASSURANCE

Provide only grounding products of the firms regularly engaged in the manufacture of grounding and bonding products (of types and ratings required) and ancillary grounding materials (including stranded cable, copper braid and bus, grounding electrodes and plate electrodes) and bonding jumpers, whose products have been in satisfactory use in similar service for not less than 5 years.

1.04 TESTING

All installed grounding electrodes and systems shall be resistance tested in accordance with IEEE STD 81 using the FALL-OF-POTENTIAL Method. Testing shall be conducted in the presence of the Government Inspector. Test results shall be documented and submitted as required by the Schedule of Submittals.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING

A. The Contractor shall provide electrical grounding systems and equipment as shown on the drawings including all materials, cable, connectors, welds, terminals, rods, electrodes, and bonding jumpers required for a complete system.

B. Grounding wires and bonding jumpers shall be copper unless otherwise noted.

C. Grounding wire sizes for service entrance and building steel grounding shall be minimum size as shown on the drawings.

D. Grounding rods shall be copper-clad steel rods not less than 3/4” diameter and not less than 10’ in length 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 a name or trademark of the manufacturer and the length of the rod in feet.

PART 3 EXECUTION

3.01 GROUNDING

A. Provide a complete equipment safety grounding system (“green wire” ground) for the entire electrical system as required by Article 250 of the NEC, and as specified herein.

B. Provide additional grounding as indicated on the drawings for an equi-potential ground plane system (ground grid) for the raised floor areas.

C. All grounding wire, lugs, jumpers and bus shall be copper.

D. Provide building grounding system if shown on the drawing. The building grounding system shall include grounding of steel framework, perimeter ground loop and ground rods. Steel framework of the building shall be grounded with driven ground rod at the base of every corner column and intermediate exterior column not greater than 60 ft apart. Grounding conductor shall be electrically connected to the ground rod and each steel column and shall extend around the perimeter of the building. Grounding-conductor loop around the perimeter of the building and the tap connections from the building steel to the ground loop shall be with bare 4/0 AWG copper ground wires. The perimeter ground loop shall be buried not less than 18 inches below grade and 2 ft from the building foundation.

E. All feeder and branch circuits shall contain an equipment ground wire. No flexible metal conduit of any kind or length shall be used as the equipment-grounding conductor.

F. Equipment grounding conductors and straps shall be sized in accordance with the NEC. Refer to feeder schedules for ground wire requirements which may exceed the NEC. All equipment-grounding conductors shall be provided with green insulation equivalent to the insulation on the associated phase conductors.

G. The equipment grounding system shall be installed so all metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames and portable equipment frames operate continuously at ground potential and provide a low impedance path for ground fault currents. The system shall comply with the National Electrical Code.

H. Where parallel feeders are used, each raceway shall contain an equipment ground conductor sized in accordance with NEC 250-122 for the combined parallel circuit amperage.

I. Grounding conductors shall be continuous and no splicing shall be allowed.

J. Receptacles shall be bonded to their outlet boxes with #12 copper straps.

<u>EXCEPTIONS</u>

1. Isolated ground receptacles shall have a dedicated equipment-grounding conductor connected at the point

where the grounded circuit conductor is connected to the grounding electrode. All isolated grounding conductors shall be green with yellow stripe.

2. Straps may be omitted if self-grounding devices are utilized.

K. Bond all separately derived power sources in accordance with NEC 250-30. In addition, equipment within a computer room shall be bonded to the equi-potential ground plane.

L. For computer equipment, installed on raised floor, provide flexible grounding jumpers between each piece of computer equipment and the raised floor. Provide two grounding jumpers per cabinet, attached at opposite corners. If several cabinets are bolted together in a string, only the jumper at each end of the string is required. Solidly bolt each end of the grounding jumper. At the computer cabinet end, bolt to a metal frame member. At the raised floor end, bolt to a stringer or pedestal. Do not use stringer bolt for attaching grounding jumper. Grounding jumper shall be #8 stranded copper.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

This section applies to hangers and supports for installation of electrical raceways, boxes, luminaires, etc. from the building structure as required by the National Electrical Code and as shown on the drawings.

1.02 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to construction and installation of the electrical supporting devices.

B. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA Std. Pub No. FB1, “Fittings and Supports for Conduit and Cable Assemblies.”

C. NECA Compliance: Comply with National Electrical Contractors Association’s Standard of Installation: pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

D. UL Compliance: Provide electrical components which are UL-listed and labeled.

PART 2 PRODUCTS

2.01 PROHIBITED MATERIALS

A. Nails, wires, perforated tape or plumber’s tape are unacceptable for support or securing of conduits.

B. Power actuated “Stud Gun” driven anchors are unacceptable unless specifically allowed by the engineer.

2.02 MATERIALS

A. General: Provide supporting devices; complying with manufacturer’s standard materials, design and construction in accordance with published product and as herein specified. Where more than one type of device meets indicated requirements, selection is Installer’s option.

B. Galvanized steel channels and associated support rods shall be selected to accommodate weight of associated raceway and wire. Manufacturers shall be of the following:

1. B-Line Systems, Incorporated
2. Elcen Metal Products Company
3. Greenfield Manufacturer Company, Incorporated
4. Midland-Ross Corporation
5. Power-Strut Division; Van Huffel Tube Corporation
6. Unistrut Division; GTE Products Corporation
7. Or approved equal.

C. Luminaire supports shall be as recommended by the manufacturer.

D. Anchors of adequate size to support the load, and of a type compatible with the construction method encountered shall be provided. Anchors shall be expansion or toggle bolt type, and be supplied by one of the following manufacturers:

1. Ackerman Johnson Fastening System Incorporated
2. Elcen Metal Products Company
3. Ideal Industries, Incorporated
4. McGraw Edison Company
5. Rawlplug Company, Incorporated
6. Star Expansion Company
7. Or approved equal

2.04 FABRICATED SUPPORTING DEVICES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gages: 3 inches and smaller, 20 gage; 4 inches to 6 inches, 16 gage; over 6 inches, 14 gage.

2. Steel-Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

3. Iron-Pipe: Fabricate from cast-iron or ductile-iron pipe; remove burrs.

4. Plastic-Pipe: Fabricate from minimum Schedule 40 PVC plastic pipe or pipe size as indicated on drawings; remove burrs.

B. Sleeve Seals: Provide sleeve seals from sleeves located in foundation walls below grade, or interior/exterior walls of one of the following:

1. Lead and Oakum: Caulked between sleeve and pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instruction and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA, NEC and ANSI/NEMA for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping, properly, from building structure. Install supports within maximum spacings indicated.

D. Individual conduits shall be secured with steel pipe straps or lay-in pipe hangers.

E. Multiple rows of suspended conduit shall be supported from trapeze style hangers.

F. Multiple runs of conduit on ceiling or wall surfaces shall be surface mounted using Unistrut steel channels or approved equal.

G. Ceiling support wires shall not be used for support of conduits.

H. Do not support lay-in luminaires from the ceiling support system. Support for lay-in luminaries shall be so arranged that each corner of each fixture is supported by hanger wire anchored to the structural member or to the structure to afford adequate anchorage. Supports for recessed fixtures shall have a minimum capacity of 150 pounds.

I. Tighten sleeve seal nuts until sealing grommets have expanded to form watertight seal.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES

PART 1. GENERAL

1.01 SUMMARY

A. This section applies to raceways and boxes required for routing, splicing, termination, and connection, of wires and cables indicated on the drawings and specified herein.

B. The scope of work shall include furnishing and complete installation of the equipment and materials covered by this section, with all auxiliaries, ready for use.

1.02 REFERENCES

The latest editions of the publications listed below form a part of this specification to the extent referenced and have the same force and effect as if bound into the contract documents.

A. American National Standards Institute (ANSI)

ANSI	C80.1	Rigid Steel Conduit
ANSI	C80.3	Electrical Metallic Tubing
ANSI	C80.5	Rigid Aluminum Conduit

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

C. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA	FB1	Fittings, cast metal boxes and conduit bodies for conduit and cable assemblies.
NEMA	RN1	Polyvinyl- Chloride (PVC), externally coated galvanized rigid steel conduit, and intermediate metal conduit.

NEMA TC3	PVC fittings for use with rigid PVC conduit and tubing.
NEMA TC7	Smooth-wall coil-able polyethylene electric plastic conduit.
NEMA 250	Enclosures for electrical equipment.

D. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70-2008	National Electrical Code (NEC).

E. UNDERWRITERS LABORATORIES INC. (UL)

UL 1	UL Standard for Safety - Flexible metal conduit.
UL 1242	UL Standard for Safety - Intermediate Metal Conduit.
UL 6	UL Standard for Safety - Rigid Metal Conduit.
UL 651A	UL Standard for Safety - Type EB and A rigid PVC conduit and HDPE conduit.
UL 651B	UL Standard for Safety – Continuous length HDPE conduit.
UL 50	UL Standard for Safety - Cabinets and Boxes
UL 514A	UL Standards for Safety - -Metallic outlet Boxes
UL 514B	UL Standard for Safety - Fittings for Conduit and Outlet boxes.
UL 797	Electrical Metallic Tubing
UL 870	UL Standard for Safety - Wireways, Auxiliary Gutters, and Associated Fittings.

UL 884	UL Standard for Safety - Underfloor Raceways and Fittings.

F. FEDERAL SPECIFICATIONS (FS)

W-F-406D	Fittings for cable, power, electrical and conduit, metal, flexible.
W-F-408E	Fittings for conduit, metal, rigid (thick-wall and thin-wall (EMT) type)
WW-C-540C	Conduit, metal, rigid; and coupling, elbow and nipple, electrical conduit; aluminum.
WW-C-566C	Conduit, metal, flexible.

PART 2 PRODUCTS

2.01 CONDUIT AND CONDUIT FITTINGS.

A. Rigid Steel Conduit: Rigid steel conduit including couplings, elbows, bends and nipples shall conform to the requirements of UL 6, ANSI C80.1 and FS WW-C-540C. Steel fittings shall be galvanized by the hot-dip process. Where indicated, in corrosive areas or in direct contact with earth, rigid steel conduit shall be PVC coated and conform to NEMA RN 1, Type 20.

B. Rigid Aluminum Conduit: Rigid aluminum conduit including couplings, elbows, bends and nipples shall conform to the requirements of UL 6, ANSI C80.5 and FS WW-C-540C.

Fittings for rigid aluminum conduit shall be threaded, and shall conform to NEMA FB1 and FS W-F-480E.

C. Electrical Metallic Tubing: EMT shall be rigid metallic conduit of the thinwall type in straight lengths, elbows, or bends and shall conform to ANSI C 80.3 and the requirements of UL 797.

Couplings and connectors shall be hex-nut expansion-gland type, Zinc or Calminum 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 FB1 and FS W-F-480E.

D. Rigid Plastic Conduit: PVC conduit shall not be lighter than schedule 40. Rigid PVC shall be the slip-joint solvent-weld type, and fittings shall be unthreaded solid PVC. Conduits and fittings shall conform to UL 651 and NEMA TC3.

E. Flexible Metallic Conduit: Flexible Metallic Conduit shall meet the requirement of UL 1 and FS WW-C-566C.

Liquid-tight 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 (adapters, electrical conduit).

Fittings for liquid-tight flexible metallic conduit shall meet the requirements of UL 514B. Type I (box connector, electrical), Class 3 liquid-tight flexible metallic conduit connectors.

Flexible metallic conduit fittings shall conform to FS W-F-460D.

F. High Density Polyethylene Conduits: HDPE conduits may be in discrete lengths or in continuous lengths from a reel. Rigid conduits shall conform to UL 651A. Coil-able conduits shall conform to UL 651 B and NEMA TC7.

2.02 WIREWAYS AND AUXILIARY GUTTERS

Wireways and auxiliary gutters for use in exposed, dry locations shall be 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 no less than 16 gage. Sheet metal component parts shall be cleaned, phosphatized, and coated with a corrosion-resistant gray paint.

2.03 SURFACE METAL RACEWAYS

Surface metal raceways shall conform to the requirements of NFPA 70. The minimum size shall equal or exceed the capacity of 1/2 inch trade size conduit.

2.04 BOXES

A. 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.

B. Interior outlet boxes shall be fabricated from galvanized flat rolled sheet steel, not less than 14 gage.

C. Outlet boxes at outdoor locations shall be fabricated from corrosion resistant cast metal face plates with spring-hinged waterproof caps suitably configured for each application, including face plate gaskets and corrosion resistant fasteners.

D. Junction boxes and pull boxes shall have screw-on covers or locking hinged covers. NEMA 1 boxes will be used indoors, NEMA 3R boxes or better shall be used outdoors.

E. Floor boxes shall be cast-iron, waterproof, adjustable type, with threaded conduit hubs and vertical adjusting rings, gaskets, floor-plates and screw-on covers. All conduit connectors and entry hubs shall be insulated or shall have insulated bushings.

PART 3 EXECUTION

3.01 Conduit shall be 3/4 inch diameter minimum unless indicated otherwise on the drawing.

3.02 Rigid steel conduits shall be used in outdoor locations, and in indoor exposed locations subject to damage, or below 6 feet in vehicle or cart traffic areas.

3.03 Rigid aluminum conduit is permitted in lieu of rigid steel conduit in sizes 2 inches and large in indoor locations.

3.04 PVC conduits shall not be used except in concrete enclosed underground duct or as shown on contract drawings.

3.05 HDPE conduits shall only be used underground directly buried in earth and in concrete. The installation shall conform to article 353 of NEC.

3.06 Electrical raceway connections to vibrating equipment and machinery such as A.C. units, condensors, fans, dry type transformers, etc., shall be made with flexible metallic conduit (liquid-tight in outdoor or underfloor locations).

3.07 Electrical metallic tubing (EMT) shall be used in all indoor locations except where indicated otherwise. For outdoor locations, use of Electrical metal tubing (EMT) is permitted if provided with UL approved internal seal and gasket, and installed 6 ft and more above grade.

3.08 Surface metal raceways shall be used only in finished areas and only where specifically noted on the drawings.

3.09 All new conduits in finished area shall be concealed unless specifically noted otherwise.

3.10 Grout around all conduits at ceiling, floor, and wall penetrations to provide air-tight seal. All floor slab, and fire-rated, wall penetrations shall be sealed with fireproof compound.

3.11 Group together exposed conduits in so for as possible. Install all conduits parallel or prependicular to the building surfaces. Mount on channel strut supports.

3.12 All conduits shall be rigidly supported to the building structure. The maximum spacing of support shall be as follows:

A. Vertical Runs- 10 Foot

B. Horizontal Runs- 8 Foot

C. Below Raised Floor- 5 Foot

D. Flex Below Raised Floor- Support Not Required

Conduits shall not be supported from suspended ceiling support wires.

3.13 All conduit bends shall be made with an approved conduit bender and no bend shall have a centerline radius less than six times the diameter of the conduit.

3.14 The electrical contractor is responsible for maintaining the structural integrity of all floors and walls after core drills for conduits are made.

3.15 Use stuff boxes and cork fittings to prevent entrances of water and debris during construction prior to completion of conduit installation.

3.16 Rigid steel conduit in direct contact with earth shall be PVC coated.

3.17 Install boxes and fittings where indicated. Complying with the manufacturer's instructions applicable requirements of the NFPA 70, and recognized industry practice.

3.18 Pull boxes that are not specifically shown on the drawings but are required for proper installation of the electrical system shall be installed by the electrical contractor.

3.19 Outlet boxes shall be rigidly supported from the building structure. Junction, and pull boxes, must also be independently supported unless all connecting conduits are rigidly supported within 3 ft. of the box.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES

PART 1. GENERAL

1.01 SUMMARY

A. This section applies to raceways and boxes required for routing, splicing, termination, and connection, of wires and cables indicated on the drawings and specified herein.

B. The scope of work shall include furnishing and complete installation of the equipment and materials covered by this section, with all auxiliaries, ready for use.

1.02 REFERENCES

The latest editions of the publications listed below form a part of this specification to the extent referenced and have the same force and effect as if bound into the contract documents.

A. American National Standards Institute (ANSI)

ANSI	C80.1	Rigid Steel Conduit
ANSI	C80.3	Electrical Metallic Tubing
ANSI	C80.5	Rigid Aluminum Conduit

B. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

C. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA	FB1	Fittings, cast metal boxes and conduit bodies for conduit and cable assemblies.
NEMA	RN1	Polyvinyl- Chloride (PVC), externally coated galvanized rigid steel conduit, and intermediate metal conduit.

NEMA TC3	PVC fittings for use with rigid PVC conduit and tubing.
NEMA TC7	Smooth-wall coil-able polyethylene electric plastic conduit.
NEMA 250	Enclosures for electrical equipment.

D. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70-2008	National Electrical Code (NEC).

E. UNDERWRITERS LABORATORIES INC. (UL)

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UL 6	UL Standard for Safety - Rigid Metal Conduit.
UL 651A	UL Standard for Safety - Type EB and A rigid PVC conduit and HDPE conduit.
UL 651B	UL Standard for Safety – Continuous length HDPE conduit.
UL 50	UL Standard for Safety - Cabinets and Boxes
UL 514A	UL Standards for Safety - -Metallic outlet Boxes
UL 514B	UL Standard for Safety - Fittings for Conduit and Outlet boxes.
UL 797	Electrical Metallic Tubing
UL 870	UL Standard for Safety - Wireways, Auxiliary Gutters, and Associated Fittings.

UL 884	UL Standard for Safety - Underfloor Raceways and Fittings.

F. FEDERAL SPECIFICATIONS (FS)

W-F-406D	Fittings for cable, power, electrical and conduit, metal, flexible.
W-F-408E	Fittings for conduit, metal, rigid (thick-wall and thin-wall (EMT) type)
WW-C-540C	Conduit, metal, rigid; and coupling, elbow and nipple, electrical conduit; aluminum.
WW-C-566C	Conduit, metal, flexible.

PART 2 PRODUCTS

2.01 CONDUIT AND CONDUIT FITTINGS.

A. Rigid Steel Conduit: Rigid steel conduit including couplings, elbows, bends and nipples shall conform to the requirements of UL 6, ANSI C80.1 and FS WW-C-540C. Steel fittings shall be galvanized by the hot-dip process. Where indicated, in corrosive areas or in direct contact with earth, rigid steel conduit shall be PVC coated and conform to NEMA RN 1, Type 20.

B. Rigid Aluminum Conduit: Rigid aluminum conduit including couplings, elbows, bends and nipples shall conform to the requirements of UL 6, ANSI C80.5 and FS WW-C-540C.

Fittings for rigid aluminum conduit shall be threaded, and shall conform to NEMA FB1 and FS W-F-480E.

C. Electrical Metallic Tubing: EMT shall be rigid metallic conduit of the thinwall type in straight lengths, elbows, or bends and shall conform to ANSI C 80.3 and the requirements of UL 797.

Couplings and connectors shall be hex-nut expansion-gland type, Zinc or Calminum 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 FB1 and FS W-F-480E.

D. Rigid Plastic Conduit: PVC conduit shall not be lighter than schedule 40. Rigid PVC shall be the slip-joint solvent-weld type, and fittings shall be unthreaded solid PVC. Conduits and fittings shall conform to UL 651 and NEMA TC3.

E. Flexible Metallic Conduit: Flexible Metallic Conduit shall meet the requirement of UL 1 and FS WW-C-566C.

Liquid-tight flexible metallic conduit shall be provided with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against mositure, 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 (adapters, electrical conduit).

Fittings for liquid-tight flexible metallic conduit shall meet the requirements of UL 514B. Type I (box connector, electrical), Class 3 liquid-tight flexible metallic conduit connectors.

Flexible metallic conduit fittings shall conform to FS W-F-460D.

F. High Density Polyethylene Conduits: HDPE conduits may be in discrete lengths or in continuous lengths from a reel. Rigid conduits shall conform to UL 651A. Coil-able conduits shall conform to UL 651 B and NEMA TC7.

2.02 WIREWAYS AND AUXILIARY GUTTERS

Wireways and auxiliary gutters for use in exposed, dry locations shall be 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 commerical quality no less than 16 gage. Sheet metal component parts shall be cleaned, phosphatized, and coated with a corrosion-resistant gray paint.

2.03 SURFACE METAL RACEWAYS

Surface metal raceways shall conform to the requirements of NFPA 70. The minimum size shall equal or exceed the capacity of 1/2 inch trade size conduit.

2.04 BOXES

A. 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.

B. Interior outlet boxes shall be fabricated from galvanized flat rolled sheet steel, not less than 14 gage.

C. Outlet boxes at outdoor locations shall be fabricated from corrosion resistant cast metal face plates with spring-hinged waterproof caps suitably configured for each application, including face plate gaskets and corrosion resistant fasteners.

D. Junction boxes and pull boxes shall have screw-on covers or locking hinged covers. NEMA 1 boxes will be used indoors, NEMA 3R boxes or better shall be used outdoors.

E. Floor boxes shall be cast-iron, waterproof, adjustable type, with threaded conduit hubs and vertical adjusting rings, gaskets, floor-plates and screw-on covers. All conduit connectors and entry hubs shall be insulated or shall have insulated bushings.

PART 3 EXECUTION

3.01 Conduit shall be 3/4 inch diameter minimum unless indicated otherwise on the drawing.

3.02 Rigid steel conduits shall be used in outdoor locations, and in indoor exposed locations subject to damage, or below 6 feet in vehicle or cart traffic areas.

3.03 Rigid aluminum conduit is permitted in lieu of rigid steel conduit in sizes 2 inches and large in indoor locations.

3.04 PVC conduits shall not be used except in concrete enclosed underground duct or as shown on contract drawings.

3.05 HDPE conduits shall only be used underground directly buried in earth and in concrete. The installation shall conform to article 353 of NEC.

3.06 Electrical raceway connections to vibrating equipment and machinery such as A.C. units, condensors, fans, dry type transformers, etc., shall be made with flexible metallic conduit (liquid-tight in outdoor or underfloor locations).

3.07 Electrical metallic tubing (EMT) shall be used in all indoor locations except where indicated otherwise. For outdoor locations, use of Electrical metal tubing (EMT) is permitted if provided with UL approved internal seal and gasket, and installed 6 ft and more above grade.

3.08 Surface metal raceways shall be used only in finished areas and only where specifically noted on the drawings.

3.09 All new conduits in finished area shall be concealed unless specifically noted otherwise.

3.10 Grout around all conduits at ceiling, floor, and wall penetrations to provide air-tight seal. All floor slab, and fire-rated, wall penetrations shall be sealed with fireproof compound.

3.11 Group together exposed conduits in so for as possible. Install all conduits parallel or prependicular to the building surfaces. Mount on channel strut supports.

3.12 All conduits shall be rigidly supported to the building structure. The maximum spacing of support shall be as follows:

A. Vertical Runs- 10 Foot

B. Horizontal Runs- 8 Foot

C. Below Raised Floor- 5 Foot

D. Flex Below Raised Floor- Support Not Required

Conduits shall not be supported from suspended ceiling support wires.

3.13 All conduit bends shall be made with an approved conduit bender and no bend shall have a centerline radius less than six times the diameter of the conduit.

3.14 The electrical contractor is responsible for maintaining the structural integrity of all floors and walls after core drills for conduits are made.

SECTION 26 08 00

COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section describes the formal commissioning and functional performance testing of selected electrical systems. It specifies the additional requirements and procedures with which the Contractor shall comply when noted on the drawings or in the Commissioning Plan.

B. If the Contractor is not required by the drawings and the Schedule of Submittals to perform the formal commissioning and functional performance testing described in this section, the Contractor is not relieved of the testing and acceptance requirements expressly stated elsewhere in this specification.

C. Electrical commissioning is mainly concentrated in lighting systems, generators, back-up power systems, alternative power sources (e.g. solar), and electrical power to HVAC systems.

1.02 SUBMITTALS

If required by the Schedule of Submittals, the Contractor shall submit the following:

A. A list of commissioning team members (SD-01) who will represent the Contractor in performance of the commissioning and functional performance testing at least two (2) weeks prior to start of commissioning and testing. Commissioning team members shall be familiar with the electrical system being installed and shall also be qualified as required in related sections of this specification.

B. A commissioning and testing schedule (SD-07), at least two (2) weeks prior to the proposed testing start date.

C. A listing of all testing equipment, identifying equipment calibration dates within one year of the testing date.

1.03 SEQUENCING AND SCHEDULING

The work described in this section shall begin only after all work required in related sections, including Section 23 09 00 “INSTRUMENTATION AND CONTROLS FOR HVAC,” Section 23 09 23 “DIRECT DIGITAL CONTROLS / UTILITY CONTROL SYSTEM,” and Section 23 05 93 “TESTING, ADJUSTING AND BALANCING FOR HVAC” has been successfully completed; and all test and inspection reports and O&M manuals required in these sections have been submitted and approved.

PART 2 PRODUCTS (NONE)

PART 3 EXECUTION

3.01 COMMISSIONING TEAM AND FUNCTIONAL PERFORMANCE TESTS

The Contractor shall designate team members to participate in the commissioning and functional performance testing specified herein. The Contractor shall designate an Electrical Representative. In addition, the Government will be represented by a Government Construction Management Inspector, a Government UCS representative, a Government Maintenance and Operations Representative, and a Government Commissioning Agent.

Each checklist included in the Commissioning Plan shall be completed by the commissioning team. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

3.02 COMMISSIONING CHECKLISTS

The Commissioning Plan will include a Pre-functional Checklist and a Functional Test List. The Pre-functional Checklist must be completed before Functional Testing begins.

A. Pre-functional Checklists – There will be a Pre-functional Checklist for each electrical system and subsystem. The purpose of the pre-functional checklist is to verify that all components of the electrical system are present, properly installed, and ready for functional testing. The Pre-functional Checklists are YES/NO lists. Any “NO” finding indicates that a component of the system is not properly installed and must be corrected.

B. Functional Test Lists – The purpose of Functional Testing is to demonstrate that the systems perform safely and as intended by the designer during all operating conditions.

3.03 TESTS

A. The commissioning and functional performance tests shall be performed in a manner which essentially duplicates the checking, testing, and inspection methods established in the related sections. Where checking, testing, and inspection methods are not specified in other sections, methods shall be established which will provide the information required. Requirements in related sections are independent from the requirements of this section and shall not be used to satisfy any of the requirements specified in this section.

B. The Contractor shall provide all materials, services, and labor required to perform the commissioning and functional performance tests.

C. A commissioning and functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test.

D. Functional performance tests shall be performed for all items noted in the Commissioning Plan. Tests shall prove all modes of operation, and shall verify the integration of UCS, electrical controls, and electrical equipment into a complete system. Fragmented checkout and testing of components by individual sub-contractors, although necessary, shall only be considered as preliminary to the required testing stated in this section. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

END OF SECTION

SECTION 26 22 13

LOW VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

This section applies to low voltage distribution transformer 500 KVA or less with primary and secondary voltages less than 600 volts as indicated on the drawing and specified herein.

1.02 REFERENCES

The latest edition of the publications listed below form a part of this specification to the extent referenced and have the same force and effect as if bound into the contractor documents.

National Electrical Manufacturer's Association (NEMA) Publication

ST-20	Dry Type Transformers for General Applications

1.03 CODES AND STANDARDS

Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are specified:

National Fire Protection Association (NFPA) Standard:

70-2008	National Electrical Code (NEC)

PART 2 PRODUCTS

2.01 MATERIALS

A. Transformers shall conform to NEMA ST-20. Size and rating of the transformers are shown on the drawings.

B. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include:

1. Hevi-Duty

2. General Electric

3. Sorgel/Square D

4. Westinghouse

5. Or approved equal

C. All transformers shall be factory-assembled, general-purpose, air-cooled, dry-type. The transformers shall have, as a minimum, four 2-1/2 percent taps, 2 above and 2 below rated primary volts.

D. The insulation system shall have a 220° C rating, with a 115° C temperature rise above 40° C ambient. The insulation system shall be capable of carrying a 15 percent overload without exceeding a 150° C rise in ambient temperature. The maximum temperature of the top of the enclosure shall not exceed a rise of 35°C above 40°C ambient temperature.

E. Provide terminal enclosure, with cover, to accommodate primary and secondary coil wiring connections and electrical supply raceway terminal connector. Equip terminal leads with connectors installed. Limit terminal compartment temperature to 75°C when transformer is operating continuously at rated load with ambient temperature of 40°C. Provide wiring connectors suitable for copper wiring. Cushion-mount transformers with external vibration isolation supports; Sound-level ratings not to exceed 50 db. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap. Provide transformers with fully-enclosed sheet steel enclosures. Apply manufacturer’s standard light gray indoor enamel over cleaned and phosphatized steel enclosure. Transformers rated 3-15 kVA shall be suitable for wall mounting.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount each transformer in the location shown in accordance with manufacturer's written instruction, applicable requirements of NEC and in accordance with recognized industry and in accordance with recognized industry practices to ensure that products fulfill requirements.

B. Transformers shall not be in physical contact with walls, ductwork, piping, or other building elements except for base and flexible conduit connection.

C. Mount each unit on pad type vibration isolators. Select isolators to match unit weight.

D. All conduit connections at the transformer end shall be of the flexible type. Minimum flexible conduit length is 24 inches and maximum 72 inches.

E. Coordinate transformer installation work with electrical raceway and wire/cable work as necessary for proper interface.

3.02 GROUNDING

A. Connect the grounding equipment conductors associated with primary and secondary feeders to the transformer ground terminal.

B. Provide bonding jumper between the secondary neutral and the transformer ground terminal. The size of the bonding jumper shall be as per NEC 250-28 (a).

C. Connect the secondary neutral terminal of the transformer to the building ground using grounding electrode conductor. The size of grounding electrode conductor shall be as per NEC 250-66.

3.03 IDENTIFICATION

Identify the transformer with an engraved laminated plastic identification Plate (1/4 inch white letters) permanently attached on the front of the transformer identifying transformer size, primary and secondary voltage, and the power source.

Example: 45KVA, 3PH
480V-208Y/120V
TRANSFORMER
FED FROM PANEL 0007

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

This section applies to panelboards as indicated on the drawings and specified herein.

1.02 REFERENCE

The latest edition of the publications listed below form a part of this specification to the extent referenced and have the same force and effect as if bound into the contract documents.

Federal Specification (FS)

W-P-115B	Panel, Power Distribution

1.03 CODES AND STANDARDS

Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are specified.

National Fire Protection Association (NFPA) Standard

70-2008	National Electrical Code (NEC)

PART 2 PRODUCTS

2.01 MATERIALS

A. The panelboards shall conform to FS W-P-115B, Type 1, Class 1 as shown on the drawing and as specified herein.

Cabinet and trim shall be of code gauge steel (minimum) with 4 inch (minimum) wiring gutter all around. All panelboards shall be equipped with a hinged, locking door. Two keys shall be furnished with each cabinet, and all locks on all cabinets shall be keyed alike. The panel shall have a continuous piano hinged cover for easy access to the interior of the panel.

B. Where panels occur adjacent to one another, cabinets and doors for each panel shall be of the same height.

C. Panelboards shall be painted with gray lacquer over rust preventative primer. Sides and top of surface mounted panels shall be painted to match fronts.

D. Panels shall be of the circuit breaker type, and shall have capacity and arrangement as shown on the panel schedules or one-line diagram.

E. Branch circuit breakers shall be bolt-on type and shall be of the ambient compensated, thermal magnetic type, which will provide inverse time delay overload, and instantaneous short circuit protection. Branch circuit breakers shall have one, two, or three poles as designated on the panel schedule. No circuit breakers utilizing handle ties for two or three pole operation will be acceptable. Voltage and current ratings shall be as indicated on the drawings.

F. Refer to panel schedules on drawings for exact circuit breaker arrangements and interrupting capacities.

G. Provide a typewritten directory for each panel, placed inside the panel door.

H. Each panel shall be equipped with a ground lug for feeder ground.

I. Each panel and cabinet and the units comprising same shall bear the manufacturer's nameplate and the U.L. label.

J. All three-phase, four-wire panels shall be equipped with a fully rated neutral bar.

All bus shall be 1000 ampere per square inch (APSI) copper.

Mounting hardware shall be provided for all future breaker spaces as shown on the panel schedule.

2.02 ACCEPTABLE MANUFACTURERS

A. Panelboards shall be Square "D" Company, G.E., Westinghouse, Siemens, or approved equal.

Breakers shall be manufactured by the respective panelboard manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount panels in locations shown, making sure that code-required clearances exist.

B. Where cabinets cannot be set fully flush due to shallowness of partition, trim protruding sides with approved metal or hardwood molding, fasten to cabinet so as to conceal intersection of wall and cabinet.

C. If panel is damaged during shipping or installation, damaged portion shall be sanded smooth and entire panel repainted.

D. Install panelboard in accordance with NEC 408.

E. Identify panelboards with an engraved laminated plastic nameplate (1/4-inch white letters) permanently attached to the front of the cover identifying panel name, voltage, amp rating, and power source from which it is energized. See Section 26 05 53, paragraph 2.03 Nameplate Colors for color coding of panelboard nameplates.

Example:

PANEL KDX, 208Y/120V, 100A
FED FROM PANEL VC

F. Provide and install schedule giving circuit number, amperage, and equipment served. Submit copy of schedule per schedule of submittals.

G. Where modification to an existing panelboard is required, update panelboard schedule to reflect work performed. Submit copy of updated panelboard schedule per schedule of submittals.

H. All spare breakers shall be kept in the off position upon completion of work.

END OF SECTION

SECTION 26 26 00

POWER DISTRIBUTION UNIT

PART 1 GENERAL

1.1 SUMMARY

This section of the specification applies to supply and installation of Power Distribution Unit (PDU) as indicated on the drawings and specification herein.

1.2 REFERENCES

Power Distribution Unit (60 Hz) shall conform to these specifications and, where applicable, the following standards as a minimum:

A. National Fire Protection Association (NFPA-70)

B. Underwriters' Laboratories (UL)

C. National Electrical Manufacturers Association (NEMA)

D. American National Standards Institute (ANSI)

E. American Society of Testing and Materials (ASTM)

F. Institute of Electrical and Electronics Engineers (IEEE)

G. Occupational Safety and Health Association (OSHA)

H. Federal Information Processing Standard Publication (FIPS PUB 94)

1.3 SUBMITTALS

The following shall be submitted with the power distribution unit as per Schedule of Submittals:

1.3.1 Pre- construction Submittals (SD-01)

a. Dimension and weight of PDU.
b. Dimension and weight of HV Junction Box.
c. Factory acceptance test procedures for approval.
d. Site acceptance test procedures for approval.

1.3.2 Shop Drawings (SD-02)

a. Dimensional plan and elevation of the power distribution unit.
b. Construction details of the enclosure.
c. Complete diagrams of all control and power connections.

1.3.3 Product Data (SD-03)

a. Component schedule for power distribution unit.
b. Manufacturers' catalog data for main input circuit breaker, secondary panels, branch circuit breakers, spike suppressor.

1.3.4 Test Reports (SD-06)

a. Factory Test Report for PDU.
b. Test Report for Computer Cables.
c. Site Acceptance Test Report.

1.3.5 Certificates (SD-07)

The manufacturer shall submit a copy of the specification with each sub-paragraph noted with the term, "compliance", "deviation", or "alternate".

By noting the term "compliance" it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviation.

By noting the term "deviation" it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.

By noting the term "alternate" it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. Any alternate shall be fully described as to what the manufacturer proposes to provide.

1.3.6 Manufacturer's Instructions (SD-08)

Preprinted material describing installation procedure of PDU, precaution and special tool requirements.

1.3.7 Operation and Maintenance Data (SD-10)

Complete sets of Operating and Maintenance manuals shall be provided. Instructions shall be provided in stiff vinyl three-ring binders with a master

index. In addition to hard copies CD ROM shall be provided as per section 01 33 00, paragraph 1.11 of TSRC-7. Information included in the O & M manual shall include general operating procedures , preventive maintenance and inspection recommendations, special tools and test equipment required, trouble shooting and spare parts listings.

1.3.8 Closeout Submittals (SD-11)

a. Manufacturer's completion certificate per paragraph 3.1 H of this specification.
b. Manufacturer's warranty certilficate per paragraph 3.2 of this specification.

PART 2- PRODUCT SPECIFICATION

2.1 POWER DISTRIBUTION UNIT (60 HZ)

The PDU shall be UL listed as a complete unit in accordance with UL Standard 478 for Electronic Data Processing Unit and Systems. The quantity and ratings of PDU shall be as indicated on the project drawing and specified herein.

A. Enclosure:

The PDU shall be enclosed in a code gage metal self-support structure to form one complete metal enclosed module. Complete structure shall be designed for bottom cable entry access and hinged door access to internal components to permit maintenance, inspection, test, and trouble shooting.

B. Input Breaker:

Input breaker shall be molded case, thermal-magnetic type with thermal inverse time tripping an instantaneous magnetic tripping on high fault currents. Minimum interrupting capacity must be 25 kA. The circuit breaker shall conform to NEMA standard AB-1 and UL standard 489. A shunt trip accessory shall be provided.

C. Transformer:

The PDU shall contain a step-down electro-statically shielded isolation transformer. The transformer shall have the following ratings unless specified otherwise on the drawings:

1. Power rating: As shown on the drawing.

2. K- Factor: K-13.

3. Primary windings: 480 volt, AC, 60 Hz, three phase, three wire with one ground.

4. Secondary windings: 208Y/120 volts, three (3) phase, (4) four wire, AC, 60 Hz.

5. Winding insulation: Primary and secondary winding shall be rated for 220 degree C.

6. Impedance: Minimum 3.5% +/- acceptable manufacturer's tolerance.

7. Harmonic distortion: 0.5% or less

8. Full load efficiency: 97% or better

9. Standards: NEMA ST-20, ANSI C33.4, ANSI C89.2.

10. Power transformer shall be open coil, common core, convection air- cooled, and mounted in power module cabinet. Thermal overload sensor (s) shall be imbedded in windings. Sensor (s) shall sound audible signal at winding temperature of 180 degree C and shut down module at 220 degree C. The primary windings shall be provided with six taps; two 2.5% full capacity above normal and four 2.5% full capacity below normal. Auto-transformer design and construction are not acceptable.

D. Secondary Panels:

1. The PDU shall be provided with two (2) – 42 pole panels.

2. The panel construction shall conform to NEMA Standard PB-1, UL-50, UL-67.

3. Each panel shall have a three pole thermal magnetic molded case main breaker sized for 125% of full load current.

4. Each panel shall have 225 ampere, three-phase copper bus, isolated fully rated neutral, and ground bar. Neutral and ground buses shall be drilled, tapped and provided with one terminal screw for each pole position.

5. The branch circuits shall have interrupting rating of not less than 10,000 amperes, rms symmetrical, 240 volts AC, 60 Hz

6. Provide breakers and blank spaces as per PDU schedule as shown on the drawing. All breakers shall be bolt-on type with thermal/magnetic protection. Each breaker shall clearly identify the “on” the “off”, and the “tripped” positions. Mounting hardware shall be provided for all blank spaces for future breakers.

7. Each panel shall be provided with type written panel directory identifying pole position, breaker size and number of pole, type of outlet and equipment served.

E. High Voltage Junction Box:

The power distribution unit shall be supplied with a high voltage junction box with main input power terminal blocks for connection of incoming AC power. A 10 foot high voltage main input power cable shall be provided for connection between the junction box and the PDU. The power cable shall consist of the appropriate size and number of phase conductors, and parity sized ground conductor inside a UL/CSA listed liquid-tight, flexible metal conduit. Conductor insulation shall be 90 degree C minimum. All conductors shall be copper.

F. Control Panel:

Control Panel shall be provided with the PDU and shall provide the following.

1. Fully guarded and illuminated Emergency Power Off (EPO) pushbutton to shunt trip the input circuit breakers. Provide provisions for remote trip.

2. Audible and visual alarm warning for transformer over-temperature/overload conditions.

3. Monitoring capability of the following parameters:

   a. Input and output voltage (L-L, L-N)
   b. Output current (each phase, neutral and ground)
   c. Output KVA

G. Spike Suppressor:

The PDU shall be provided with a spike suppressor as follows:

1. High energy metal oxide resistors.

2. Less than 1 nanosecond response time.

3. Clipping level shall be 184 volts at a system nominal 170 volt peak line voltage.

4. Peak current handling capability shall not be less than 15,000 amperes.

5. Energy absorption capability shall not be less than 200 joules.

H. The PDU shall include a computer-grade single point ground in accordance with FIPS Pub 94 and the requirements of the NEC. The isolation transformer neutral shall be solidly grounded in accordance with NEC.

I. Complete access to entire interior shall be provided by means of key locked hinged access doors.

J. Mount entire cabinet on heavy-duty swivel casters and permanent leveling jacks.

K. Remote Monitoring:

Provisions shall be provided for remote monitoring of the PDU. Provide the required controls and interfaces to provide the Owner with a two-wire communication circuit which is completely compatible with the Owner's central monitoring system. Provide the capability of monitoring the following parameters:

1. Input and output voltage (L-L, L-N)

2. Output current (each phase, neutral and ground)

3. Output KVA

4. Summary Alarm

L. Identification Tag:

The PDU shall be provided with an engraved laminated plastic identification tag with its KVA rating, input and output voltages and power source from which it is energized. The background color and letters will be as per section 26 05 53, paragraph 2.03.
Example:

4207 – PDU0001
50KVA, 3 PH
480V- 208Y/120V
FED FROM DISC. SW RM 147

M. Factory Test:

The manufacturer shall provide certified test reports with the PDU demonstrating that the unit has passed the following tests:

A. Overload Test: The PDU shall be connected to a resistive load bank and gradually brought to 100% rated current output (full load power output). The load shall be increased to 150% for 1 minute and returned to 100%. Input and output current, voltage and power shall be recorded.

B. Step load test: While at 100% rated load, the unit shall have load switched off then back on three consecutive times within 1 minute. Input and output current, voltage and power at The step shall be recorded.

C. Phases loss test: Input power shall have one phase disconnected. The output load shall be increased to 100% and held for 1 minute. Input and output current and voltage shall be recorded on all phases.

All tests above shall be conducted in such a manner as to demonstrate that output voltages remain within 5% of nominal for all time periods 1/60 second (one cycle) and above.

2.2. COMPUTER POWER CABLES

A. Construction

Provide computer power cables in accordance with the schedules on the drawings. The cables shall be 90 degree C insulated copper conductors, pairity sized neutral and grounding conductors in liquid-tight flexible metal conduit. The lengths of cables shall be based on the location of outlets as shown on the drawing. Provide at least 10 percent additional lengths to for any adjustment of location in the field.

B. Identification

Each cable shall be permanently labeled at each end with the assigned circuit number and cable length.

C. Testing

All cables shall be checked and tested after installation. Phase rotation, insulation resistance and ground integrity shall be verified.

PART 3 - EXECUTION

3.1 INSTALLATION AND TESTING

A. Install PDU in the location shown in accordance with manufacturer's instruction manual, applicable requirements of NEC and in accordance with recognized industry practices.

B. Connect the secondary neutral of PDU to the building ground and also to the raised floor supporting structure (signal reference grid) using grounding electrode conductor. The size of the grounding electrode conductor shall be as per NEC 250-66.

C. Install all computer power cables and outlets under raised floor as per drawings.

D. The manufacturer shall provide a complete functional test of the complete PDU at the site.

E. The manufacturer shall provide the services of a field service engineer for site testing and installation supervision for as many

days as required. Site testing may require weekend or overtime work.

F. Field service must be unlimited and must continue until satisfactory system operation and customer approval has been achieved.

G. All field service work shall be performed by the manufacturer's own trained employees. Locally subcontracted field service is not acceptable.

H. The manufacturer shall furnish a written report certifying that the equipment is installed and tested to the full satisfaction of the manufacturer.

I. The final acceptance is to be made after the equipment has been adjusted and has demonstrated (site acceptance test) that it fulfills the requirements of these specifications and supplier has furnished all required test documents in accordance with the specified testing procedures.

3.2 MISCELLANEOUS

The manufacturer shall warrant the equipment specified herein to be free from defects in material or workmanship. In the event any defects are discovered within 12 months from the delivery of such hardware, the manufacturer shall perform repairs or replacement, at its own option, of any defective products at no cost to the owner.

The manufacturer shall provide on-site training for the customer's personnel in the operation of the system.

Power Distribution Unit shall be provided with adequate lifting means and be capable of being rolled or moved into installation position and bolted directly to the floor without the use of floor sills.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 This section applies to wiring devices, such as wall switches, receptacles, floor outlets, weatherproof outlets and device plates.

1.02 REFERENCES

The latest editions of the publications listed below form a part of the specification to the extent referenced and have the same force and effect as if bound into the contract documents.

A. National Electrical Manufacturers Association (NEMA)

NEMA PR 4	Plugs, Receptacles and cable connectors of the pin and sleeve type for industrial use.
NEMA WD 1	General requirements for wiring devices.
NEMA WD 6	Wiring Devices- Dimensional requirements

B. National Fire Protection Association (NFPA)

NFPA 70-2008	National Electrical Code

C. Underwriters Laboratories, Inc. (UL)

UL 20	UL Standard for Safety - General use snap switches
UL 486A	UL Standard for Safety Wire Connectors

PART 2 PRODUCTS

2.01 MATERIALS

A. Wall Switches

Snap switches installed for the control of incandescent, HID, and fluorescent luminaires shall be industrial/institutional, heavy-duty, specification grade, general-purpose, non-interchangeable devices conforming to UL 20 and NEMA WD 1, as indicated.

Snap switches shall be the toggle type: Single-two-position devices rated 20 amperes at 277 volts, 60 hertz, AC only, and meet the requirements of UL 20.

All snap switches shall be made by the same manufacturer. All snap switches shall have ivory color handle unless indicated otherwise.

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.

B. Receptacles.

Receptacles shall be specification grade, 3 wire grounding, duplex, straight blade, and conforming to NEMA PR4, NEMA WD 1 and to NEMA WD configurations. All receptacles shall be ivory in color unless indicated otherwise. The receptacles shall be provided with one piece mounting strap with integral ground contacts, reinforced thermoplastic polyester base, low resistance contact blades, two screws per power terminal suitable for side and back wiring, with an impact resistant nylon cover.

Receptacles for 125V AC, 20A (NEMA 5-20R) shall be type 5362 of Hubbell / Pass & Seymour / Arrow Hart / Leviton / Bryant or equal.

Receptacles for 250V, AC, 20A (NEMA 6-20R) shall be Type 5462 of Hubbell / Pass & Seymour / Arrow Hart / Leviton / Bryant or equal.

Locking receptacles shall conform to NEMA WD 6. One plug shall be furnished with each locking receptacle.

Receptacles for 125V, AC, 20A locking (NEMA L5-20R), shall be Type 2310 of Hubbell / Pass & Seymour / Arrow Hart / Leviton / Bryant or equal.

Receptacles for 125V, AC, 30A locking (NEMA L5-30R), shall be Type 2610 of Hubbell / Pass & Seymour / Arrow Hart / Leviton / Bryant or equal.

Receptacles for 250V, AC, 20A locking (NEMA L6-20R), shall be Type 2320 of Hubbell / Pass & Seymour / Arrow Hart / Leviton / Bryant or equal.

Receptacles for 250V, AC, 30A locking (NEMA L6-30R), shall be Type 2620 of Hubbell / Pass & Seymour / Arrow Hart / Leviton / Bryant or equal.

Receptacles shall meet the requirements for retention of plugs, overload, temperature, and assembly security in accordance with NEMA-WD-1.

C. Floor Outlets

Convenience outlets installed in floors for connection to 120-volt AC, single-phase circuits shall consist of single or duplex receptacles enclosed in floor boxes with cover plates especially approved for this purpose.

D. Weatherproof Outlets

All convenience duplex receptacle outlets installed in outdoor damp or wet locations for connection to 120 VAC circuits shall be GFI type and shall be provided with while-in-use type weatherproof enclosure, Pass & Seymour #W1UC10-G or equal.

Receptacles Under Raised Floors

Receptacle outlets under raised floors shall be provided in cast aluminum boxes. A single gang box shall be shallow and have a 3/4" hub, Appleton FS-1-75-A or approved equal.

E. 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 corrosion-resistant steel, not less than 0.040-inch thick, with beveled edges, and a brushed satin finish. Mounting screws shall be corrosion-resistant steel with oval countersunk heads finished to match the plate.

F. Occupancy Sensors

UL listed. Occupancy sensors and power packs shall be designed to operate on the voltage indicated. Occupancy sensor mounting as indicated. Sensor shall have an LED occupant detection indicator. Sensor shall have adjustable sensitivity and adjustable delayed-off time range of 5 minutes to 30 minutes, minimum. Ceiling mounted sensors shall have 360 degree coverage unless otherwise indicated.

a. Ultrasonic sensor shall be crystal controlled and shall not cause detection interference between adjacent sensors.
b. Infrared sensors shall have a daylight filter. Sensor shall have a lens that is applicable for indicated usage.
c. Ultrasonic/Infrared Combination Sensors shall keep lights on if either the ultrasonic or infrared sensors detect movement.

G. Digital Time Switch

Provide digital time wall switch (Watt Stopper # TS-400 or equal) for total lighting load less than 800 watts at 120V or 1200 watts at 277V. For total lighting load more than 800 watts at 120V or 1200 watts at 277V, provide time switch with 24V control (Watt Stopper # TS-400-24 or equal) and associated power pack suitable for the application. The timer switch shall be provided with visual warning that flashes lights at 5 minutes and 1 minute prior to time-out.

PART 3 EXECUTION

3.01 INSTALLATION OF WIRING DEVICES AND ACCESSORIES

A. Install wiring devices and accessories as indicated, and in accordance with manufacturer’s written instruction, applicable

requirements of NEC, and recognized industry practices to fulfill project requirements.

B. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.

C. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.

D. Install galvanized steel wall plates in unfinished spaces.

E. Install wiring devices after wiring work is completed. Provide separate neutral conductor for each receptacle circuit. Do not put more than six current carrying conductors in one conduit for receptacle circuits unless indicated otherwise on the drawing.

F. Install wall plates after painting work is completed.

G. Install telephone/power service poles in accordance with final furnishings arrangement plan: plumb, true, and secure.

H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

I. Receptacles shall be mounted with the bottom of the receptacle 18 inches above the finished floor unless otherwise noted.

J. Switches shall be mounted vertically with the top of the switch 48 inches above the finished floor unless otherwise indicated. Notify engineer of any discrepancies before roughing in outlet and obtain a new location. Gang multiple switches at one location under a single multi-gang plate. Locate switches on strike side of door between 6 inch and 12 inches from edge of door frame.

K. Label all receptacles and switches indicating the source from which they are energized.

L. Locate occupancy sensor(s) as indicated and in accordance with the manufacturer's recommendations to maximize energy savings and to avoid nuisance activation and deactivation due to sudden

temperature or airflow changes and usage. Set sensor “on” duration to 15 minutes.

3.02 PROTECTION

Protect installed components from damage. Replace damaged items prior to final acceptance.

3.03 FIELD QUALITY CONTROL

A. Testing: Prior to energizing circuits, test wiring for electrical continuity and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing, test wiring devices and demonstrate compliance with requirements, operating each device at least six times.

B. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

This section applies to motor and circuit disconnects as indicated on the drawings and specified herein.

1.02 REFERENCE

The latest editions of the publications listed below form a part of this specification to the extent referenced and have the same force and effects as if bound into the contract documents.

A. National Electrical Manufacturer's Association (NEMA) Publications.

1.	KS 1	Enclosed Switches
2.	ICS 6	Enclosures for Industrial Controls and Systems
3.	250	Enclosures for Electrical Equipment (1000 Volts Maximum)

B. Federal Specifications (FS)

WW-C-375B	Circuit Breakers, Molded Case, Branch Circuit and Service

1.03 CODES AND STANDARDS

Comply with provisions of following codes, specifications, and standards, except where more stringent requirements and specified.

National Fire Protection Association (NFPA) Standard

70-2008	National Electrical Code (NEC)

1.04 QUALITY ASSURANCE

Each major component of equipment shall have, as a minimum, the manufacturer's name, address, and catalog or style number on a nameplate securely attached to the item of equipment. Nameplates for individual items of electrical equipment shall be as specified in referenced publications and shall be provided on each item of equipment.

PART 2 PRODUCTS

2.01 DISCONNECTS

Provide Type 3R enclosure for outdoor installations and Type 1 enclosure for indoor installations, in accordance with NEMA ICS 6 and NEMA 250, surface-mounted, Type HD in accordance with NEMA KS 1. Voltage and current rating shall be as shown on the drawings.

2.02 All switches shall be provided with ground lugs.

2.03 Provide solid neutral where shown on drawings.

2.04 FUSES

Fast-acting, one-time, current limiting, 200,000 asymmetrical interrupting capacity (AIC), Class RK1, 600V or 250V, sized as shown

2.05 MOLDED CASE CIRCUIT BREAKERS
Provide molded case circuit breakers to comply with FS WW-C-375B.

PART 3 EXECUTION

3.01 Locate each disconnecting device so it is easily accessible to, and visible from, the equipment serviced.

3.02 Mount motor and circuit disconnects in accordance with Articles 110-13 (a) and 300-11 of the NEC.

3.03 Ground motor and circuit disconnects in accordance with Article 250 of the NEC.

3.04 Identify the disconnect with an engraved laminated plastic name plate permanently attached to the front of the cover. Letters shall be 1/4-inch high and legend shall describe the equipment served, the power source, and fuse size (when applicable).

Example: Fusible DISC. SW for
Air Handling Unit No.1
60A, 480V, 3PH, 3W (45 A Fuses)
Fed from Panel 0007

END OF SECTION

SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

Motor control devices as indicated on the drawings and specified herein.

1.02 REFERENCE

The latest editions of the publications listed below form part of this specification to the extent referenced and have the same force and effect as if they were bound into the contract documents.

National Electrical Manufacturer's Association (NEMA) Standard:

250 Enclosures for Electrical Equipment (1000 volts maximum)

1.03 CODES AND STANDARDS

Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are specified.

National Fire Protection Association (NFPA) Standard

70-2008 National Electrical Code (NEC)

PART 2 PRODUCTS

2.01 MOTOR STARTERS

A. Rated in accordance with Article 440 of the NEC for hermetic motors and in accordance with Article 430 of the NEC for non-hermetic motors; UL-listed line voltage magnetic type, with thermal overload, low voltage protection, auxiliary interlocks, NEMA 1 general purpose enclosures, conforming to NEMA 250. Combination starters of the fusible disconnect, magnetic only circuit breaker, or thermal magnetic circuit breaker types shall be used as indicated on the drawing.

B. Combination starters shall have an internal control transformer with primary and secondary fuses. The control voltage shall be 120Vac.

Operating the disconnect switch or circuit breaker handle to the off position shall remove all power within the enclosure except at the line side of the disconnecting device.

C. A red LED type pilot light shall be mounted on the motor starter enclosure to indicate the motor running.

D. One spare set of Normally-Open type of auxiliary contacts shall be provided to interface with external controls to provide run indication.

2.02 MANUAL MOTOR STARTERS

Manually-operated toggle switch equipment with one thermal overload relay mounted in NEMA 1 enclosure.

PART 3 EXECUTION

3.01 Provide each motor with an individual motor starter unless the application is specifically excepted by Articles 430 and 440 of the NEC.

3.02 Install motor starters in accordance with the manufacturer's recommendations.

3.03 Install suitable sized thermal units in all motor starters. Do not jump or bypass thermal overloads.

3.04 Identify each motor starter with an engraved laminated plastic nameplate (1/4-inch white letters) permanently attached to the front of the cover with a legend describing the equipment served and the power source.

Example: Starter for Air Handling Unit No. 1 Motor
5HP, 480 V, 3P
Fed from Panel 0007

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.1 SUMMARY

This section of the specification applies to supply and installation of variable torque variable frequency drives as indicated on the drawing and specified herein.

1.2 REFERENCES

The variable frequency drives shall conform to these specifications and, where applicable, the following standards as a minimum:

A. National Fire Protection Association (NFPA 70).

B. Underwriter's Laboratories (UL)

C. National Electrical Manufacturing Association (NEMA)

D. American National Standard Institute (ANSI)

E. Occupational Safety and Health Association (OSHA)

F. Institute of Electrical and Electronics Engineers (IEEE)

1.3. SUBMITTALS

The following shall be submitted along with variable frequency drives as per Schedule of Submittals:

1.3.1 Pre-construction Submittals (SD-01)

a. Dimensional outline drawings, including maximum weight.
b. Factory acceptance test procedures for approval.
c. Site acceptance test procedures for approval.

1.3.2 Shop Drawings (SD-02)

a. Elementary power and control wiring diagrams
b. Enclosure outline drawings including front and side views of the enclosure, conduit entrance locations.
c. Drive nameplate detail with legend.

1.3.3 Product Data (SD-03)

a. Manufacturer's catalog data of the unit showing horsepower, voltage, maximum current ratings and the options provided.
b. Component list and manufacturer's catalog data of all the major components.

1.3.4 Test Reports (SD-06)

a. Factory test report.
b. Site acceptance test report

1.3.5 Certificates (SD-07)

The manufacturer shall submit a copy of the specification with each sub-paragraph noted with the term, "compliance", "deviation", or "alternate".

By noting the term "compliance" it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviation.

By noting the term "deviation" it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.

By noting the term "alternate" it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. Any alternate shall be fully described as to what the manufacturer proposes to provide.

1.3.6 Manufacturer's Instructions (SD-08)

Provide preprinted material describing installation procedure of the variable frequency drive, precaution and special tool requirements.

1.3.7 Operation and Maintenance Data (SD-10)

Complete sets of Operating and Maintenance manuals shall be provided. Instructions shall be provided in stiff vinyl three-ring binders with a master index. In addition to hard copies CD ROM shall also be provided. Information included in the O & M manual shall include general operating procedures , start-up settings of drive parameters, preventive maintenance and inspection recommendations, special tools and test equipment required, trouble shooting and spare parts listings.

1.3.8 Closeout Submittals (SD-11)

a. Manufacturer's completion certificate per paragraph 3.1 H of this specification.

b. Manufacturer's warranty information per paragraph 3.2 of this specification.

PART 2 PRODUCT SPECIFICATION

2.1 QUALITY ASSURANCE

A. The manufacturer of the ac drive shall be certified ISO 9001 facility.

B. The ac drive and all associated equipment shall be UL listed and labeled.

C. The ac drive shall be designed, constructed and tested in accordance with the applicable sections of the NEMA, NEC and OSHA standards.

D. All drive door mounted pilot devices shall be tested to verify for proper operation.

2.2 GENERAL DESCRIPTION

A. The ac drive shall convert the 60 Hz ac input power supply to variable frequency power using pulse width modulation technique.

B. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert 60 Hz, 3 ph ac input power to a fixed dc voltage. This power section shall be insensitive to phase rotation of ac input power supply.

C. The output power section shall change the fixed dc voltage to variable frequency ac voltage. This section shall utilize insulated gate bipolar transistors (IGBT) as required by the current rating of the motor.

2.3 CONSTRUCTION

A. The ac drive power converter shall be enclosed in NEMA Type 1, Type 12K or Type 3R enclosure as shown on the drawing. The enclosure will include an external operated circuit breaker type disconnect switch, industrial rated operator controls, user terminal strip connections and bypass controls.

B. All drives shall have a line reactor included in the enclosure.

C. The manufacturers IGBT technology shall reduce the voltage spike, commonly inherent with IGBT's, by modifying the DV/DT (turn-on profile).

D. The enclosure shall provide a full nameplate amp draw capacity over the entire range of carrier frequency (motor sound adjustments) rating marked on the nameplate.

E. The drives internal power connections shall be solid copper buss construction.

F. The enclosure shall provide dedicated user terminals for power and control device connections. All control wiring shall have permanent wire markings printed on the wire insulation. Both ends of control wiring shall contain wire markings as per control elementary diagram.

G. The combination enclosure shall contain ball-bearing fans for cabinet cooling and heat-sink cooling. The cabinet fan shall utilize a thermal sensor control on the IGBT board to control fan start-stop, optimizing fan life and protecting the board from overheating. Fans shall be accessible from the front and shall not require removal of the ac power drive converter to facilitate maintenance and/or fan replacement.

H. A mechanical interlock shall be provided to prevent the personnel from opening the drive door when the disconnect is in the "ON" position. It shall be possible for authorized personnel to defeat this interlock. Provision will be provided to padlock the disconnect in the "OFF" position.

2.4 APPLICATION DATA

A. The ac drive shall be capable of operating NEMA design B squirrel cage induction motor as indicated on the drawing.

B. The ac drive shall be sized to operate a variable torque load.

C. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 60 Hz.

D. Line notching, transients, and harmonics on the incoming lines shall not affect the drive performance.

E. The drive shall not require an input isolation transformer.

2.5 ENVIRONMENTAL RATINGS

A. The ac drive shall meet NEMA and UL standards.

B. The ac drive shall be designed to operate at an ambient temperature from -10 degree C to 40 degree C (14 degree F to 104 degree F).

C. The storage temperature range shall be -25 degree C to 65 degree C (-13 degree F to 149 degree F).

D. The maximum relative humidity shall be 95 percent at 40 degree C, non-condensing.

E. The ac drive boards shall be coated with a Conformal Coating to protect the boards from electrical shorts from dirty environments.

2.6 RATINGS

A. The ac drive shall be able to withstand voltage variations of -15% to + 10% and imbalance no greater than 3% without tripping or affecting the drive performance.

B. The ac drive shall operate from an input frequency range of 60 Hz ± 5%.

C. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.

D. The efficiency of the ac drive shall be 96 percent or higher at 100 percent speed and the rated load.

E. The ac drive shall have over current capacity of 110 percent for 1 minute.

2.7 PROTECTION

A. Upon power-up, the ac drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, dc power supply and control power circuit.

B. The ac drive shall be protected against short circuits, between output phases and ground. Over-voltage protection shall also be provided between phase to phase and phase to ground utilizing a Metal Oxide Varistors (MOVs).

C. The ac drive shall contain an incoming line reactor(s) to prevent harmonic distortions.

D. The ac drive shall have a minimum ac under-voltage power loss ride-through of 200 milliseconds (12 cycles).

E. The ac drive shall have programmable ride-through function, which will allow logic to maintain control for a minimum of one-second (60 cycles) without faulting.

F. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function shall provide up to 6 programmable restart attempts. The time delay before restart attempts shall be 30 seconds.

G. Upon loss of the analog process follower reference signal, the ac drive shall be programmable to display a minimum of the last four (4) faults.

H. The drive shall have thermal overload protection that is UL listed.

2.8 ADJUSTMENT & CONFIGURATIONS

A. The ac drive shall be factory programmed to operate all specified optional devices.

B. The acceleration and deceleration ramp times shall be variable form 0.05 to 9.999 seconds.

C. The memory shall retain and record run status and fault type of the past 8 faults.

D. The software shall have an energy economy function that, when selected, will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio shall be maintained during acceleration. The output voltage shall then automatically adjust to meet the torque requirement of the load.

2.9 KEYPAD DISPLAY INTERFACE

A. The keypad display interface shall offer the modification of ac drive adjustments via a touch keypad. All electrical values, configuration

parameters, I/O assignments, application action and activity function access, faults, local keycard control, adjustment storage, and diagnostics shall be in plain English. The keypad shall be “captive hardware” type, capable of programming or storing programs.

B. The display shall be a high resolution, LCD, backlit screen.

C. The keypads shall be both detachable and be interchangeable with the keypads of other VFDs.

D. The ac drive model number, torque type, software revision number, horsepower, output current, motor frequency and motor voltage shall be listed on the drive identification display as viewed on the LCD display.

E. The keypad interface shall be configured to display selectable outputs such as speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, dc voltage, motor thermal state, motor speed, and number of hours the drive has operated.

F. The operator terminal shall provide a main menu consisting of status, programming, drive configuration, and keypad operation. A hardware jumper lock shall protect drive setup from unauthorized personnel by limiting access to the programming and drive configuration menus. A software password shall be configured to limit access to all menus except status.

2.10 OPERATOR CONTROLS

A. The control power for the digital inputs shall be either 120VAC or 24VDC. The digital outputs shall be in the form of dry contacts capable of controlling 120VAC or 24VDC.

B. The internal power supply shall incorporate automatic current limitation that protects the internal power supply if incorrectly connected or shorted. The solid state logic output will be current limited and will not be damaged if shorted.

C. Two voltage free relay output contacts shall be provided. One of the contacts shall indicate ad drive fault status. The other contact shall indicate a drive run status.

D. The combination enclosure shall have following dedicated operator controls:

1. Hand-Off-Auto-Communication Selector Switch
2. AFC-Off-Bypass Selector Switch
3. Test-Normal Selector Switch
4. Power on (red) LED indicator
5. Drive Run (green) LED indicator
6. Drive Fault (yellow) LED indicator
7. Auto Mode (yellow) or Bypass Run (yellow) LED indicator

E. When indicated on the drawing, the combination enclosure shall include a 120 Vac smoke purge relay option. Upon receiving a user-supplied 120Vac signal, the smoke purge relay shall isolate the ac drive and run the motor at full speed on bypass.

F. The combination enclosure shall include terminal point connection for fire/freeze state interlock, to prevent drive or bypass operation.

2.11 MODES OF OPERATION

A. The ac drive shall include mechanically and electrically interlock isolation and bypass contactors complete with thermal overload relay, circuit breaker disconnect, control circuit transformer, Hand-Off-Auto-Communication selector switch, AFC-Off-Bypass switch and Test-Normal selector switch.

B. In Hand mode, the ac drive shall run at selected speed as set up by the use of key pad. In Off mode, the drive shall stop. In Auto mode, drive shall start and stop over a user supplied contact. This contact shall also start and stop at bypass when both Auto and Bypass modes are selected. In Auto mode, the speed control will be from the user supplied 4-20mA signal. In Communication mode, the start, stop and speed control shall be over network communication signals.

C. The operator shall have full control of the bypass starter by operation of the AFC-Off-Bypass selector switch.

D. The isolation contactor for the bypass shall be sequenced to provide motor isolation during a drive ready state of operation.

E. The Test-Normal selector switch shall provide test operation of the power converter while operating the motor in bypass.

2.12 SERIAL COMMUNICATION

A. The ac drive shall have serial communication option of METASYS N2.

B. In Hand, Off or Auto modes, the METASIS N2 shall be able to monitor all the drive status, such as, speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, dc voltage, motor thermal state, elapsed time and motor speed including the mode of operation of the drive.

C. In Communication mode, all monitoring and control function shall be through METASIS N2 serial communication system.

PART 3 EXECUTION

3.1 INSTATLLATION AND TESTING

A. Install ac drive in the location shown in accordance with manufacturer's instruction manual, applicable requirements of NEC and in accordance with recognized industry practices.

B. The manufacturer shall provide a complete functional test of the complete ac drive at the site.

C. The manufacturer shall provide the services of a field service or regional drive engineer for site testing and installation supervision for as many days as required. Site testing may require weekend or overtime work.

D. Field service must be unlimited and must continue until satisfactory system operation and customer approval has been achieved.

G. All field service work shall be performed by the manufacturer's own trained employees. Locally subcontracted field service is not acceptable.

H The manufacturer shall furnish a written report certifying that the equipment is installed and tested to the full satisfaction of the manufacturer.

I. The final acceptance is to be made after the equipment has been adjusted and has demonstrated (site acceptance test) that it fulfills the requirements of these specifications and supplier has furnished all required test documents in accordance with the specified testing procedures.

3.2 WARRANTIES & REQUIREMENTS

The manufacturer shall warrant the equipment specified herein to be free from defects in material or workmanship. In the event any defects are discovered within 12 months from the delivery of such hardware, the manufacturer shall perform repairs or replacement, at its own option, of any defective products at no cost to the owner.

The manufacturer shall provide on-site training for all of customer's required personnel in the operation and maintenance of the system. The manufacturer shall provide the VFD software for the customer's ability to modify the devices program. The manufacturer shall provide 24/7 technical assistance for system faults utilizing free 800 number accessibility.

END OF SECTION

SECTION 26 43 13

TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

PART 1 GENERAL

1.01 SUMMARY

This section applies to the quality, performance, and installation of transient voltage surge suppression devices -(TVSS) as indicated on the drawings and specified herein.

1.02 REFERENCE

The latest edition of the publications listed below form a part of this specification to the extent referenced and have the same force and effect as if bound into the contract documents.

70-2008	NFPA National Electrical Code (NEC)
1449, 1283	Underwriter's Laboratories, Inc. (UL)
1100 Section 8.6.1 C62.41, C62.45	ANSI/ IEEE
LS-1 2.2.7	NEMA

1.03 SUBMITTALS

The following submittals shall be furnished as per schedule of submittals:

A. Shop Drawings (SD-02)
Outline dimension drawing indicating mounting arrangement.
Schematic wiring diagram indicating rating and catalog number of each component.

B. Product Data (SD-03)
Catalog cuts and specification of complete equipment and individual components.

C. Certificates (SD-07)
Certified test data from individual third party testing laboratory documenting NENA LS and IEEE C62.41 performance, and the ability of the device to meet or exceed all requirements of this specification.
Completion certificate by the TVSS manufacturer's representative as per section 3.01 E of this specification.

PART 2 PRODUCTS

2.01 MATERIALS

A. The TVSS shall be of a parallel design with fast responding transient energy protection that diverts and dissipates the surge energy.

B. The TVSS, as a minimum, shall provide over-current and over temperature protection in the form of component level fusing to ensure safe failure.

C. The TVSS shall be UL listed at or above the available fault current level at the point of TVSS application, per UL 1449. The TVSS shall be marked with the short circuit current rating. The TVSS's short circuit rating shall be, as a minimum, the same rating as the panelboard to which it is connected.

D. Response Time:

The TVSS shall be self-restoring and fully automatic with a total response time not to exceed 1 nanosecond.

E. MCOV:

The maximum continuous operating voltage (MCOV) shall be capable of sustaining 115% of nominal RMS voltage continuously without degrading in accordance with NEMA LS-1.

F. Component Limitations:

The TVSS shall only use solid-state clamping components to limit the surge voltage. TVSS components that "crowbar" short-circuit the AC power system (e.g. spark gaps, gas tubes, selenium cells, or SCR's) shall not be acceptable.

G. Protection Modes:

The TVSS system shall provide (per IEEE Std. 1100-1999 8.6.1 & NEMA LS-1 2.2.7) dedicated, independent, distinct protection circuitry for every possible mode in the electrical distribution system at the point of TVSS application. For example, a 480Y/277V, 3-phase Wye, 4-wire plus ground system has 10 distinct modes that require independent and dedicated protection (i.e., L1-L2, L2-L3, L3-L1, L1-N, L2-N, L3-N, L1-G, L2-G, L3-G, N-G). Reduced mode TVSS with only 3, 4, or 7 dedicated, distinct, independent protection modes are not acceptable and are not to be submitted. For 6 mode delta systems, 6 dedicated, independent, distinct protection modes are required (L1-L2, L2-L3, L3-L1, L1-G, L2-G, L3-G). When a mode of protection is specified, the protective mode must be specifically included. Thus, Line-to-Neutral-to-Line is not acceptable where Line-to-Line is specified.

H. Status Indicators:

TVSS units shall have panel front status monitors as a minimum to indicate a continuous positive status of each protected phase.

I. Equipment Certification:

Items shall be listed by Underwriters Laboratories, shall bear the UL seal, shall bear the Marking “UL 1449 Listed”, shall have been tested under UL 1449, and shall be marked in accordance with the referenced standard. TVSS units shall be UL 1283 Listed as an Electromagnetic Interference Filter and marked accordingly.

J. Circuit Configuration:

The circuit configuration of the suppression units shall be bi-directional, thermal stress reducing, totally encapsulated, custom parallel, and solid state. (Series units or units equipped with “load carrying” components are expressly prohibited due to the possibility of single point series failures causing power interruption to protected loads.)

K Enclosures:

Unless otherwise noted, provide NEMA 1 or better enclosure for indoor mounting and NEMA 4 enclosure or better for all outdoor locations. All units will contain Form C, N/O or N/C, dry relay contacts, if so specified, and weatherproof fittings to maintain the required NEMA integrity.

L. Maintenance Restrictions:

No suppression unit shall be supplied which requires scheduled preventive maintenance or replacement parts (lights and fuses excluded). Units requiring functional testing, special test equipment, or special training to monitor surge protection device (SPD) status are not acceptable. TVSS shall require NO routine maintenance. TVSS devices are considered non-repairable items.

M. Commonality:

All new SPDs provided shall be from the same manufacturer.

N. All SPDs shall meet or exceed the following performance criteria:

Service Entrance (Category C):

The TVSS shall provide a minimum protection of **240kA per phase** and be capable of meeting the Category C3 Measured Limiting Voltage criteria as shown in the Section 2.02, below.

Building Distribution Panels (Category B):

The TVSS shall provide a minimum protection of **180 kA per phase** and be capable of meeting the Category B3/C1 Measured Limiting Voltage criteria as shown in the Section 2.02, below.

Branch Panels/Panelboards *(Non-Electronics)* (Category A):

The TVSS shall provide a minimum protection of **120kA per phase** and be capable of meeting the Category B3/C1 Measured Limiting Voltage criteria as shown in the Section 2.02, below.

Branch Panels/Panelboards *(Electronics)* (Category A):

The TVSS shall provide a minimum protection of **120kA per phase** and be capable of meeting the Category A1 Measured Limiting Voltage criteria as shown in the Section 2.02, below.

2.02. UL 1449 MEASURED LIMITING VOLTAGE:

The TVSS shall meet the Measured Limiting Voltage (let-through voltage) requirements shown in the tables below for voltage and locations specified. Measurements shall be taken with the surge applied at a point where the TVSS leads extend 15 cm (6 inches) from the SPD enclosure. No data measured at a module, lugs, component, or undefined will be accepted. Surge shall be applied at 90° phase angle unless otherwise indicated below. Scope Settings: Time Base = 20 microseconds, Sampling Rate = 250 megasamples/sec. These settings

assure Let-through Voltage test results are accurate. SPDs shall meet the following criteria:

A. Service Entrance

ANSI/IEEE **Cat. C3 Impulse Wave** The let-through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Cat. C3 Impulse Wave (20kV, 10,000amps) at the 90 degree phase angle, shall be less than (values are total let-through voltage (LTV) measured from the insertion point of the transient on the sine-wave to the peak of the transient):

Mode / Voltage	208Y/120V	480Y/277V	480V, 3ØΔ
L-N	950V	1200V	N/A
L-L	1160V	1425V	1420V
L-G	850V	1050V	1420V
N-G	870V	1350V	N/A

B. Distribution and Branch Panels/Panelboards (Non-Electronics):

ANSI/IEEE **Cat. B3/C1 Combination** Wave Impulse Let-Through Voltage: The let-through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Cat. B3/C1 Combination Wave Impulse (6kV, 3000 amps) at the 90 degree phase angle, shall be less than; (values are total let-through voltage (LTV) measured from the insertion point of the transient on the sine-wave to the peak of the transient):

Mode / Voltage	208Y/120V	480Y/277V	480V, 3ØΔ
L-N	430V	565V	N/A
L-L	650V	955V	650V
L-G	450V	600V	650V
N-G	480V	890V	N/A

C. Branch Panels/Panelboards *(Electronics*)

ANSI/IEEE **Cat. A1 Ring Wave** Let-through-Voltage: The let-through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Cat. A1 Ring Wave (2kV, 67 amps, 100kHz ring wave) at the 270 degree phase angle, shall be less than; (values are total let-through voltage (LTV) measured from the insertion point of the transient on the sine-wave to the peak of the transient):

Mode / Voltage	208Y/120V	480Y/277V	480V, 3Ø∆
L-N	50V	75V	N/A
L-L	60V	155V	150V
L-G	65V	120V	150V
N-G	40V	400V	N/A

2.03 WARRANTY

All TVSS devices shall be warranted to be free from defects in materials and workmanship under normal use in accordance with the instructions provided for a period of twenty-five (25) years.

Any TVSS device which shows evidence of failure or incorrect operation, including damage as the result of lightning strikes, during the warranty period shall be replaced as a complete unit (not just modules, subassemblies, or components) by the manufacturer at no charge to the owner. Warranty will provide for multiple exchanges of any inoperable devices at any time during the warranty period which starts at the date of substantial completion of the system to which the surge suppressor is installed.

2.02 ACCEPTABLE MANUFACTURERS

All surge suppression devices shall be manufactured by an ISO 9000 – 2000 certified company normally engaged in the design, development, and manufacture of such equipment. The acceptable manufacturers include Surge Suppression, Inc., Northern Technologies, Control Concepts, Liebert Corporation or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide surge suppressor at distribution and panelboard locations as indicated on the drawings. The TVSS device shall be located immediately adjacent to the panelboard being protected (close-nipple to panel-boards).

B. Install the TVSS with #10 AWG minimum conductors to a dedicated 30-amp breaker(s) in panel per manufacturer's installation instructions and close to the Neutral Bus. The dedicated breaker shall serve as a means of disconnect for the surge protection device (SPD). If a dedicated breaker is not provided, an SPD with internal 30-amp fuse or a UL Listed fused disconnect switch shall

be installed as a minimum. The conductors serving the TVSS shall be kept at the minimum length (not more than 18 inches) and shall be twisted together (one twist per 12” of wire) to reduce the TVSS system input impedance. The TVSS shall be installed in accordance with the manufacturer’s recommended practices and in compliance with N.E.C. requirements.

C. The electrical contractor shall verify the proper application of the TVSS (i.e., voltage, phases, etc.). The electrical contractor shall assure that all Neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated TVSS. The electrical contractor will ensure that neutral-to-ground bonds do not exist at locations that are not service entrances or newly derived power sources.

D. The electrical contractor shall furnish all labor, materials, equipment, and services necessary for and incidental to the installation of the TVSS system components as specified herein.

E. A TVSS manufacturer trained representative must be available to witness installation of products and to provide technical advice. The specifying engineer will not approve the installation of these TVSS devices until the installation has been inspected and approved by the TVSS manufacturer’s factory trained representative. The TVSS manufacturer’s factory trained representative shall provide a certificate attesting to the proper installation of the TVSS devices to the specifying electrical engineer prior to the engineer’s inspection of the electrical installation.

F. The electrical contractor shall coordinate with other electrical work as necessary to interface installation of the transient voltage surge suppression systems with other work on the site.

END OF SECTION

SECTION 26 51 00

INTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY.

This section applies to luminaires, complete with lamps and hangers as indicated on the drawings and specified herein.

1.02 CODES AND STANDARDS.

Comply with provisions of following codes, specifications and standards, except where more stringent requirements are specified:

National Fire Protection Associates (NFPA) Standard:

70-2008 National Electrical Code (NEC).

1.03 QUALITY ASSURANCE.

Each major component of equipment shall have, as a minimum, the manufacturer's name, address, and catalog or style number on a nameplate securely attached to the item of equipment. Nameplates for individual items of electrical equipment shall be as specified in referenced publications and shall be provided on each item of equipment.

PART 2 PRODUCTS

2.01 LAMPS:

Lamps shall be included with all new light fixtures.

All linear fluorescent lamps shall be biomercury, high efficiency, rapid start T8 type, 3500 °K color temperature with CRI of 80 as minimum, unless otherwise indicated on the drawing.

Incandescent lamps shall not be used unless specified on the drawings.

2.02 FIXTURES:

Fixtures shall be of the wattage and type listed on the drawings, suitable for the exact type of ceiling in which the fixture is installed.

2.03 BALLAST:

Fluorescent fixtures shall have CBM and ETL approved, Class P, high efficiency (PF=.95 minimum & BF between 0.85 and 1.0), universal voltage (120V/277V), low THD (less than 10%), instant start, electronic ballast, unless shown otherwise.

All electronic dimming ballasts controlled by the same controller shall be of the same manufacturer.

Ballasts for compact fluorescent fixtures shall be programmed start.

2.04 EMERGENCY LUMINAIRES

The emergency luminaires with battery packs shall be provided with self-diagnostic test feature which shall automatically perform diagnostic routine test at least once every 30 days.

2.05 EXIT SIGNS

The exit signs shall be internally illuminated, self-luminous, non-electric type in which the light is generated by the action of tritium gas on a phosphorescent material and shall be rated for twenty (20) year life while meeting the minimum required UL brightness, unless otherwise indicated.

All exit signs shall be UL listed, meet the requirements of OSHA regulations and NFPA Life Safety Code 101, and shall be licensed by the US Nuclear Regulatory Commission.

The manufacturer of exit signs shall furnish a written statement confirming acceptance of all returned exit signs for disposal after the end of life.

PART 3 EXECUTION

3.01 Structurally support all luminaires. Suspend pendant mounting fixtures from bar joists or other structure using channel and/or anchors and threaded rod. Support lay-in fixtures on each corner with hanger wire as indicated in paragraph 3.01H of Section 26 05 29. Install all fixtures at the height indicated on drawings. Provide fixture studs as necessary. Secure surface mounted fixtures to masonry walls with bolts and lead anchors or to dry-wall partitions and ceilings with sheet metal screws into metal or wood studs.

3.02 Route conduit for lay-in fixtures so as not to interfere with ceiling tile removal.

3.03 Flexible metal conduit may be used from J boxes to fixtures or from fixture to fixture with lengths as permitted by the NEC.

3.04 1/2" conduit may be used for switch legs only.

3.05 Provide mounting bracket for emergency luminaires.

3.06 Emergency lights and exit signs shall be connected to the normal lighting circuit ahead of the control switch.

3.07 All fluorescent lamps on electronic dimming ballast control shall be seasoned or burned in at full light output for 100 hours before dimming.

3.08 Install lights in accordance with the NEC.

END OF SECTION

SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SUMMARY.

This section applies to exterior luminaires, complete with lamps and hangers as indicated on the drawings and specified herein.

1.02 CODES AND STANDARDS.

Comply with provisions of following codes, specifications and standards, except where more stringent requirements are specified:

National Fire Protection Associates (NFPA) Standard:

70-2008 National Electrical Code (NEC).

National Electrical Manufacturer's Association (NEMA)

NEMA C78.42 High-Pressure Sodium Lamps

NEMA C78.43 Metal-Halide Lamps

1.03 QUALITY ASSURANCE.

Each major component of equipment shall have, as a minimum, the manufacturer's name, address, and catalog or style number on a nameplate securely attached to the item of equipment. Nameplates for individual items of electrical equipment shall be as specified in referenced publications and shall be provided on each item of equipment.

PART 2 PRODUCTS

2.01 HIGH-INTENSITY DISCHARGE (HID) LAMPS

All high intensity discharge (HID) lamps shall be either high pressure sodium or metal halide type as indicated on the drawing.

The high pressure sodium lamps shall be as per NEMA C78. 42, and shall have a color temperature of 2200 °K with color rendering index (CRI) of 21 as minimum.

The metal halide lamps shall be as per NEMA C78.42, and shall have a color temperature of 4000 °K with CRI of 65 as minimum.

2.02 FLUORESCENT LAMPS

All fluorescent lamps shall be biomercury, high efficiency, rapid start T8 type, 3500 °K color temperature with CRI of 80 as minimum unless indicated otherwise on the drawing.

2.02 LUMINAIRES:

Of the wattage and type listed on the drawings, suitable for the exact type of ceiling in which installed.

2.03 BALLASTS:

The ballasts for high intensity discharge luminaries shall be electronic type unless indicated otherwise. The ballasts shall be capable to operate at ambient temperature of – 25 °C, and tolerate operation of up to 85 °C case temperature without damage. The ballast shall have a minimum ballast factor of 1.0, power factor greater than 0.9, and maximum input current total harmonic distortion of 15%.

The ballasts for fluorescent fixtures with CBM and ETL approved, Class P, high efficiency, universal voltage (120V/277V), low harmonic (less than 10% THD) instant start electronic ballast unless shown otherwise. The ballast shall have a minimum starting temperature of -15 °C.

2.04 LUMINAIRES FOR PARKING LOT AND STREET LIGHTS

All luminaires for parking lot and street lights shall be of dark bronze finish and shall include one piece low copper die-cast aluminum alloy housing, one piece low copper die-cast aluminum alloy lens frame, field adjustable optical reflector pre-wired with quick disconnect plug, one piece extruded aluminum support arm with circular cut suitable for round pole, type Kim Lighting AR/SAR or equal. Provide metal halide or high pressure sodium bulb as shown on the drawing.

The poles shall be of dark bronze finish and shall be 6 inch round aluminum non-tapered type, constructed of a seamless round extruded aluminum tube alloy welded to a cast aluminum base. Base shall have a two piece cast aluminum cover and shall be secured to base by stainless steel screws. A hand-hole shall be provided 18 inch up from the base with a gasketed cover and ground lug. Four galvanized anchor bolts shall be provided complete with eight nuts, eight flat washers and a template. The length of the pole shall be as shown on the drawing. All poles longer than

25 ft shall be provided with factory installed pendulum vibration dampener (internally mounted), with flush stainless steel socket head fasteners, finished to match poles. The poles with luminaries shall be capable to withstand a steady wind load of 80mph with 104mph of wind gust. The poles and their associated hardware shall be compatible with luminaries as per recommendation of the manufacturer of luminaires. .

PART 3 EXECUTION

3.01 Structurally support all luminaires either on building structure or poles as indicated on the drawing.

3.02 For fixture mounted on external building structure, provide fixture studs as necessary. Secure surface mounted fixtures to masonry walls with bolts and anchors..

3.02 Install pole mounted luminaires as per recommendations of fixture and pole manufacturer..

3.03 For pole mounted fixtures provide concrete footing as per pole manufacturer's recommendations. Furnish concrete footing detail for approval prior to installation.

3.04 Install all luminaires in accordance with the NEC.

END OF SECTION

SECTION 28 31 00

FIRE DETECTION AND ALARM SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

This section applies to fire-alarm and detection systems, or components thereof, as indicated on the drawings and specified herein.

1.02 REFERENCES

The latest editions of the publications listed below form a part of this specification to the extent referenced and have the same force and effect as if bound into the contract documents.

A. National Fire Protection Association (NFPA)

1.	70-2008	National Electrical Code
2.	72	National Fire Alarm Code
3.	90A	Installation of Air Conditioning and Ventilating Systems
4.	92A	Smoke Control Systems
5.	101	Life Safety Code

B. Underwriter's Laboratories (UL) Standards

1.	UL 38	Standard for Safety Manually Actuated Signaling Boxes
2.	UL 268	Standard for Safety Smoke Detectors
3.	UL 464	Standard for Safety Audible Signal Appliances

1.03 QUALITY ASSURANCE

The equipment to be provided shall be the standard catalog product of a manufacturer regularly engaged in the manufacture of fire-alarm equipment that meets the requirements specified herein. Fire-alarm equipment shall be the latest standard design and approved by Underwriter's Laboratories and/or Factory Mutual. Devices shall be approved by the control panel manufacture and fire alarm authority having jurisdiction for use with the new or existing panel.

1.04 SYSTEM REQUIREMENTS

A. The fire-alarm system shall be nominal 24V DC and non-coded. The system shall comply with NFPA 72, NFPA 90A and NFPA 101.

B. System component installation shall be in accordance with NFPA 70, Article 500 in hazardous facility locations.

C. All fire-alarm circuits shall be electrically supervised. They shall be Class B, Style B for Initiating Device Circuits (IDC); Class B, Style 3 for Signaling Line Circuit (SLC) and Class B, Style Y for Notification Appliance Circuits (NAC).

D. The fire-alarm system shall be capable of communicating with the Simplex 4120, Network Communicating System. The contractor shall be responsible for connecting the new fire alarm system to the existing network communication system to notify MSFC Fire Department of any fire alarm and/or trouble condition.

1.05 SUBMITTALS

The following submittals shall be furnished as per schedule of submittals:

A. As-built wiring and conduit riser diagram showing each conduit junction box, initiating device, notification appliance, end-of-line resistor, number of wires in each conduit and wire color codes/wire marks.

B. As-built schematic diagram of the FACP showing all terminals which include alarm initiating circuits, alarm notification circuits, 120 VAC power and control circuits, 24 VDC battery power supply circuit and communication circuit for base station.

C. As-built location drawing for FACP, junction boxes, initiating devices, notification appliances, end-of-line resistors.

D. Manufacturer's catalog data for all components.

E. Test Reports.

F. Battery size calculation.

G. Manufacturer’s installation, operation and maintenance manual.

PART 2 PRODUCTS

2.01 FIRE ALARM CONTROL PANEL (FACP)

The fire alarm control panel shall be microprocessor based, field programmable, and of modular design, for ease of future extension or modification, or both. The front of the panel shall have steady “power on“ (green) “alarm” (red) and “trouble” (amber) indicating lights. In addition, each zone shall have separate “alarm" and “trouble” indicating lights.

A. Indicating lights shall be visible when the cabinet is closed. The unit shall also contain the following switches accessible only by unlocking and opening the unit:

1. Alarm Silence
2. Trouble Silence
3. Power On-Off
4. Alarm/Trouble Reset

B. The FACP shall function when a detector or manual alarm station or water-flow switch connected to the unit is activated. The fire-alarm indicator and alarm-control circuits shall energize and activate the external audible and visible signal and auxiliary devices, providing zone indication and sending an alarm signal to the remote central station fire monitoring system.

C. The FACP shall contain components and circuitry to operate a local annunciator and auxiliary devices such as air handlers, ventilating fans, damper solenoids, and magnetic door holders.

D. The FACP shall report the following conditions as trouble: open supervised circuits, ground faults, loss of primary power, power supply anomalies, low battery voltage, loss of battery voltage, and activation of the alarm silence switch. These troubles shall activate the trouble indicator and a trouble buzzer located within the cabinet, provide zone indication, and send a trouble signal to the central station fire monitoring system.

E. System Power Switch: The on-off switch shall disconnect all power sources to the control panel (120V AC and 24V DC).

F. System Reset Switch: The alarm/trouble reset switch shall reset the detector system in alarm or trouble. Trouble signals shall not be self-restoring without activating the reset switch.

G. Alarm and Trouble Silence Switch: the alarm and trouble silence switches shall silence the alarm and trouble audibles. Either switch placed in other than the normal position shall provide the following:

1. Report as a trouble to the central station fire monitoring system.

2. Transfer audible noise to a panel lamp visual indication.

3. Re-ring the trouble audible if the problem has been cleared but the switch has been left in the silence position.

H. When the alarm silencing switch is in the silence position, subsequent alarms in other zones shall operate the alarm-sounding devices.

I. The FACP shall be approved for use with the detectors and manual alarm stations and other fire alarm devices.

J. Relays shall be supervised, continuous duty, have self-cleaning contacts of silver or an alloy of equivalent performance, and be UL/FM approved for system use. Supervisory relays shall be protected against dust by individual covers. Relays that provide zone and external functions such as remote reporting, control device activation, signal lights, and bells shall have at least one set of spare contacts. Relays shall be permanently marked with the coil resistance, operating-current range, and internal pin connections identified by standard pin numbers.

K. The FACP cabinet shall be steel and shall be provided with a hinged cover and an integral pin-tumbler cylinder lock that will accept the key presently in use with other control units existing in the area. Locks for panels to be installed in control panels are available from ESP LOCK CORP. of Leominster, MA, 01453. The cabinet shall be painted with a prime coat and one or more finish coats of scratch-resistant baked paint.

L. An etched metal or engraved laminated-plastic identification plate shall be affixed to the cabinet door of the alarm-control unit to identify the cabinet as a fire-alarm cabinet.

M. The FACP shall have a supervised, normally closed, dry, single pole double throw (SPDT) contact that opens for trouble conditions and a normally open, dry, SPDT contact that closes for alarm conditions. Conductors shall be installed from these contacts as shown on the drawings to a new four-point terminal strip in the indicated telephone terminal cabinet (TTC).

N. The FACP shall be provided with a battery backup, automatically switched, alternative power source. Interruption of primary power shall cause the unit to switch automatically to the secondary power source and initiate a trouble signal.

O. The backup battery shall be capable of operating the alarm control unit in normal supervisory condition for 24 hours, minimum. An alarm signal receipt during battery backup operation shall cause an alarm signal to be sent via the remote report circuit and shall sound the local alarm-signaling appliances for 5 minutes, minimum.

P. The FACP shall be capable of operating on facility power when the backup batteries are disconnected for any reason. A system trouble signal shall be sent if the battery is disconnected or has low voltage.

2.04 HEAT-ACTUATED DETECTORS

A. Heat-actuated detectors (HADs) shall be rated 136 degrees F fixed temperature and 15 degrees F per minute rate-of-rise. HADS shall be self-restorable for the rate-of-rise feature and nonrestorable for fixed temperature.

B. Non restorable detectors shall have a visual identifier to show when device has been expended to facilitate replacement.

2.05 PRODUCT-OF-COMBUSTION DETECTORS

A. Detectors shall operate on the ionization or the smoke obscuration principle, or both, and shall be activated by the presence of combustion gases, invisible particles, or visible smoke particles. The detectors shall include a molded base, detector head, and locking means. Smoke detectors shall conform to UL 268.

B. The detector head shall be a plug-in unit and shall contain no moving parts. It shall require no replacements or readjustments to restore it to normal operation after an alarm has been given. The sensitivity shall be adjustable to compensate for ambient operating conditions.

C. The base shall have terminals for making connections and shall incorporate a light emitting diode or neon indicator that shall provide a visual indication when the detector initiates an alarm. The base shall contain the receptacle for the plug-in detector head. Components of the detectors shall be rust and corrosion resistant.

2.06 MANUAL ALARM STATIONS

A. Manual alarm stations shall be break-glass alarm-initiating devices designed in accordance with UL 38 for use with automatic and manual fire alarm systems.

B. The door shall have a protected, pull-down operating lever with finger grip that does not project out from the front of the case. Terminal blocks shall be readily accessible from station front.

C. Stations shall be the noncoded type which, when operated, break a glass rod, close one or more sets of contacts and lock the contacts in the operated position until reset. Stations with a pushbutton that depend upon a spring-loaded device to close the contacts when the handle is pulled are not acceptable. Stations shall not be resettable without the use of a key or a wrench. Exposed metal surfaces of enclosing cases shall be painted with a prime coat and one or more finish coats of red enamel to produce a smooth, hard, durable finish. Identification and directions for operating manual-alarm stations shall be provided on the cover in raised or depressed white-enameled letters. Plastic or composite material is not acceptable.

D. Surface-mounted stations shall be furnished with matching cast-iron or cast-aluminum back boxes.

E. Manual alarm stations shall be positioned so that they are readily accessible. Locations shall comply with NFPA 101 and NFPA 72.

F. A flush pin-tumbler cylinder lock and key shall be provided on general alarm type stations to sound the general alarm for fire drill or test without breaking the glass rod in the latching mechanism. Locks on manual alarm stations shall be keyed alike and shall accept the keys presently in use with other manual alarm stations at the installation.

2.07 ALARM HORN

A. Fire-alarm horns shall be designed in accordance with UL 464. The horn shall produce at least 86 Db at 10 feet and shall conform to NFPA 72.

B. Horns shall be in red with white “Fire” lettering.

C. Surface-mounted alarm horns installed in unfinished areas with conduit exposed shall be secured to surface-mounted back boxes. Back boxes shall be cast iron or cast aluminum, with 3/4-inch threaded conduit connections. Surface-mounted alarm bells installed outdoors shall be weatherproof with a neoprene gasket and shall be protected against corrosion.

D. Exposed metal surfaces shall be factory painted with a prime coat and one or more finish coats of red enamel to provide a smooth, hard, durable finish.

2.08 STROBE LIGHTS

Strobe lights shall conform to NFPA 72 and shall be capable of accepting Xenon type flash tube rated at 70,000 to 250,000 candle power in excess of 1,000 hours of operation at 1 to 2 flashes per second.

Actuated by solid state trigger circuity enclosed in Laxan, or approved equal, lens. Units utilized for direct current applications shall be polarized for supervision purposes. Strobe lights in combination with alarm horn shall be provided where indicated on the drawing.

PART 3 EXECUTION

3.01 SERVICES OF A FIRE-ALARM SPECIALIST

A. The services of a qualified specialist thoroughly experienced in the work shall be provided to supervise the installation, make adjustments, and perform test on the fire-alarm system at the site.

B. The specialist for this service shall be one who can present evidence of experience in system coordination and testing of the kind specified herein. Work shall be done by or under the direct supervision of this specialist. Evidence of these qualifications shall be submitted to the Contracting Officer.

3.02 SOFTWARE MODIFICATION

Any modification or reprogramming of FACP as necessary shall be performed by the fire alarm specialist. Software modification of the existing graphic display systems at Central Fire Alarm Station and Central Maintenance Facility shall also be performed by the specialist to reflect the change in floor plan, change in room number, change in fire alarm devices as necessary.

3.03 SYSTEM SEQUENCE OF OPERATION

A. Normal operation

All switches shall be in the normal position. The available power lamp shall be ON and the trouble and detector identification lamps shall be OFF. All circuits shall be electrically supervised.

B. Alarm condition

Detectors, manual alarm stations, water flow switches or other alarm devices shall close a contact that activates the appropriate alarm control unit. The alarm control unit shall transmit a signal to the remote reporting device of the base fire alarm system, activate the building alarm bells provide zone indication when used, control air-handling and ventilating units, provide an input to remote annunciators when used and provide indication or control to other devices.

C. Trouble condition

System conditions, identified in the paragraph entitled "Alarm-Control Unit," that will transmit a trouble signal to the remote reporting device of the base fire alarm system, shall provide zone indication (when used), activate a trouble signal in the alarm-control unit, and provide input to remote annunciators (when used). The trouble signal in the alarm-control unit shall be comprised of a trouble lamp and buzzer.

3.04 INSTALLATION

A. Alarm-control units

An alarm-control unit, complete with accessories and devices, shall be installed in each protected building.

B. Heat-actuated detectors (HAD)

HADs shall be provided and installed as specified by analysis and calculations required by NFPA 72.

C. Product-of-combustion detectors

Product-of-combustion detectors shall be installed in accordance with applicable NFPA standards. Smoke detectors shall be installed after the work of other trades has been accomplished. Product of combustion detectors shall be wired to fire control alarm panel and not to MSFC UCS.

D. Manual alarm stations

Manual stations (center of unit) shall be mounted 48-inches above the finished floor level.

E. Horns/Strobe Unit

Horn/strobe units shall be mounted 90 inches above the finished floor level (top of unit) and below the bottom surface of the ceiling, unless noted otherwise on drawings.

F. Strobe Units

Strobe Units shall be mounted 90 inches above finished floor (top of unit, unless noted otherwise on drawings.

G. Wiring

All wiring must be in metal conduits and copper conductor must be used. The conductor size shall not be less than 16 AWG stranded/14 AWG solid for Initiating Device Circuits and not less than 14 AWG for Notification Alarm Circuits. Conductors shall be continuous from terminal point to terminal point. Splicing of conductors shall not be permitted.

All fire-alarm circuits shall be installed in separate raceways. They must not be included in the same raceway containing ac power or ac control wiring. The connectors for electrical metal tubing shall be compression type.

H. Power Source

The normal power source for the FACP shall be 120 VAC. The system shall operate when supplied with 85 to 110 percent of normal voltage.

The fire-alarm system disconnect and protective device shall be a circuit breaker of fuse switch and shall be red with a factory finish.

In addition, the device shall be marked FIRE-ALARM with 1/8 inch high letters on laminated plastic identification plate.

I. Color Codes

All wiring must be appropriately color coded and permanent wire marker must be used to identify the terminals for each zone at the control panel. All junction boxes that are visible or accessible shall be painted in red or use red conduit as an alternative. If red conduit is used, and a piece of fire alarm device is removed, then the box cover shall be labeled for fire alarm system.

J. End-Of-Line Resistor

The End-Of-Line Resistor shall be installed in an accessible location to facilitate maintenance and inspection. The exact location of End-Of-Line Resistor shall be clearly marked on “As-Built” drawing.

3.05 TEST REQUIREMENTS

A. Acceptance Test

Upon completion of installation or alteration the complete system shall be tested by the fire alarm specialist to ensure that the system meets the design objective and is fully operational. The test shall be performed in the presence of the government inspector, the design engineer, the safety engineer and the facility maintenance technician. The test shall demonstrate satisfactory operation of the entire system. All components of the fire alarm system shall be tested as per requirement of NFPA 72, Table 7-3.1 and 7-3.2.

B. Reacceptance Test

A reacceptance test shall be performed after system components are added or deleted; after any modification, repair or adjustment to system hardware or wiring; or after any change of software per requirement of NFPA 72, Section 7-1.6.

C. Test Report

The fire alarm specialist shall furnish a certified test report upon completion of Acceptance or Reacceptance Test for approval. The test results shall be recorded in the Inspection and Testing Form per NFPA 72, Section 7-5.1.

END OF SECTION

SECTION 28 33 00

FUEL- GAS DETECTION ALARM SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

This section applies to oxygen deficiency monitoring system as indicated on the drawings and specified herein.

1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

A. Factory Mutual Approval Guide (FMS) (1976. Supp. I, March 76, Supp. II, June 76)

B. National Fire Protection Association (NFPA) Standards, No. 70-2008, National Electrical Code (NEC)

1.03 QUALITY ASSURANCE

Each major component of equipment shall have, as a minimum, the manufacturer's name, address, and catalog or style number on a nameplate securely attached to the item of equipment. Nameplates for individual items of electrical equipment shall be as specified in referenced publications and shall be provided on each item of equipment. It is required that statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. The statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

1.04 DESCRIPTION AND OPERATION

The equipment shall be properly installed completely interconnected and placed in working order. The system shall provide electrically supervised detection of the non-coded type as indicated on the drawings and as specified herein. Operation of any detection device shall result in the automatic actuation of the control unit relays for activating both the remote horns and lights.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

Materials and equipment shall be new standard products of the manufacturer's latest design, and suitable to perform the functions intended. Where two or more pieces of equipment must perform the same functions, they shall be duplicates produced by one manufacturer. The name of the manufacturer and the serial numbers shall appear on all major components.

2.02 COMBUSTIBLE (HYDROGEN SPECIFIC) & OXYGEN DEFICIENCY DETECTING EQUIPMENT

This equipment shall be as specified on the drawing or equal as approved by the Contracting Officer. Detector circuit design shall be suitable for the types and numbers of detectors, as approved, and shall limit detector circuit current not to exceed ratings of the detectors and associated relays.

2.03 OXYGEN DEFICIENCY DETECTOR

Detection is by an electrochemical cell in which oxygen produces a chemical reaction directly proportional to the oxygen content of the atmosphere surrounding the detector. A definite current, produced by this reaction, is amplified and used to trip an alarm circuit at a pre-set point. Minimum shelf life of the detectors shall be six months.

A. Control Unit

Control unit shall be installed as part of the system in each protected building. The control unit(s) shall be located where indicated and shall be housed in an enclosure suitable for wall mounting. The control unit shall include a suitable means for testing the system and shall have an indicating meter that will show at all times the current passing through each detector circuit. The unit shall be arranged so as to operate the alarm relays in the event of activation and to continue operation until silenced by a switch within the unit cabinet. Operation of the silencing switch shall light an indicator lamp. Meter and indicator lamp shall be plainly visible when the cabinet of the control unit is closed. Relays shall be of the plug-in type.

B. The control panel shall have adequate high pass RF filter traps on the input leads of all appropriate operational amplifiers such to permit the system to function normally when subjected to radio frequency in the range of 164 to 175 megacycles. The Contractor shall furnish certification of satisfactory compliance with the above requirement.

The front panel indicator lamps shall be color coded as follows:

Oxygen Detection	Pilot light, green LED type, to show that module is in normal operation.
	Alarm light, red LED type, to show that oxygen concentration at detector location has dropped below alarm level. Actuation level fully adjustable, initially set at 19.0 percent oxygen.

2.04 POWER SUPPLY

A. Primary power supply shall be a 120-volt AC source. Battery back-up is required. Rectifiers shall be of the solid state type.

B. Power-Supply wiring shall be installed in intermediate metallic conduit or electrical metallic tubing in accordance with the drawings. Transformer, rectifier, resistor(s), charger, batteries and other required power-supply components shall be incorporated in the control unit, or a separate power-supply unit may be furnished and installed if approved for the application. A battery-test switch and light shall be provided in each control unit.

C. The Master Control Unit shall be provided with an integral 12 to 32 Volt DC Power Supply, equipped as required to act as a standby power in event of primary power failure. Standby power shall be capable of sustaining unit for a minimum of 10 minutes.

PART 3 EXECUTION

3.01 INSTALLATION AND WIRING

System components shall be securely fastened to their supports independently of the wiring. Runs of conduit, tubing, wire, and cable shall be straight, neatly arranged, properly supported, and parallel or perpendicular to walls and partitions. Circuits and apparatus installed in hazardous locations shall conform to the National Electrical Code.

3.02 QUALIFICATION OF INSTALLER

The system shall be installed by an experienced firm regularly engaged in the installation of combustible gas detection and alarm systems in accordance with NFPA standards. The Contracting Officer may reject any proposed installer who cannot show evidence of such qualifications.

3.03 TOOLS, SPARE PARTS, AND OPERATIONS AND MAINTENANCE MANUAL

Special tools necessary for the maintenance of the equipment shall be furnished. One spare set of fuses of each type and size required shall be furnished. A hydrogen gas calibration unit shall be provided. Three sets of operations and maintenance manuals shall be provided.

3.04 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance. Cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings or other surfaces as necessary for the proper installation support, or anchorage of the conduit or other work shall be carefully done. Damage to buildings, piping, or equipment shall be repaired and refinished by skilled mechanics of the trades involved.

3.05 TESTS

After complete installation of the equipment, and at the time as directed by the Contracting Officer, the Contractor shall conduct tests to demonstrate that operating and installation requirements of this specification have been met. Each detector shall be activated by a hydrogen gas bottle representing the adjusted LEL. Also, the malfunction feature shall be tested for each control unit. Contracting Officer shall document results of test and place in file for future records.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.01 Construction materials, equipment, and procedures shall be in accordance with Alabama Department of Transportation "Standard Specifications for Highway Construction" (ALDOT Specs), 1992 edition, Section 201 - Clearing And Grubbing.

1.02 All trees, shrubs, plants and other items to remain will be identified on the drawings. Protect all landscaping to remain from damage during construction.

1.03 Prior to any excavation or digging operation or any surface penetration 6” or greater on any ground surface, a digging permit shall be obtained from MSFC Facilities Management Office, AS23 (phone; 544-6759, 544-3118.)

1.04 RELATED SECTIONS

A. Section 01 35 43, Environmental Procedures

B. Section 02 82 00, Asbestos Remediation

PART 2 PRODUCTS

2.01 Asphaltum base paint and herbicides shall be as approved by Contracting Officers Technical Representative (COTR).

PART 3 EXECUTION

3.01 Clearing

Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below natural ground.

3.02 Grubbing

All areas within the construction area shall be grubbed of all objectionable matter on or projecting through the ground surface. All fill areas shall be grubbed to a depth of at least one foot below the natural ground.

3.03 Disposal

A. Disposal shall comply with the Waste Management Plan submitted by the contractor in accordance with Section 01 35 43, “Environmental Procedures.”

B. Disposal of waste at the Redstone Arsenal Landfill shall comply with paragraph 3.05, “Redstone Arsenal Landfill (RSAL)” and other applicable portions of Section 01 35 43.

END OF SECTION

SECTION 31 20 00

EARTH MOVING

PART 1 GENERAL

1.01 SUMMARY

Earthwork shall include grading, rough and finish, excavating, backfilling, and compaction for structures, utilities, roadways, and parking areas. All work under this section shall be in accordance with Alabama Department of Transportation "Standard Specifications for Highway Construction", 1992 (ALDOT Specs), Sections 201 "Clearing and Grubbing" and 210 "Excavation and Embankment".

1.02 SUBMITTALS

Submit for approval items listed in the Schedule of Submittals in accordance with Section 01 33 00, SUBMITTALS.

PART 2 PRODUCTS

2.01 Fill Material

Borrow material shall be selected to meet requirements and conditions of the particular fill for which it is to be used. Borrow material shall be AASHTO standard M145 soil types A-1, A-2-4, A-2-5, A-3, or others lab tested and being capable of attaining the required density. Borrow material shall be responsibility of the Contractor. Structure backfill shall be crushed Stone No. 57, as specified in ALDOT Specs.

PART 3 EXECUTION

3.01 Topsoil shall be removed without contamination with subsoil and stock piled in convenient to areas for later application or at locations designated. Topsoil shall be removed to full depth and shall be stored separate from other excavated materials and piled free of roots, stones, and other undesirable materials.

3.02 Excavation: After all stripping has been completed, excavation of every description, regardless of material encountered, within the grading limits of the project shall be performed to the lines and grades designated. Satisfactory excavation material shall be transported to and placed in fill areas within the limits of the work. All unsatisfactory material and surplus material shall be disposed of in areas approved for surplus material storage.

3.03 Preparation of Ground Surface for Fill: All vegetation, such as roots, brush, heavy sods, heavy growth of grass, and all decayed vegetable matter, rubbish, and other unsatisfactory material within the area upon which fill is to be placed shall be stripped or otherwise removed before the fill is started. Sloped ground surfaces steeper than one vertical to four horizontal on which fill is to be placed shall be plowed, stepped, or broken up as directed, in such manner that the fill material will bond with the existing surface.

3.04 Fills and Embankments: The completed fill shall conform to the shape of the typical sections indicated or shall meet the requirements of the particular case. Fill shall be satisfactory material as defined in paragraph 2.01 and shall be reasonably free from roots, other organic material, trash, and stones having a maximum diameter greater than 6 inches. No frozen material will be permitted in the fill. Stones having a dimension greater than 4 inches will not be permitted in the upper 6 inches of fill or embankment. Fill shall be placed in layers not to exceed 6 inches compacted thickness.

3.05 Finished Excavation, Fills, and Embankments: All areas covered by the project, including excavated and filled sections and adjacent transition areas, shall be uniformly smooth graded. The finished surface shall be reasonably smooth, compacted, and free from irregular surface changes.

3.06 Placing Topsoil: On areas to receive topsoil, the compacted subgrade soil shall be scarified to a 2-inch depth for bonding of topsoil with subsoil. Topsoil then shall be spread evenly and graded to the elevations and slopes shown. Topsoil shall not be spread when frozen or excessively wet or dry. Topsoil shall be free of stones greater than 3/4–inch nominal diameter and other debris. If required to properly prepare topsoil, disturbed areas shall be graded and spread with a landscape box, or raked by hand if necessary, in order to remove stones larger than 3/4-inch diameter.

3.07 Compaction and Density: Requirements are specified as a percentage of the maximum density obtained by the test procedures of ASTM D 1557-91. Each layer shall be compacted to not less than the percentage of Modified Proctor Density specified below:

Designation	Location	Cohesive	Cohesion-less
Fill, Embankment, And/Or Backfill	Under proposed structures, building slabs, steps, and paved areas	90	100
Fill, Embankment, And/Or Backfill	Under sidewalks and grassed areas	85	90
Subgrade	Under building slabs, steps, and paved areas, top 12 inches	90	95
Subgrade	Under sidewalks, top 6 inches	85	90

3.08 Test Procedure: Field in-place density shall be determined by Nuclear Densometer Method. Testing shall be performed by an independent testing laboratory approved by the COTR. Test as specified on drawings or as directed by COTR. Test reports shall be submitted not more than 48 hours after testing is completed.

3.09 Off-Site Borrow Materials: Contractor shall be responsible for all testing prior to bringing soil on site. Testing shall include those required to verify compliance with environment standards. The following are minimum for Environmental Soil Testing:

EPA	SW846
Pesticides	(Method 8080)
Herbicides	(Method 8150)
TPH	(Method 503E)
Total Metals	(Method 6010) Ag, Ar, Cd, Cr, Hg, Pb, Se

END OF SECTION

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 GENERAL

1.01 Description: The work under this section shall consist of the removal and disposal of all excavated materials of any nature required for the construction of all box culverts (including bridge type), pipe culverts (including pipe arches), storm drains, and other minor structures in accordance with these Specifications and to reasonable close conformity with the lines and grades shown on the plans or designated by the Contracting Authority. This section shall further include backfilling of structure foundations with suitable material in accordance with plan details or as directed.

1.02 Classification of Materials

A. Excavation: All excavation for structures below natural ground or the designated subgrade, whichever is lower, or the elevation designated by the Contracting Authority will be classified as Structure Excavation and shall include all materials encountered regardless of their nature, exclusive of water or other liquids, which will not be classified as excavated material, necessary for the proper construction of the structure.

B. Backfill

1. Foundation Backfill: Special selected material ordered placed under a structure to provide a suitable foundation for the structure shall be classified as Foundation Backfill.

2. General Backfill: Material used for ordinary backfill shall include special material for areas immediately adjacent to weepholes and a drainage belt for large masonry structures.

PART 2 PRODUCTS

2.01 Foundation Backfill: Foundation Backfill is a special selected material (approved free-draining commercial or local material) suitable for use as foundation for the structure.

2.02 General Backfill: Material used for General Backfill shall be compactable soil of acceptable quality except that material for areas immediately adjacent to weepholes shall be free-draining material conforming to the following:

A. Local material shall have a permeability coefficient of at least 0.01 cm/sec., measured by the AASHTO T 215 constant head permeameter, with 90% passing the 3/4 inch sieve and a maximum of 10% passing the No. 8 sieve.

B. Commercial material shall be aggregates meeting the requirements of ALDOT #467 or ALDOT #57. Other commercial aggregates will be considered and can be used if approved by the Contracting Authority.

PART 3 EXECUTION

3.01 General: The excavation shall include trenching for utility and foundation drainage systems. Unsatisfactory material shall be removed, and satisfactory material shall be placed and compacted, as specified by Section 31 20 00, EARTH MOVING. Work shall be done in accordance with Section 214 of the ALDOT Specifications, 1992 Edition.

3.02 Drainage: Excavation shall be performed so that the area of the site, the area immediately surrounding the site, and the affecting operations at the site will be continually and effectively drained.

3.03 Utility and Drain Trenches: Trenches for underground utilities systems and drain lines shall be excavated to the required alignments and depths. The bottoms of trenches shall be graded to secure the required slope and shall be tamped if necessary to provide a firm pipe bed. Unsuitable material shall be removed and replaced as required by the COTR.

3.04 Borrow: Where satisfactory materials are not available in sufficient quantity from required excavations, approved materials shall be obtained from approved sources. Borrow to be as specified in Section 31 20 00, EARTH MOVING.

3.05 Excavated Materials: Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required under this section or shall be separately stockpiled if it cannot be readily placed.

3.06 Final Grade of Surfaces for Concrete Support: Excavation to final grade shall not be made until just before concrete is to be placed. Rock shall be worked down to a satisfactory bed or sidewall.

3.07 Filling and Subgrade Preparation: Satisfactory materials free from roots, debris, organic materials, or stones larger than 3 inches shall be used in bringing fills to the lines and grades indicated and for replacing unsatisfactory materials. When backfilling under paved areas, crushed aggregate type "A" shall be used as specified in Section 32 11 16, Aggregate Subbase Courses.

3.08 Backfilling and Compaction: Backfilling shall not begin until construction below finish grade has been approved; underground utilities systems have been inspected, tested, and approved; forms have been removed; and the excavation has been cleaned of trash and debris. Backfill shall be brought to indicated finish grade in 6" lifts compacted thickness and shall be compacted to 95% Modified Proctor Density under roadways and parking areas, and shall include backfill for outside grease interceptors and underground fuel tanks. Backfill shall not be placed in wet or frozen areas. Backfill shall not be placed against foundation walls prior to 7 days after completion of the walls. As far as practicable, backfill shall be brought up evenly on each side of the wall and sloped to drain away from the wall. Test for density requirements shall be performed on the final 2 (two) feet of fill below subgrade on each lift. Test reports shall be submitted for approval.

3.09 Submit proctor analysis on each different material.

END OF SECTION

SECTION 31 23 23

FLOWABLE FILL

PART 1 GENERAL

1.01 SUMMARY

This work shall consist of placing a flowable mortar fill material ("flowable fill"). Uses include, but are not limited to, placement under existing bridges, around or within box culverts or culvert pipes, in open trenches, or at other locations as shown on the drawings or as specified.

1.02 SUBMITTALS

Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals and Section 01 35 43, Environmental Compliance. In accordance with Section 01 35 43, the Contractor shall submit a report for flowable fill admixtures (fly ash) covered under the EPA regulations for recoverable materials. When such products cannot be provided the Contractor shall provide a non-compliance report stating the reason the product cannot be used and the nature of the product to be used. For an all-inclusive list of products and recoverable material contents see the latest EPA web site for construction products containing recoverable materials

1.03 REFERENCES

A. The State of Alabama Department of Transportation "Standard Specifications for Highway Construction", 1992 Edition (ALDOT Specs).

B. American Society for Testing and Materials ASTM C 109-92

C. American Society for Testing and Materials ASTM C 939-94a

D. American Concrete Institute, Manual of Concrete Practice, 229R-99

1.04 QUALITY ASSURANCE

A. Flowable fill shall be manufactured and delivered to the site by a supplier experienced in "Ready Mixed Flowable Fill" work. Job mixed shall not be used unless approved by the Contracting Authority.

B. "Ready Mixed Flowable Fill" design mix shall be available for inspection and/or approval as noted on The Schedule of Submittals.

C. Compressive Strength Test: Make two, 2" cubes for each truck. One cube shall be tested at 7 days and the other at 28 days. Test reports shall be submitted as noted on the Schedule of Submittals. As an alternative to the 2” cubes, contractor can prepare 6” diameter x 12” long test cylinders and provide 7 day and 28 day cokpressive strength test results per ASTM C 109.92, ASTM C 939-94A, and ACI 229R-99.

PART 2 PRODUCTS

All materials shall meet requirements for the respective items in accordance with the State of Alabama Department of Transportation "Standard Specifications for Highway Construction", 1992 edition (ALDOT) except as noted.

A. Flowable fill: Ready-mix flowable mortar having a compressive strength between 50 psi and 150 psi at 28 days unless otherwise noted on drawings. Reference ACI 229R-99.

B. Cement shall be Type 1; Meet the requirements of ALDOT Spec. Section 815.

C. Fly Ash shall meet requirements of ALDOT Spec. Section 806.01 (b).

D. Fine Aggregate for flowable mortar shall be natural or manufactured sand consisting of mineral aggregate particles. The gradation of this material shall be as follows:

Sieve Size	% Passing
3/8 inch	100
No. 8	80-100
No. 16	60-100
No. 30	45- 80
No. 50	12- 40
No. 100	1.5- 25
No. 200	0- 5

E. It is intended that the sand be a fine sand that will stay in suspension in the mortar to the extent required for proper flow. ALDOT Section 802 type 105 and 106 are local sands suitable for fine aggregate.

PART 3 EXECUTION

3.01 DRAINAGE SYSTEM

The shoulder area shall first be constructed with suitable soil, and with a drainage system if shown on drawings. This work shall be done in conjunction with the pipe placement.

3.02 PLACEMENT

A. Flowable fill shall be discharged from the mixer by a reasonable means into the remaining area to be filled. Filling operations shall proceed simultaneously on both sides of the structure so that the two fills are kept at approximately the same elevation at all times.

B. When placing pipe, if the pipe starts to float, the filling operation shall cease. An external load shall be applied to the pipe, sufficient to hold it in place, before the filling is continued. As an alternate, the filling may be suspended until the buoyancy effect of the flowable fill has ceased.

C. The flowable fill shall be placed to the elevation shown on the drawings. When not shown, the flowable fill shall be placed as follows:

1. At unpaved areas, place flowable fill to 12 inches below subgrade elevation if the subgrade elevation is not more than 5 feet over the top of the pipe. If the subgrade is more than 5 feet over the top of the pipe, flowable fill shall be placed to an elevation 24 inches over the top of the pipe, and the remainder shall be backfilled with soil or aggregate as designated by the drawings.

2. At asphalt paved areas, place flowable fill up to the pavement base level. Do not begin paving operations on flowable fill for a minimum of eight hours after backfilling.

3.03 LIMITATION OF OPERATION

A. Flowable fill shall not be placed on frozen ground.

B. Flowable fill batching, mixing, and placing may be started, if weather conditions are favorable, when the temperature is at least 34 degrees F and rising. At time of placement, flowable fill must have a temperature of at least 40 degrees F. Mixing and placing shall stop when the temperature is 38 degrees F or less and falling.

C. To the extent practicable, each filling stage shall be a continuous operation.

END OF SECTION

SECTION 31 31 16

TERMITE CONTROL

PART 1 GENERAL

1.01 SUMMARY

Provide termite control treatment for the entire new building, new building addition or area noted on the drawings.

1.02 SUBMITTALS

Submit for approval items listed in the Schedule of Submittals in accordance with Section 01 33 00, SUBMITTALS.

1.03 QUALITY ASSURANCE

A. In addition to requirements of these specifications, comply with the manufacturer's instructions and recommendations for work, including preparation of substrate and application.

B. Product application: By a professional pest control operator, licensed in accordance with regulations of the State of Alabama.

C. Use only termiticides which bear a Federal registration number of the U.S. Environmental Protection Agency.

1.04 PRODUCT WARRANTY

A. Furnish written warranty certifying that applied soil termiticide treatment will prevent infestation of subterranean termites and that, if subterranean activity is discovered during the warranty period, Contractor will re-treat soil and repair or replace materials damaged by termite infestation at no cost to the government.

B. Provide warranty for a period of 5 years from date of treatment, signed by Applicator and Contractor.

PART 2 PRODUCTS

2.01 SOIL TREATMENT SOLUTION

A. Use an emulsible concentrate termiticide for dilution with water, specially formulated to prevent infestation by termites. Fuel oil is not permitted as a diluent.

B. Treatment solutions: Submitted by the Applicator for approval by the A/E and applicable jurisdictional authorities if indicated on the Schedule of Submittals.

C. Apply treatment solutions with utmost care to avoid contamination of soils and plantings.

D. Follow all warnings, precautions and instructions as directed by the manufacturer's product label and jurisdictional authorities.

PART 3 EXECUTION

3.01 JOB CONDITIONS

A. Do not apply soil treatment solution until excavating, filling, and grading operations are completed, except as otherwise required in construction operations.

B. To insure penetration, do not apply soil treatment to frozen or excessively wet soils or during inclement weather.

3.02 SENSITIVE AREAS

A. Apply with caution at Child Care Centers.

B. Do not apply to Playground Areas.

3.03 SURFACE PREPARATION

Remove foreign matter which could decrease effectiveness of treatment on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and foundations. Toxicants may be applied before placement of drainage fill under slabs, if recommended by toxicant manufacturer.

3.04 APLICATION RATES

Apply soil treatment solution as directed by the manufacturer's product label and all applicable federal, state and local rules and regulations.

3.05 POST SIGNS

Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs when areas are covered by other construction.

3.06 REAPPLICATION OF SOIL TREATMENT

Reapply soil treatment solution to areas disturbed by subsequent excavation, landscape grading, or other construction activities following application.

END OF SECTION

SECTION 31 35 19

GEOSYNTHETIC SLOPE PROTECTION

PART 1 GENERAL

1.01 SUMMARY

This section covers needle punched non-woven geotextile construction fabric, including product specification, construction procedures, and inspection procedures.

1.02 SUBMITTALS

Submit for approval items listed in the Schedule of Submittals in accordance with Section 01 33 00, submittal procedures.

PART 2 PRODUCTS

2.01 Fibers used in the manufacture of geotextile, and the threads used in polymers, composed of at least 85% by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvedges. These materials shall conform to the performance requirements for soil retention, permeability, and clogging resistance and the physical requirements for constructability, survivability, and durability of a needle punched non-woven fabric similar to Amoco 4557, or A/E approved equal.

2.02 Geotextile rolls shall be furnished with suitable wrapping for protection against moisture, and extended ultra-violet (UV) exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient for inventory and quality control purposes. Rolls shall be stored in a manner which protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.

PART 3 EXECUTION

3.01 Geotextile Exposure Following Placement: Exposure of geotextiles to the elements between lay down and cover shall be a maximum of 14 days to minimize damage potential.

3.02 Erosion Control Placement: The geotextile shall be placed and anchored on a smooth graded surface approved by the Contracting Authority. The geotextile shall be placed in such a manner that placement of the overlying materials will not excessively stretch or tear the fabric. Anchoring of the terminal ends of the geotextile shall be accomplished through the use of key trenches or aprons at the crest and toe of slope. See drawings for details.

3.03 Slope Protection Placement

Successive geotextile sheets shall be overlapped in such a manner that the upstream sheet is placed over the downstream sheet and/or upslope over downslope. In underwater applications, the geotextile and required thickness of backfill material shall be placed the same day. The backfill placement shall begin at the toe and proceed up the slope.

Rip rap and heavy stone filling shall not be dropped onto the geotextile from the height of more than 1 ft. Slope protection and smaller sizes of stone filling shall not be dropped onto the geotextile from a height exceeding 3 ft. Any geotextile damaged during placement shall be replaced as directed by the Contracting Authority at the Contractor's expense.

3.04 Seams - The geotextile shall be joined by overlapping. All seams shall be subject to the approval of the Contracting Authority.

Overlapped seams shall have a minimum overlap of 2 ft.

3.05 Repair - A geotextile patch shall be placed over the damaged area and extend 3 ft. beyond the perimeter of the tear or damage.

3.06 Installation Procedures

Install geotextile in accordance with manufacturer's instruction or as a minimum the following shall apply:

The following general construction considerations apply for the riprap-geotextile erosion protection system:

A. Grade area and remove debris to provide smooth, fairly even surface.

1. Depressions or holes in the slope shall be filled so that the fabric will not have to bridge them and possibly be torn when cover materials are placed.

2. All sharp objects, large stones, limbs and other debris shall be removed prior to placement to prevent fabric damage from tearing or puncturing during stone placement.

B. Place fabric loosely, with length of fabric placed from top to bottom of slope.

C. Overlap fabric as required.

1. For overlaps, adjacent rolls of fabric shall be overlapped a minimum of 2 ft. Overlaps shall be in the direction of water flow and stapled or pinned to hold the overlap in place during placement of stone. Pins shall be 3/16 in. diameter, 18 in. long steel pins, pointed at one end, and fitted with 1.5 in. diameter washers at the other end. Pins shall be spaced along all overlap alignments at a distance of approximately 3 ft. center to center.

2. The fabric shall be pinned in a loose condition so that it easily conforms to ground surface and will "give" when the stone is placed.

D. Place revetment (cushion layer and/or riprap) over the geotextile width, taking care to avoid puncturing or tearing it.

1. Revetment shall be placed on the geotextile within 5 days for untreated UV susceptible geotextiles and within 14 days for UV-treated and low UV susceptible geotextiles.

2. For sloped surfaces, placement shall always start from the base of the slope, moving up slope and from the center outwards.

3. In no case shall stone weighing more than 100 lb. be allowed to roll downslope.

4. Field trials shall be performed to determine if placement techniques will damage the fabric and to determine the maximum height of safe drop without damaging the fabric. For Class A fabrics, height of drop for stones less than 250 lb. shall be less than 3 ft. Stones greater than 250 lb. shall be placed with no free fall unless field trials demonstrate that they can be dropped without damaging the fabric.

5. Grading of slopes shall be performed during placement of riprap and grading shall not be allowed after placement if grading results in stone movement directly on the fabric.

3.07 Field Inspection

A. Pay close attention to the construction procedures. If significant movement of stone riprap (greater than 6 in.) occurs during or after placement, stone shall be removed to inspect overlaps to make sure they are still intact. Field trials shall be performed to demonstrate that placement procedures will not damage the geotextile. If damage is observed, the Contracting Authority shall be contacted and the contractor shall change the placement procedure.

B. For placement adjacent to structures requiring special installation procedures, the Contracting Authority shall discuss placement details with the engineer, and inspection requirements and inspection methods shall be worked out in advance of construction.

END OF SECTION

SECTION 32 11 16

AGGREGATE SUBBASE COURSES

PART 1 GENERAL

1.01 SUMMARY

Work in this section shall consist of all crushed aggregate used as a base or sub-base for a controlled fill. Work in this section shall be in accordance with ALDOT Section 301, 1992 Edition.

1.02 SUBMITTALS

Submit for approval items listed in the Schedule of Submittals in accordance with Section 01 33 00, SUBMITTALS.

PART 2 PRODUCTS

2.01 Material shall be type "A" or "B" as specified by ALDOT Specifications Section 825, and shall be plant mixed. Material type and thickness will be shown on drawings.

PART 3 EXECUTION

3.01 Subgrade shall be approved before placement of any base or sub-base will be permitted. The sub-grade shall be checked to ensure grade lines and elevations are correct. Base courses shall be placed in layers of 6 inches compacted thickness or less.

3.02 Each layer of base shall be compacted to not less than 95%Modified Proctor Density. Base course shall be placed at optimum moisture. Density test shall be performed on each layer and for each 1200 square yard area.

END OF SECTION

SECTION 32 12 00

FLEXIBLE PAVING

PART 1 GENERAL

1.01 SUMMARY

This section covers the materials and work required to apply bituminous surface treatments and the placement of bituminous concrete as a base or a wearing course.

1.02 SUBMITTALS

Submit for approval items listed in the Schedule of Submittals in accordance with Section 01 33 00, SUBMITTALS.

Testing service qualifications shall be submitted to engineer prior to placement of asphalt when testing is required.

Core sample thickness shall be reported to engineer on the day the cores are taken and noted on as-built drawings.

PART 2 PRODUCTS

2.01 Surface Treatment Materials shall be in accordance with Alabama Department of Transportation "Standard Specifications for Highway Construction" (ALDOT Specs) Section 401.02, 1995 Edition.

2.02 The grade of bituminous material shall be within the following limits unless the type and grade are specified on the plans.

A. PRIME:

Emulsified Asphalt.....AE-P
Tar.....RT 2 or RT 3
Cutback Asphalt.....MC30 or MC70 for tight base; MC250, RC70, or RC250 for open bases.

B. ASPHALT FLUSH COAT:

Emulsified Asphalt.....RS 1
RS 2
CRS 1
CRS 2

C. LIQUID SEALS AND SURFACE TREATMENTS:

Asphalt Cement.....AC5, AC10
Cutback Asphalt.....RC 250, RC 800, RC 3000,
MC 800, MC 3000
Emulsified Asphalt...RS 1
RS 2
CRS 1
CRS 2
Tar.....RT 9, RT 10, RT 11, RT 12

D. SURFACE TREATMENT WITH LATEX RUBBER ADDITIVE:

Emulsified Asphalt...RS 2
CRS 2

Where conditions require the placement of a bituminous plant mix overlay over a bituminous surface treatment, a curing period of 3-21 days will be required before placement of the plant mix overlay, unless otherwise authorized by the COTR in writing.

E. AGGREGATE

Coarse aggregate for bituminous treatments shall be crushed aggregate meeting the requirements of ALDOT Section 801. The kind of aggregate materials used shall be at the Contractor's option within these limits: Aggregates for the final application (wearing layer) shall be limited to siliceous aggregate such as granite, slag (including reclaimed open hearth slag from cold piles approved by COTR), or light weight aggregate (expanded clays or shales produced by the Rotary Kiln Method). The use of carbonate stone such as limestone or dolomite will be permitted.

F. Bituminous Concrete for Leveling, Widening, and Patching shall be as specified by ALDOT Specs Section 411.

G. Bituminous Concrete for Binder Layer shall be as specified by ALDOT Specs Section 414.

H. Bituminous Concrete for Wearing Course shall be as specified by ALDOT Specs Section 416.

I. All Bituminous Concrete Pavements will be specified on plans as to mix type.

J. Paint for striping of asphalt shall be Class 1 Permanent Paint per ALDOT Section 856, “Traffic Marking Materials.”

PART 3 EXECUTION

3.01 Equipment and Procedures for Placement shall be specified by the ALDOT Section 410.

3.02 When patching or adjoining an existing pavement, the existing shall be saw cut to match the plans and shall be tacked. Weather shall be dry and temperature 40 degrees F or above before placement is permitted. When temperature is 45 degrees F and falling placement shall be suspended. Rolling and Finishing Operations shall be completed during daylight hours.

3.03 The mixture shall be laid only upon an approved underlying course which is dry and only when weather conditions are suitable. The COTR may, however, permit work of this character to continue when overtaken by sudden rains, up to the amount which may be in transit from the plant at the time, provided the surface just ahead of the placing is swept clear of water and the mixture is within the temperature limits specified. The layer placed under such conditions shall be at the Contractor's risk and shall be removed and replaced by him without extra compensation should it prove unsatisfactory.

3.04 Bituminous plant mix layers of 200 pounds per square yard or less shall not be placed when the surface or air temperature is below 40 degrees F. Air temperature shall be 40 degrees F before the spreading operation is started. Spreading operations shall be stopped when the air temperature is below 45 degrees F and falling. Rolling and finishing operations shall be completed during daylight hours.

3.05 Completed bituminous-concrete base and surface course shall be tested for thickness during construction for compliance to the specified requirements as noted on the construction drawings. The in-place pavements shall have one core specimen taken for each 50 square yards of completed bituminous-concrete course or as noted on the construction drawings. The diameter of the pavement core specimens shall be not less than three inches. Locations for the core specimens will be as directed by the COTR. Test holes shall be repaired as directed on the construction drawings. Thickness shall vary from the indicated thickness by not more than ½ inch for the base course and ¼ inch for the surface course.

3.06 Paint striping shall be accomplished in accordance with ALDOT Section 701, “Taffic Stripe, Class 1 Permanent Paint” and as noted on the drawings.

END OF SECTION

SECTION 32 31 13

STEEL CHAIN-LINK FENCES AND GATES

PART 1 GENERAL

1.01 SUMMARY

This section covers steel fencing, including posts, fabric, gates, barbed wire, and miscellaneous accessories.

1.02 SUBMITTALS

Submit for approval items listed in the Schedule of Submittals in accordance with Section 01 33 00, SUBMITTALS.

PART 2 PRODUCTS

2.01 General

A. Fencing materials shall conform to the requirements of FS RR-F-191, and be as specified.

B. Pipe sizes indicated are the nominal outside diameter.

2.02 Zinc Coating

A. Ferrous-metal components and accessories, except as otherwise specified, shall be hot-dip galvanized after fabrication.

B. The weight of zinc coating shall average 2.0 ounces per square foot, and no individual specimen, when tested in accordance with ASTM A90, shall show less than 1.8 ounces per square foot, unless otherwise specified.

C. Zinc coating shall conform to the requirements of the following:

Pipe: ASTM A53
Hardware and accessories: ASTM A153, Table 1

D. Galvanizing repair material shall be cold-applied zinc-rich coating conforming to DOD-P-21035.

2.03 Fabric

A. Fabric shall consist of No. 9-gage wires woven into a 2-inch diamond mesh, with dimensions of fabric and wire conforming to FS RR-F-191 and FS RR-F-191/1, Type I with 1.2 ounces per square foot zinc galvanizing.

B. Fence heights to 12 feet shall have one-piece fabric widths.

2.04 Top and Bottom Selvages

A. Fabric over 60 inches high with 2-inch mesh shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

B. Top and bottom selvages shall be knuckled for 1-3/4-inch and 1-inch mesh fabric.

2.05 Line Posts

Minimum acceptable line posts shall be as follows:
Up to 6-feet high: 1-1/2-inch pipe weighing 2.72 pounds per linear foot
Over 6-feet high: 2-inch pipe weighing 3.65 pounds per linear foot

2.06 End, Corner, and Pull Posts

Minimum acceptable end, corner, and pull posts shall be as follows:
Up to 6 feet high: 2-inch weighing 3.65 pounds per linear foot
Over 6 feet high: 2-1/2-inch pipe weighing 5.79 pounds per linear foot

2.07 Sleeves

Sleeves for setting into concrete construction shall be of the same material as post sections. The size shall be 1-inch greater than the diameter or dimension of the post, unless otherwise indicated. Flat plates shall be welded to each sleeve base to provide anchorage and prevent intrusion of concrete.

2.08 Top Rail

Rails shall be at least 1-1/4-inch pipe weighing 2.27 pounds per linear foot. Expansion couplings approximately 6-inches long shall be provided at each joint in top rails.

2.09 Central Rails Between Line Posts

Center rails if required by the drawings,shall be 1-1/4-inch pipe weighing 2.27 pounds per linear foot.

2.10 Post-Brace Assembly

Bracing shall consist of 1-1/4-inch pipe weighing 2.27 pounds per linear foot and 3/8-inch-diameter adjustable-length rod.

2.11 Tension Wire

Wire shall be galvanized, No. 7-gage, coiled spring wire, provided at the bottom of the fabric only. Zinc coating shall weigh not less than 1.6 ounces per square foot.

2.12 Barbed Wire Supporting Arms

A. Supporting arms for barbed wire shall be steel, wrought iron, or malleable iron, complete with provisions for anchorage to posts and for attaching 3 rows of barbed wire to each arm. Supporting arms may either be attached to posts or integrated with the post top weather cap.

B. The Contractor shall provide a single 45-degree arm for three strands of wire for each post where barbed wire is indicated.

2.13 Barbed Wire

Wire shall conform to FS RR-F-221 and FS RR-F-191/4, two-strand, 12-1/2-gage wire with 14-gage 4-point round barbs spaced 5 inches on center.

2.14 Stretcher Bars

Bars shall be one-piece lengths equal to the full height of the fabric with a minimum cross section of 3/16 inch by 3/4 inch, in accordance with FS RR-F-191.

2.15 Post Tops

Tops shall be steel, wrought iron, or malleable iron designed as a weathertight closure cap. One cap shall be provided for each post, unless equal protection is provided by a combination post-cap and barbed-wire supporting arm. Caps shall have an opening to permit through passage of the top rail.

2.16 Stretcher Bar Bands

Bar bands for securing stretcher bars to posts shall be steel, wrought iron, or malleable iron spaced not over 15 inches on center. Bands may also be used in conjunction with special fittings for securing rails to posts. Bands shall have projecting edges chamfered or eased.

2.17 Gate Posts

The Contractor shall provide a gate post for supporting each gate leaf as follows:

A. Up to 6-feet wide: Provide 2.875 inch O.D. pipe weighing 5.79 pounds per linear foot.

B. Over 6-feet and up to 13-feet wide: Provide 4.00 inch O.D. pipe weighing 9.11 pounds per linear foot.

C. Over 13-feet and up to 18-feet wide: Provide 6.624 inch O.D. pipe weighing 18.97 pounds per linear foot.

D. Over 18-feet wide: Provide 8.625 inch O.D. pipe weighing 24.70 pounds per linear foot.

2.18 Gates

A. Perimeter gate frames shall be fabricated of tubular members. Additional horizontal and vertical members shall be provided as required to ensure proper gate operation and for attachment of fabric and hardware. Sizes of frame members listed are minimum; larger sizes shall be provided as required.

B. For gate leaves up to 6-feet high or 6-feet wide, perimeter gate frames shall be 1.66 inch O.D. pipe weighing 2.27 pounds per linear foot.

C. For gate leaves over 6 feet high or 6 feet wide, perimeter gate frames shall be 1.90 inch O.D. pipe weighing 2.72 pounds per linear foot.

D. Gate frame assembly shall be welded or assembled with special malleable or pressed-steel fittings and rivets to provide rigid connections. Fabric shall be installed with stretcher bars at vertical edges; stretcher bars may also be used at top and bottom edges. Stretcher bars and fabric shall be attached to gate frames on all sides at intervals not exceeding 15 inches. Hardware shall be attached with rivets or by other means that will provide equal security against breakage or removal.

E. Where barbed wire is indicated above gates, the end members of gate frames shall be extended approximately 1-foot above the top member with provision for attaching the wire. Vertical support arms shall be provided at intermediate points, spaced the same as line posts.

F. Diagonal cross-bracing, consisting of 3/8-inch-diameter adjustable-length truss rods on welded gate frames, shall be provided where necessary to

obtain frame rigidity without sag or twist. Nonwelded gate frames shall have diagonal bracing.

G. Fabric shall be as specified for fences.

2.19 Gate Hardware and Accessories

A. Gate hardware and accessories shall conform to FS RR-F-191.

B. Hinges shall be malleable iron, forged steel, or pressed steel to suit gate size, non-lift-off type, offset to permit 180-degree opening.

C. Latch shall permit operation from either side of the gate, with a padlock eye provided as an integral part of the latch.

D. Stops and holders of malleable iron shall be provided for vehicular gates. Stops shall automatically engage the gate and hold it in the open position until manually released.

E. Double gates shall be provided with a cane bolt and ground-set keeper, with latch or locking device and padlock eye designed as an integral part.

F. Manufacturer's standard heavy-duty track ball-bearing hanger sheaves, overhead framing and supports, guides, stays, bracing, and accessories shall be provided as required for easy operation of manual sliding gates.

2.20 Miscellaneous Hardware

Miscellaneous hardware shall be provided as required and shall be hot-dip galvanized.

2.21 Wire Ties

A. Wires for tying fabric to line posts shall be 16-gage galvanized steel wire spaced 12 inches on center. For tying fabric and braces, wire ties shall be spaced 24 inches on center. For tying fabric to tension wire, 0.105-inch hog rings shall be spaced 24 inches on center.

B. The manufacturer's standard procedure will be accepted if procedures are of equal strength and durability to that specified above.

2.22 Concrete

Concrete shall conform to ASTM C94. The mix shall be designed to obtain concrete with a minimum 28-day compressive strength of 3000 psi.

PART 3 EXECUTION

3.01 General

A. Obtain a dig permit from the MSFC Facilities Management Office, AS23, (phone: 544-6859 or 544-3118) prior to any excavation, drilling, or digging operation or any ground surface penetration 6 inches or greater in depth.

B. The fencing installation shall not begin before the final grading has been completed and finish elevations have been established, unless otherwise approved

3.02 Excavation

A. Excavations for post footings shall be drilled holes in undisturbed or compacted soil, of minimum sizes as indicated.

B. Footings shall be spaced for line posts 10 feet on center maximum and at closer intervals when indicated.

C. The bottoms of the holes shall be approximately 3-inches below the bottoms of the posts. The bottom of each post shall be set not less than 36-inches below finished grade when in firm, undisturbed soil. Posts shall be set deeper, as required, in soft and problem soils and for heavy, lateral loads.

D. Soil from excavations shall be spread uniformly adjacent to the fence line or on areas of Government property, as directed.

E. When solid rock is encountered near the surface, the Contractor shall drill into the rock at least 12 inches for line posts and at least 18 inches for end, pull, corner, and gate posts. Holes shall be drilled at least 1 inch in diameter greater than the largest dimension of the placed post.

F. If solid rock is below the soil overburden, the Contractor shall drill to the full depth required, except that the penetration into rock need not exceed the minimum depths specified above.

3.03 Setting Posts

A. Loose and foreign materials shall be removed from holes and the soil moistened prior to placing concrete.

B. Posts shall be centered and aligned in holes 3 inches above the bottom of the excavation. Concrete shall be placed around posts in a continuous

pour and vibrated for consolidation. Each post shall be checked for alignment and held in position during placing and finishing operations.

C. Tops of footings shall be trowel finished and sloped or domed to shed water away from posts. Hold-open devices, sleeves, and other accessories shall be set in concrete, as indicated.

D. Exposed concrete shall be kept moist for at least 7 days after placement or cured with a membrane curing material, as approved.

E. Posts set in concrete construction shall be set vertically, with tops aligned and held in position until concrete has set.

3.04 Concrete Strength

Concrete shall have a minimum compressive strength of 3000 PSI at 28 days. Concrete integrity shall be maintained throughout the construction of the fence.

3.05 Top Rails

Top rails shall run continuously through post caps or extension arms, bending to radius for curved runs. Expansion couplings shall be provided as recommended by the fencing manufacturer.

3.06 Center Rails

Center rails shall be one piece between posts, where indicated, set flush with posts on the fabric side, using special offset fittings where necessary.

3.07 Brace Assembly

A. The Contractor shall provide bracing assemblies at end and gate posts and at both sides of corner and pull posts, with the horizontal brace located at midheight of the fabric.

B. Brace assemblies shall be installed so that posts are plumb when the diagonal rod is under proper tension.

C. Two complete brace assemblies shall be provided at corner and pull posts where required for stiffness and as indicated.

3.08 Tension Wire Installation

Tension wires shall be installed weaving them through the fabric and tying them to each post with not less than 7-gage galvanized wire or by securing the wire to the fabric with 10-gage ties or clips spaced 24 inches on center.

3.09 Fabric Installation

A. Fabric shall be provided in single lengths between stretch bars with bottom barbs placed approximately 1-1/2-inches above the ground line. Fabric shall be pulled taut and tied to posts, rails, and tension wires with wire ties and bands.

B. Fabric shall be installed on the security side of fence, unless otherwise directed.

C. Fabric shall remain under tension after the pulling force is released.

3.10 Stretcher Bar Installation

Stretcher bars shall be threaded through or clamped to fabric 4 inches on center and secured to posts with metal bands spaced 15 inches on center.

3.11 Barbed Wire Installation

Three parallel strands of barbed wire shall be installed on the security side of the fence as specified or indicated. Wire shall be pulled taut and fastened securely to each support arm.

3.12 Gate Installation

Gates shall be installed plumb, level, and secure, with full opening without interference. Ground-set items shall be installed in concrete for anchorage as recommended by the fence manufacturer. Hardware shall be adjusted for smooth operation and lubricated where necessary.

3.13 Tie Wires

Tie wires shall be U-shaped to the pipe diameters to which attached. Ends of tie wires shall be twisted not less than two full turns and bent so as not to present a hazard.

3.14 Fasteners

Nuts for tension bands and hardware shall be installed on the side of the fence opposite the fabric side. Ends of bolts shall be peened to prevent removal of nuts.

3.15 Zinc-Coating Repair

Galvanized surfaces damaged by welding or abrasions, and cut ends of fabric, barbed wire, or other cut sections shall be cleaned and repaired with specified galvanizing repair material applied in strict conformance with the manufacturer's printed instructions.

3.16 Tolerances

Posts shall be straight and plumb within a vertical tolerance of 1/4 inch after the fabric has been stretched. Fencing and gates shall be true to line with no more than 1/2 inch deviation from the established centerline between line posts. Defects shall be repaired as directed.

END OF SECTION

SECTION 32 92 00

TURF AND GRASSES

PART 1 GENERAL

Description of work: This specification covers the furnishing and installation of seed and sod. Products shall match existing material and/or shall be as directed by the Contracting Officer. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

PART 2 PRODUCTS

2.01 Seed shall be the latest season's crop and shall be delivered in original sealed packages bearing the producer's guaranteed analysis for percentages of mixtures and pure live seed. Seed shall be labeled in conformance with U.S. Department of Agriculture rules and regulations under the Federal Seed Act and applicable ALDOT Spec. Sections 650 - 658. Weed seed shall not exceed 1 percent by weight of the total mixture.

2.02 Sod shall be nursery grown, field sod, certified sod, or approved sod as classified in ALDOT Specification Section 654.

2.03 Sprigs shall be healthy living stems, stolons, or rhizomes and attached roots of grass without adhering soil. Sprigs shall include two to three nodes, shall be 4 to 6 inches long, and shall be obtained from approved sources where the sod is heavy and dense. Harvesting and planting operations shall be coordinated to prevent exposure of sprigs to the sun for more than 30 minutes before covering and moistening.

2.04 Water shall not contain elements toxic to plant life.

2.05 Straw or hay according to Section 860, Roadside Improvement Materials of ALDOT Standard Specifications for Highway Construction. Hay or straw shall not contain nor introduce grass seed foreign to the type required per this section.

PART 3 EXECUTION

3.01 Preparation: Except on slopes steeper than 2 horizontal to 1 vertical, the soil shall be tilled to a depth of at least 4 inches. On slopes between 2 horizontal to 1 vertical and 1 horizontal to 1 vertical tillage, depths shall be 2 inches. On slopes steeper than 1 horizontal to 1 vertical, no tillage will be permitted.

3.02 Application:

A. Planting Seasons and Conditions: Planting shall not be done when the ground is frozen, snow covered, or in an unsatisfactory condition for planting.

Grass seed shall be distributed in conformance with the following table according to the applicable season of the year, and shall be watered sufficiently to establish a healthy stand of grass during the growing season. Straw or hay shall be strewn over seed to protect seed until establish growth occurs.

Grass Species	Seeding Required Per/Acre	Seeding Dates
Bermudagrass, Common (Unhulled)	30 lbs	Mar – Jun
Bermudagrass, Common (HS)	30 lbs	Apr – Jul
Fescue (turf grass)	40 lbs	Feb – May Sept - Nov
Kentucky Blue Grass	40 lbs	Sept – Apr
Rye Grass	70 lbs	Aug – Nov

During months not suitable for seeding of Bermuda and Fescue grasses, the Contractor shall stabilize erosive soils by sowing Kentucky Blue Grass and/or Rye Grass. If grass sown during the winter months does not germinate and grow, the Contractor shall stabilize erosive areas by re-seeding, spreading straw, applying mulch, jute netting or other approved means and material. At the appropriate season Bermudagrass or Fescue shall be sown at the rates shown in the table in accordance with these specifications.

B. Seed shall be broadcast uniformly. Cover seed to an average depth of 1/4 inch. Distribute straw or hay over seeded area. Immediately after seeding, water the soil to a depth of 6 to 8 inches.

C. When required by drawings, sod shall be installed instead of seed and be accomplished in accordance with the ALDOT Specification Section 654.

D. When spot sodding, the sod shall be cut into plugs 2 inches square or 2 inches in diameter. The individual pieces of sod shall be placed on 12 - inches centers and pressed firmly into the soil by foot pressure or by tamping.

E. After sod pieces have been placed in position, the sodded area shall be rolled or tampered so that air pockets are eliminated.

F. Water shall be applied to the sodded areas at a rate sufficient to ensure thorough wetting of the soil to a depth of at least 4 inches.

G. When required by contract drawings, sprigging shall be accomplished instead of seeding. Sprigs shall be planted in such quantity as to provide a minimum of 25 viable sprigs or 108 linear inches of viable sprigs per square yard of areas. Immediately after sprigging operations have been completed, the planted area shall be firmed with a cultipacker or a roller. Water shall be applied at the time of sprigging operations wetting the soil to a depth of 4 inches.

H. Protection of Turfed Areas: Immediately after seeding, sodding, or sprigging, the area shall be protected against traffic or other use by erecting barricades, as required, and approved signs shall be placed at appropriate intervals until final acceptance.

3.03 ALDOT specifications shall be applied for general construction and methods.

END OF SECTION

SECTION 32 93 00

PLANTS

PART 1 PRODUCTS

1.01 RELATED WORK

A. Section 31 10 00 Clearing

B. Section 31 20 00 Earth Moving

C. Section 32 92 00 Turf and Grasses

1.02 Submittals

A. Contractor shall provide the following, in addition to that specified in Section 01 33 00:

1. Product Data (SD-03). An itemized listing of all plant material installed, if different from that specified, including but not limited to: botanical name, common name, size, spacing requirements and growth habits.

2. Product Data (SD-03). Herbicide that kills weeds, but is safe for trees and shrubs.

1.03 QUALITY ASSURANCE

A. Contractor shall ensure that all plant and planting materials shall be free from disease, display a healthy growth pattern and shall be grown and planted in accordance with the Alabama Nurseryman's Association.

B. All plant materials shall be guaranteed to be live, healthy and free of disease for a period of one-year from the time of acceptance of the project by the COTR under normal growing conditions. Contractor shall replace all dead plant materials per written instructions and directions from the COTR.

PART 2 PRODUCTS

2.01 PLANT MATERIALS

A. Plants or plant material shall include trees, shrubs, ground covers, vines, flowers, and other plants specified in the design documents.

B. Provide plants typical of their species and variety in a good healthy condition in accordance with Part 1 – General, 1.03 Quality Assurance.

C. Plants shall meet the requirements for spread and height indicated on the plans.

D. Plants larger than those specified in the plant list with corresponding root system may be used upon approval of the COTR.

E. Plants with broken or cut back terminal leaders may be rejected.

F. Plants planted in rows shall be matched in form and size unless specified or indicated otherwise on the plans.

G. All plants which fail to comply with these specifications in any way will be rejected by the COTR and shall be removed immediately from the project site by the contractor under the direction of the COTR.

H. Balled and Burlapped Plants (B&B):
   a. Root balls shall be firm and unbroken, moist, and of the specified size.
   b. Broken or loose root balls will be rejected. Failure to conduct good handling and digging practices may be cause for rejection of plant.
   c. No manufactured or artificially produced or mudded-in root balls will be accepted.
   d. A container grown plant, in lieu of a “B&B” root ball, will be accepted provided it meets specified sizes, complies with “American Standard for Nursery Stock” (ANSI Z60.1), and meets criteria for container grown plants.

I. Container Grown Plants:
   a. Container grown plants shall be grown in sufficiently sized container for a minimum of 1 year with a root system to have developed to hold its soil together and shall be firm, whole, and moist when taken from the container.

b. No loose root systems in the container, no root bound systems in the container, and no circling of the root system in the container will be accepted.

2.02 MULCH & LANDSCAPING FABRIC

A. Mulch shall consist of premium finely shredded or ground hardwood chips or pine chips graded to ¼ inch to ½ inch diameter and maximum of 3 inches in length. Green or freshly chipped or shredded mulch will be rejected. Bark nuggets will be rejected.

B. Mulch shall be free of weeds, weed seed, chaff, diseases, or other foreign material.

C. Landscaping fabric shall allow water and air penetration to the root systems of plants while retarding the growth of weeds and grass in the prepared landscaping areas.

2.03 PLANTING SOIL

A. Provide good topsoil free from roots and debris or a planting mixture of clean, rich topsoil and sphagnum peat approved by the COTR shall be used in preparation of planting soil for backfilling around root system of planted materials.

2.04 STAKES, STAKING HOSE AND STAKING WIRE:

A. Stakes shall be required for staking plants and trees taller than 10 feet in height. Stakes shall be steel posts uniform in shape, size and color and shall be a minimum of 6 feet in length.

B. Trees and plants shall be staked with three stakes placed evenly around the tree to provide proper vertical support, evenly distributed.

C. Multi-trunk trees shall be staked with two to three stakes per tree and shall be installed to provide adequate vertical support to trees while minimizing damage to the tree.

D. Reinforced garden hose of not less than ½ inch inside diameter or other material approved by COTR of sufficient length to prevent contact of staking wire with bark of tree or plant shall be provided.

E. Staking wire shall be no. 14 gauge pliable galvanized wire or other material as approved by the COTR. Staking wire shall be provided to stake, guy and secure trees and plants.

2.05 SLEEVES

A. Provide corrugated pipe or other material approved by COTR at base of tree trunk for trees not planted in mulched islands to protect from damage caused by lawn mowing, trimming and maintenance.

PART 3 – EXECUTION

3.01 OPTIMAL PLANTING SEASONS

A. Evergreen plants (B&B and Container): Planting period shall be from October 1 to November 30 and from February 15 to April 1.

B. Deciduous plants (B&B and Container): Planting period shall be from September 15 to December 15 and spring planting prior to April 1.

C. At the option of the COTR, planting may be conducted under unseasonable conditions, except in weather below 32° F or above 90° F, without variance from the specifications for plant survival guarantee.

3.02 PREPARATION

A. Provide notice of commencement of construction to COTR and coordinate with COTR to obtain dig permits prior to planting operations.

B. Provide barriers or fencing as directed and approved by COTR to protect the general public from injury when planting installation is within street, parking lot or sidewalk access.

C. Provide silt fencing for sedimentation control and dust control methods if required and approved by the COTR due to weather or other site conditions.

3.03 LOCATION OF PLANTS

A. COTR shall determine approved material storage location on site for landscaping plant materials if required by contractor prior to start of construction.

B. Contractor shall mark all locations and layout of all planting areas and secure approval by COTR prior to excavation.

C. Contractor shall mark the location of all plants in accordance with the plans and secure approval from the COTR prior to planting. Trees are to be marked individually. Shrubs or plant groups are to be marked for the quantity on the plans without marking individual plants unless directed otherwise by the COTR.

D. Make field adjustments in plant locations where underground or overhead obstruction is encountered, or where changes have been made in construction as approved by the COTR.

3.04 PLANTING

A. Excavate the plant pit, centered at the location marks, cylindrical in shape with a diameter of 2-1/2 times larger than the ball or root condition, with vertical sides and flat or saucer-shaped bottom. Excavate plant pit to a depth equal to the nursery grade of the root crown for all balled and container root systems to allow placement of the root ball approximately even with or slightly above the surrounding grade.

B. Balled & Burlapped and Container Plants:
   a. All container and balled root systems shall be moist at time of planting.
   b. Remove all ties and wrap from branch system, except plant identification.
   c. Remove plant root system carefully from the container prior to planting without disturbance to root systems.
   d. Place plants centered erect, and with desired orientation in planting pit with the root crown placed approximately 2 inches above the existing grade.
   e. After plant placement, cut twine, wire, wire mesh, and burlap and fold from sides of ball and remove from pit.
   f. Carefully compact planting soil backfill in layers, filling all voids until two-thirds of plant pit is complete; apply water from above to allow soil to settle.
   g. Lightly compact the settled topsoil of planting mix.
   h. Continue backfilling and form a 3-inch depth saucer around plant, as detailed on plans.
   i. Water plant and surrounding area until backfill is thoroughly moist.

3.05 PERIMETER EDGING

A. Planting areas shall receive a spaded earth edge around the entire perimeter of the planting area. Edge shall be excavated at a 45° angle to the surrounding area to a depth of 8 inches.

3.06 MULCHING & LANDSCAPING FABRIC

A. Place landscaping fabric around all trees and in shrub beds as directed by COTR to retard the growth of weeds in the newly planted areas.

B. Place mulch to a minimum depth of 3 inches in the planting saucer or in the planting beds immediately after planting, per the details shown on drawings. Mulch is to be kept off trunks of trees and shrubs.

C. Provide a minimum 2-foot radius mulch area from tree trunks and shrub branch lines.

D. Provide continuous mulch area around plant groupings.

E. Surface of mulch layer shall be approximately 2 inches below curbs or edging materials.

F. Thoroughly water mulched areas. Rake to a smooth finish surface.

G. Apply herbicide one (1) month after planting to kill weeds.

3.07 STAKING AND GUYING. If specified on the contract drawings, the contractor shall comply with the following.

A. The Contractor shall insure that all plants and trees are secured in an upright, plumb condition prior to completion of project per approval by COTR.

B. Staking or guying shall be completed immediately after planting for all single stem plants and trees over 1 inch caliper and for multi-trunk trees and shrubs over 10’ in height.

C. Locate stakes uniformly from trunk of plant equal to ½ the distance between the securing collar and grade.

D. Set posts vertically into unexcavated soil at a minimum 2 foot depth or until firm providing a required post height above grade.

E. Secure with fabric webbing or wire in rubber hose a minimum of 4 feet above grade or between one-half to two-thirds distance from grade to tree top, around trunk from each stake, with a slight tension while not causing harm to the plant or tree.

F. Provide 3 stakes for trees. Locate stakes equally spaced around plant with one stake located to the southwest of the plant or as directed by the COTR.

3.08 PRUNING

A. Prune broken, damaged, or otherwise defective branches from trees and shrubs. All branches which may not develop properly shall be removed. Competing leaders and suckers shall also be eliminated.

B. Prune trees to develop an upright leader which will promote the symmetry of the tree. Flowering or specimen trees shall be pruned to develop their natural form.

C. Contractor shall provide proper and sharp pruning tools to provide a clean cut.

D. Plant materials incorrectly pruned will be rejected.

E. All pruning shall be done to retain the natural shape of the plant. Do not prune terminal leader of a plant.

F. All cuts shall be made so as not to injure the branch collar or adjacent branches or trunk. Do not leave protruding stubs or prune to the closest outward growing bud.

3.09 CLEANUP

A. Perform cleanup of daily operations during installation of work and upon completion of work.

B. Remove from site all excess materials, trimmings, branches, soils, debris, and equipment as directed by the COTR.

C. Repair any damage resulting from planting operations.

3.10 ACCEPTANCE AND REVIEW

A. The COTR will review the plants and installations to determine completion of the subject contract work. The Contractor shall provide notification of at least 5 days before requested review by the COTR.

B. After the plant and installation review, a listing of acceptance, deficiencies, incomplete work, and requirements for completion of work will be provided to the Contractor.
C. The Contractor shall maintain plants, mulch areas, and staking as specified until corrections or completion of work is approved by the COTR.

D. All plants shall be in a live and healthy condition, of the specified variety and size, and all requirements and maintenance have been complied with. All plants that are dead or not in a vigorous, thriving condition shall be removed and replaced by the Contractor.

E. Mulched areas are to be free of weeds and grasses.

F. Plants that are missing are to be installed during the specified planting season.

G. Contact COTR prior to planting replacements plants for inspection and approval of plants and to verify location.

H. The warranty period for all plants shall begin upon date of acceptance for completed installations.

END OF SECTION

SECTION 33 12 16

WATER UTILITY DISTRIBUTION VALVES

PART 1 GENERAL

1.01 SUMMARY

A. This section specifies valves for plumbing, water utility distribution piping systems.

B. Metal Tags - all piping equipment, control valves, header branch valves & accessories shall be provided with a 2" dia, brass or aluminum, ID tag indicating the equipment designation number, function of the control, etc. (This must match the drawing or control diagram designations). Also include project drawing number. Tags shall be wired to valve or equipment w/#12 AWG (0.0808 inch dia.) galvanized wire. All information is to be stamped.

PART 2 PRODUCTS

2.01 GENERAL VALVE SELECTION CRITERIA

A. Valve patterns for each installation shall be as indicated symbolically on the drawings (i.e. ball valve, gate valve, etc.).

B. Valves shall be selected from the tables in paragraph 2.02 unless the drawings indicate a specific type designation, or a valve is specified by manufacturer and model number.

C. The working pressure ratings for valves submitted may differ from those specified herein, provided they are adequate for the actual system operating pressures and temperatures.

D. Flow factors and orifice sizes specified are minimums, unless otherwise noted on the drawings.

E. Valves shall be full line size, except where a smaller valve equals or exceeds the flow capacity required herein.

2.02 VALVE TYPE SELECTIONS

A. WATER SERVICE - POTABLE, CHILLED, HEATING, AND INDUSTRIAL WATER UP TO 150 PSIG.

		VALVE TYPE DESIGNATIONS							
LINE SIZE	**LOCATION**	**GATE**	**GLOBE**	**CHECK**	**BALL**	**BUTTERFLY**	**NEEDLE**	**SOLENOID**	**RELIEF**
UP TO	**BELOW GRADE**	**GTV-1**							
2"	**ABOVE GRADE**	**GTV-2**	**GLV-1****	**CHV-1**	**BLV-1, BLV-2**	**BFV-1**	**NV-1***	**SOV-1**	**SRV-1**
2 1/2" AND	**BELOW GRADE**	**GTV-1**				**BFV-3**			
LARGER	**ABOVE GRADE**	**GTV-3**	**GLV-2**	**CHV-2**	**BLV-3, BLV-4**	**BFV-2**			**SRV-1**

*** AVAILABLE UP TO 3/4" NPT ONLY. ** "SEE 2.04A FOR HOSE BIBB SPECIFICATIONS"**

2.03 VALVE TYPE SPECIFICATIONS

A. GATE VALVE

1. TYPE GTV-1: AWWA approved, iron body, bronze mounted, non-rising stem, double disc, parallel seat, 200 psi water working pressure, square operator nut, end connections as required; Stockham G-700 Series or approved equal.

2. TYPE GTV-2: Bronze body, rising stem, Class 125, solid disc, Stockham Fig. B-100 (threaded), Hammond #IB640 (threaded), Stockham Fig. B-108 (soldered), Hammond #IB635 (soldered), or approved equal.

3. TYPE GTV-3: Iron body, bronze mounted, rising stem, Class 125, flanged, solid wedge disc, OS&Y type; Stockham Fig. G-623, Hammond #IR1140, or approved equal.

4. TYPE GTV-4: Not used.

5. TYPE GTV-5: Not used.

6. TYPE GTV-6: Not used.

7. Suggested Manufacturers:

   a. GTV-1: Stockham, Mueller, Kennedy, or approved equal.

   b. GTV-2 thru GTV-6: Stockham, Crane, Nibco, Powell, Milwaukee, Hammond, or approved equal.

B. GLOBE VALVES

1. TYPE GLV-1: Bronze body and disc, Class 125; Stockham Fig. B16 (threaded), Hammond #IB440 (threaded), Stockham Fig. B17 (soldered), Hammond #IB418 (soldered), or approved equal.

2. TYPE GLV-2: Iron body, bronze mounted, Class 125, flanged, OS&Y type, renewable seat and disc; Stockham Fig. G-512, Hammond #IR116, or approved equal.

3. TYPE GLV-3: Not used.

4. TYPE GLV-4: Not used.

5. TYPE GLV-5: Not used.

6. TYPE GLV-6: Not used.

7. TYPE GLV-7: Not used.

8. TYPE GLV-8: Not used.

9. TYPE GLV-9: Not used.

10. TYPE GLV-10: Not used.

11. TYPE GLV-11: Not used.

12. TYPE GLV-12: Not used.

13. SUGGESTED MANUFACTURERS:

    a. GLV-1 thru GLV-7: Stockham, Crane, Nibco, Powell, Milwaukee, Hammond, or approved equal.

    b. GLV-8 and GLV-9: Not used,

    c. GLV-10 thru GLV-12: Not used.

C. CHECK VALVES

1. TYPE CHV-1: Bronze body and disc, swing type, Class 125; Stockham Fig. B319 (threaded), Hammond #IB904 (threaded), Stockham Fig. B-309 (soldered), Hammond #IB912 (soldered), or approved equal.

2. TYPE CHV-2: Iron body, bronze mounted, swing type, Class 125, flanged; Stockham Fig. G-931, Hammond #IR1124, or approved equal.

3. TYPE CHV-3: Not used.

4. TYPE CHV-4: Not used.

5. TYPE CHV-5: Not used.

6. TYPE CHV-6: Not used.

7. TYPE CHV-7: Not used.

8. TYPE CHV-8: Not used.

9. TYPE CHV-9: Not used.

10. TYPE CHV-10: Not used.

11. TYPE CHV-11: Not used.

12. TYPE CHV-12: Not used.

13. TYPE CHV-13: Not used.

14. SUGGESTED MANUFACTURERS:

    a. CHV-1 thru CHV-2: Stockham, Crane, Nibco, Powell, Milwaukee, Apollo, Hammond, or approved equal.

    b. CHV-3 thru CHV-11: Not used,

D. BALL VALVES

1. TYPE BLV-1: Standard port, bronze body, chromium plated ball, TFE seats, manual lever, minimum 200 psi w.o.g. and 150 PSI

w.s.p., threaded or soldered ends; Apollo 70-100 series, Watts B-6000 Series, PBM, or approved equal.

2. TYPE BLV-2: Same specification as BLV-1 except full port; Apollo 77-100 series, Watts B-6080 Series, PBM,or approved equal. Note: Watts valve has a maximum steam pressure of 125 PSIG.

3. TYPE BLV-3: Standard port, cast iron or carbon steel body, reinforced TFE seats and seals, ANSI Class 150 flanged ends, manual lever; Apollo 88-100 Series, Watts CF-1500 Series, PBM, or approved equal.

4. TYPE BLV-4: Full port, cast iron body, reinforced TFE seats and seals, ANSI Class 125 flanged ends, manual lever; Watts G-4000 Series or PBM, approved equal.

5. TYPE BLV-5: Not used.

6. TYPE BLV-6: Not used.

7. TYPE BLV-7: Not used.

8. TYPE BLV-8: Not used.

9. TYPE BLV-9: Not used.

10. TYPE BLV-10: Not used.

11. TYPE BLV-11: Not used.

12. Suggested Manufacturers for BLV-1 through BLV-4: Stockham, Apollo, Watts, Worcester, Velan, Parker, Whitey, or approved equal.

13. TYPE BLV-12: Not used.

14. TYPE BLV-13: Not used.

E. BUTTERFLY VALVES

1. Except where otherwise indicated, provide manual detent levers for valves up to 8-inch NPS, and manual gear operators for larger sizes.

2. TYPE BFV-1: 350 PSI w.o.g., 29" Hg vacuum, bronze body, stainless steel disc and stem, Viton seals; Milwaukee "Butterball" Series BB2-100 (threaded), Series BB2-350 (soldered) or approved equal.

3. TYPE BFV-2: 200 PSI CWP, lug or wafer pattern (as noted on drawings), cast iron body, aluminum bronze disc, phenolic-backed elastomer seat; Stockham LG Series or approved equal.

4. TYPE BFV-3: Same as BFV-2, with extension stem to raise actuator to a minimum of twelve inches above grade, unless otherwise indicated.

5. TYPE BFV-4: Not used,

6. TYPE BFV-5: Not used,

7. Suggested manufacturers: Crane, Stockham, Jamesbury, Keystone, Milwaukee, Grinnell, or approved equal.

F. NEEDLE VALVES

1. TYPE NV-1: Class 200, bronze body, threaded ends, globe pattern; Stockham Fig. B-64 or approved equal.

2. TYPE NV-2: Not used,

3. TYPE NV-3: Not used,

4. TYPE NV-4: Not used,

5. Suggested manufacturers:

a. Type NV-1: Stockham, Crane, Milwaukee, or approved equal.

b. Type NV-2 thru NV-4: Not used,

G. SOLENOID VALVES

1. Valve configurations, electrical requirements, and normal position shall be as shown on the drawings.

2. Valves specified by model number below are 2-way valves. 3-way and 4-way valves for the same applications shall meet the same specifications.

3. Unless otherwise indicated, the orifice diameters of all solenoid valves shall equal or exceed the I.D. of the associated pipe or tubing.

4. TYPE SOV-1: 150 PSI w.o.g., slow closing, pilot operated, brass or bronze body, NPT connections, Buna-N disc; ASCO 8221 Series or approved equal.

   Water hammer characteristics of type SOV-1 valves shall meet the requirements of Fluid Controls Institute Standard FCI-82-1, class CC (up to 3/4") or class BB (1" to 2 1/2").

5. TYPE SOV-2: Not used.

6. TYPE SOV-3: Not used.

7. TYPE SOV-4: Not used.

8. TYPE SOV-5: Not used.

9. TYPE SOV-6: Not used.

10. TYPE SOV-7: Not used.

11. TYPE SOV-8: Not used.

12. TYPE SOV-9: Not used.

13. TYPE SOV-10: Not used.

14. Suggested manufacturers:

    a. SOV-1: Asco, Atkomatic, J.D. Gould, Magnatrol, Skinner, Parker, or approved equal.

    b. SOV 2 through SOV-10: Not used.

H. SAFETY/RELIEF VALVES (SRV'S)

1. SRV capacities and set pressures shall be as specified on the drawings.

2. SRV capacities shall be A.S.M.E. National Board certified.

3. SRV's shall provide the specified relief capacity with a maximum overpressure of 25% for water service.

4. Inlet connection sizes shall be determined by required flow capacity,not by service line size. Discharge piping shall be the full size of the SRV discharge connection, unless the drawings indicate larger.

5. TYPE SRV-1: Water and low-pressure inert gas services.

   a. Body materials - brass, bronze, iron, or carbon steel.

   b. Trim materials - brass, bronze, or stainless steel.

   c. Seat materials - Neoprene, Buna-N, Viton, EPR, or Teflon soft seats.

   d. Connections - NPT or ANSI 150# flanges.

6. TYPE SRV-2: Not used.

7. TYPE SRV-3: Not used.

8. Suggested manufacturers:

   a. Type SRV-1: Anderson-Greenwood, Kunkle, Conbraco, Watts, Cash/Acme, Crosby, Spirax/Sarco, Armstrong, or approved equal.

   b. Types SRV-2 and SRV-3: Not used.

2.04 MISCELLANEOUS VALVES AND ACCESSORIES

A. Hose Bibbs: Water service, 125 PSI w.o.g., bronze body, NPT or solder inlet connection, 3/4-inch hose thread outlet; Nibco Figure #46 or approved equal.

B. Valve Boxes: Roadway extension box, cast iron, two- or three-piece, adjustable, with tee handle valve wrench and drop lid with service identification; Kennedy, Mueller, or approved equal.

C. Chainwheel Operators: Cast iron construction, stem- or handwheel-mounted type, with chain guide, galvanized chain, and all required

mounting hardware; as manufactured by Babbitt Steam Speciality Company or approved equal.

D. Hammer-Blow Chainwheel Operators: Ductile or malleable iron construction, handwheel-mounted, with sprocket rim, hammer-blow mechanism, chain guide, galvanized steel chain, and all required mounting hardware; as manufactured by Babbitt Steam Speciality Company or approved equal.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Provide valves where indicated on the drawings, and as otherwise required for proper system operation.

B. Provide shut-off valves (Ball, Butterfly, or Gate) in all branch connections to mains, and at each piece of equipment.

C. Install all valves to be accessible for maintenance. Where valves are unavoidably concealed in furred spaces, provide maintenance access panels.

D. Install valves with stems vertical if possible. Otherwise, mount with stems horizontal.

E. Remove internal parts of valves, or otherwise protect them from excessive heat during soldering, unless manufacturer’s literature indicates otherwise.

3.02 SAFETY/RELIEF VALVES (SRV'S)

SRV relief pressure settings shall be certified in one of the following ways.

A. Submit a manufacturer's Factory Test Report verifying factory testing and adjustment.

B. Submit an independent agency's Test Report.

C. Perform a bench test in the presence of the Government Inspector.

1. Use a test media that is identical to the contents of the system where the valve will be installed.

2. Use a calibrated test gage to verify the relief pressure setting.

3. Test and adjust the SRV until it consistently relieves at the indicated pressure +/- 5 percent up to 1000 PSIG, and +/- 1 percent above 1000 PSIG.

4. Submit a Field Test Report signed by the witnessing Government Inspector.

3.03 VALVE ACCESSORIES

A. Provide valve boxes and tee handles for all type GTV-1 gate valves.

1. In paved areas, the top of the valve box shall be flush with the pavement. Repair surrounding pavement to match existing.

2. In unpaved areas, provide a 24 inch square or 24 inch diameter round x 4 inch thick reinforced concrete slab around the top of the valve box. The top of the valve box and slab shall be approximately one inch above finished grade. The slab shall taper down to grade at the edges.

B. Chain Operators

1. Provide chain operators for valves as indicated on the drawings.

2. Provide hammer-blow type chainwheel operators for gate valves.

3. When chainwheels are required for butterfly valves, provide valves with manual gear drive operators instead of detent levers.

4. When chain operators are required for ball valves, provide valves with chain levers and dual pull chains.

END OF SECTION

SECTION 33 40 00

STORM DRAINAGE UTILITIES

PART 1 GENERAL

1.01 SUMMARY

This specification covers the furnishing and installation of storm drains. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work. Work shall be in accordance with ALDOT Sections 530, 531, and 533, 1992 Edition.

1.02 SUBMITTALS

Submit for approval items listed in the Schedule of Submittals in accordance with Section 01 33 00, SUBMITTALS.

1.03 RELATED SECTIONS

Section 22 05 53 Identification For Plumbing Piping and Equipment

PART 2 PRODUCTS

2.01 Reinforced Concrete Pipe: ASTM C 76 or AASHTO M 170.

2.02 Reinforced Concrete Arch Culvert and Storm Drainpipe: ASTM C 506.

2.03 Reinforced Concrete Elliptical Culvert and Storm Drainpipe: ASTM C 507.

2.04 Nonreinforced Concrete Pipe: ASTM C 14 or AASHTO M 86, Class 1, Class 2, Class 3.

2.05 Reinforced Concrete Box Sections: ACI 346.

2.06 Clay Pipe: AASHTO M 65 or ASTM C 700.

2.07 Corrugated Steel Pipe, Pipe Arch, and Couplings: Pipe and coupling shall conform to Fed. Spec. WW-P-405.

2.08 Structural-Plate Steel Pipe, Pipe Arches, and Arches: Plate and bolted assembly shall conform to Fed. Spec. WW-P-405.

2.09 Corrugated Aluminum Alloy Pipe, Pipe Arch, and Underdrains: Pipe shall conform to Fed. Spec. WW-P-402.

2.10 Structural-Plate Aluminum Pipe, Pipe Arches, and Arches: Plate and bolted assembly shall conform to Fed. Spec. WW-P-402.

2.11 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings: ASTM D 2751.

2.12 Reinforced Plastic Mortar (RPMP) Sewer Pipe: ASTM D 2992.

2.13 Precast Reinforced Concrete Manhole: ASTM C 478 or AASHTO M 199.

2.14 Reinforced Plastic Mortar (RPM) Manholes: ASTM D 3840.

2.15. Corrugated Polyethylene (PE) Plastic Manholes: ASTM D 3753.

2.16 Glass Fiber-Reinforced Polyester Manholes: ASTM D 3841

2.17 Manhole Covers: Covers and frames shall be traffic bearing, 24" diameter.

2.18 Manhole Ladders or Steps shall be fabricated of steel or heavy-duty aluminum, minimum 16 inches in width with 3/4-inch diameter or square rungs on 12-inch centers. Steel ladders and inserts shall be galvanized after fabrication.

2.19 Precast Concrete Segmental Blocks shall conform to ASTM C 139, and shall be not more than 8 inches thick nor less than 8 inches long.

2.20 Brick shall conform to ASTM C 62, Grade SW, ASTM C 55, Grade S-I or S-II, or ASTM C 32, Grade MS. Brick structures shall be plastered with 1/2-inch or mortar over the entire outside surface of the walls.

2.21 Walls and Headwalls shall be reinforced concrete, plain concrete, or steel sheeting as indicated.

2.22 Flared End Sections shall be a standard design with pipe manufacturer and manufactured of the same material as specified for the pipe.

PART 3 EXECUTION

3.01 Excavation:

A. Where trenches are required under paved areas or driveways, the asphalt or concrete shall be sawed or cut in a smooth line 12 inches outside the trench width and existing pavement removed prior to trench excavation.

B. Trenches: Except where banks are cut back on a stable slope, excavation for trenches shall be sheeted, braced, and shored for depths of 4' or more for proper laying of pipe. Care shall be taken not to over-excavate. Remove stones as necessary to avoid point bearing.

C. 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 8 inches 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 the proper performance of the work.

D. Appurtenances: Excavation for manholes and similar structures shall be sufficient to leave at least 12 inches in the clear between the outer surfaces and the embankment or timber that may be used to hold and protect the banks.

3.02 Backfilling:

A. Subgrade for trench backfill under roadways or parking areas shall be compacted to not less than 95% Modified Proctor Density as established by ASTM D1557 specifications. Earthfill shall be placed in layers not to exceed 6 inches compacted thickness. Subgrade and embankment shall be placed at optimum moisture, not to exceed 2% deviation below or 3% deviation above optimum.

B. Commercial backfill material shall not be required for class "C" bedding material. However, the Contractor may use commercial material for fine grading and bedding at this own option and expense.

C. The Contractor shall be expected to backfill any excavation adjacent to the pavement carrying traffic which would otherwise be left exposed overnight. Such backfill shall be brought level with the existing pavement of the roadway.

D. Provide utility warning and identification tape in accordance with Section 22 05 53.

3.03 Installation:

A. General: Under no circumstances shall pipe be laid in water. No pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary.

B. Plastic Pipe and Manholes: Install plastic pipe and manholes in compliance with ASTM D 2321, ASTM D 3753, and ASTM D 3839.

C. Concrete: Laying shall proceed upgrade with spigot ends of bell and spigot pipe and tongue ends of tongue and groove pipe pointing in the direction of the flow.

D. Circular Concrete Pipe with Elliptical Reinforcing: Placement shall be such that reference lines designating top of pipes will not be more than 5 degrees from the vertical plane through the longitudinal axis of the pipe.

E. Corrugated Metal Pipe and Pipe Arch: Laying shall be with the separate sections joined firmly together with the outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

F. Structural-Plate Steel Pipe, Pipe Arches, and Arches: Tighten bolts on each section progressively and uniformly, starting at one end of the structure after all plates are in place. Repeat the operation of ensure that all bolts are tightened to meet the torque requirement of 200 foot-pounds, plus or minus 50 foot-pounds.

G. Structural-Plate Aluminum Pipe, Pipe Arches, and Arches: Tighten bolts on each plate progressively and uniformly, starting at one end of the structure after all plates are in place. Repeat the operation to ensure that all bolts are torqued to the minimum of 100 foot-pounds on aluminum alloy bolts and a minimum of 150 foot-pounds on galvanized steel bolts.

H. Manholes Ladders: Install manhole ladders when the manhole depth exceeds 4 feet. Anchor ladder adequately to the wall by means of steel inserts spaced not more than 6 feet apart vertically.

Provide at least 7 inches of space between wall and inside of rungs.

END OF SECTION

SECTION 33 46 13

FOUNDATION DRAINAGE PIPING

PART 1 GENERAL

1.01 SUMMARY

This Specification covers the furnishing and installation of drainage piping for shallow foundations and retaining walls.

1.02 SUBMITTALS

Submit for Approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00: SUBMITTALS.

1.03 REFERENCES

AASHTO M252 (2000) Standard Specifications for Corrugated Polyethylene Drainage Tubing

AASHTO M288 (2000) Standard Specifications for Geotextiles

AASHTO M294 (2000) Standard Specifications for Corrugated Polyethylene Plastic Pipe

ASTM C 444 (1995) Standard Specification for Perforated Concrete Pipe

ASTM C 700 (2002) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

ASTM D 448 (1998) Standard Classification for Sizes of Aggregate for Road and Bridge Construction

ASTM D 2661 (2002) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings

ASTM D 2665 (2002) Standard Specification for Polyvinyl Chloride (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

ASTM F 810 (2001) Standard Specification for Smoothwall Polyethylene (PE) Pipe for Use in Drainage and Waste Disposal and Absorption Fields

1.04 RELATED WORK SPECIFIED ELSEWHERE

Subgrade preparation - Section31 20 00: EARTH MOVING

Foundation Construction - Section 03 30 00: CAST-IN-PLACE CONCRETE

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe Materials.

1. Unless specified otherwise in the drawings, furnish pipe conforming to one of the following:

a. Perforated Acrylonitrile-Butadiene-Styrene (ABS): ASTM D 2661.
b. Perforated Polyvinyl Chloride (PVC): ASTM D 2665.
c. Perforated Concrete: ASTM C 444
d. Perforated Clay: ASTM C 700, Standard Strength
e. Perforated Polyethylene: ASTM F 810, NSF approved for drainage
f. Perforated High-Density Polyethylene (HDPE): AASHTO M252 or M 294, Type “S”, with soil-tight hubs

B. Drainage Fill.

1. Round, washed gravel, meeting ASTM D 448, Size Number 24.

2. Filter Fabric.

A. Non-woven polypropylene, minimum 4 ounces per square yard, 15-mil thickness, with an EOS between 70 and 100 (inclusive), and meeting the requirements of AASHTO M288.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install foundation drains where shown on the drawings. Provide not less than 4 inches of drainage fill on all sides of the pipe. Lay concrete bell-and-spigot and tongue-and-groove pipe without mortar. Use glued couplings with all plastic pipes not having push-on hubs. Lay drain pipe with perforations down. Backfill with drainage fill to the depth shown on the drawings.

B. Install filter fabric wrapped completely around all perforated pipe sections.

END OF SECTION

SECTION 33 61 13

UNDERGROUND HYDRONIC ENERGY DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SUMMARY

Work provided under this section includes high density polyethylene (HDPE) piping for underground utility services such as chilled water, hot water, and condenser water.

Uninsulated HDPE piping for underground potable and industrial water services shall be the same as carrier piping specified for chilled water.

1.02 RELATED SECTIONS

A. Section 23 05 23 General- Duty Valves for HVAC Piping

B. Section 23 05 53 Identification for HVAC Piping & Equipment

C. Section 31 23 00 Excavation and Fill

1.03 SUBMITTALS

A. Provide submittals as specified herein, on the drawings, and in the Schedule of Submittals.

When required, the piping manufacturer shall provide detailed installation drawings of the piping system to be installed. Drawings shall include all fittings, offsets, thrust block and anchor locations, expansion loop sizes and locations, and any other information required for installation of a properly functioning system. In addition, the drawings shall indicate all field welds with weld numbers, and lengths of all straight piping sections between welds or fittings.

B. At the completion of installation, the Contractor shall submit shop drawings to the COTR which accurately depict the final “as-built” conditions. These drawings will be incorporated into the record facility drawing files. The “as-built” shop drawings shall be submitted in both electronic and paper (hard copy) formats and shall comply with the format requirements described below.

Electronic files shall be submitted in either Tiff (tg4) or Cals (cals4) image format. Drawings prepared using Computer Aided Design (CAD) software are acceptable substitutes and shall be delivered in dxf, dwg or dgn format only. All Computer Aided Design (CAD) files shall be self-contained and stand-alone. All cross-referenced or reference files shall be electronically merged into the contract drawing such that each drawing file shall be a completely stand-alone document. All levels and/or layers shall be turned on.

All electronic files of drawings shall be delivered on either a CD-ROM.. All media shall be formatted so that it is compatible with Microsoft Windows XP (or above) operating system.

C. For paper (hard copy) drawings, the required drawing size shall be “E” size (40” x 28”) and shall be drawn and lettered to permit reproduction at half size. Lettering shall not be less than 1/8” in height. The AE will properly identify, size, detail, and dimension all the items and conditions on the drawings.

D. When required, the piping manufacturer shall perform a technical review of the A/E’s design drawings, and provide design review comments on the underground piping design. Review shall include recommendations for changes in piping configuration, routing, anchoring, expansion compensation, etc., as required for compliance with the manufacturer’s design and installation guidelines.

1.04 PIPE PACKAGING, HANDLING, STORAGE

A. The manufacturer shall package the pipe in a manner designed to deliver the pipe to the project neatly, intact, and without physical damage. The transportation carrier shall use appropriate methods and provide intermittent checks to insure the pipe is properly supported, stacked, and restrained during transport such that the pipe is not nicked, gouged, or physically damaged.

B. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

C. Sections of pipe having been discovered with cuts or gouges shall be cut out and removed, or repaired by a manufacturer approved extrusion welding process. The choice of repair or replacement

shall be at the discretion of the COTR. When a damaged pipe section is removed, the undamaged portions of the pipe shall be rejoined using the butt fusion joining method.

D. Fused segments of pipe shall be handled so as to avoid damage to the pipe. Care must be exercised to avoid cutting or gouging the pipe.

PART 2 PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. Pipe

Unless otherwise indicated, pipe supplied under this specification shall have a nominal Iron Pipe Size (IPS) OD, and shall be SDR 11 rated at 160 psi at 73 degrees F.

The pipe shall be produced with the dimensions and tolerances specified in ASTM F 714. Additionally, the pipe shall be inspected per industry accepted manufacturer standards for:

Diameter
Wall Thickness
Concentricity
Quick Burst Pressure and Ductility
Joint Length
Straightness
Ovality
Toe-In
Overall Workmanship Inspection on ID and OD
Print Line

The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other deleterious defects and shall be identical in color, density, melt index, and other physical properties throughout.

B. Materials

Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight (EHMW), high density polyethylene with a standard thermoplastic material designation

code of PE3408/3608 and having a minimum cell classification of a 345464C, per ASTM D3550..

The pipe shall be extruded from pre-compounded resin. In plant blending of resin is unacceptable.

The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific product. Said certification shall include a stress life curve per ASTM D 2837. The stress regression testing shall have been done in accordance with ASTM D 2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDR) of 1,600 psi, as determined in accordance with ASTM D 2837.

Further, the material shall be listed by PPI (the Plastics Pipe Institute, a division of the Society of the Plastics Industry) in PPI TR-4 with a 73 degrees F hydrostatic design stress rating of 800 psi, and a 140 degrees F hydrostatic design stress rating of 400 psi. The PPI Listing shall be in the name of the pipe manufacturer and shall be based on ASTM D 2837 and PPI TR-3 testing and validation of samples of the pipe manufacturer's production pipe.

The manufacturer's certification shall state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used, its source, and list its compliance to these specifications.

C. Pipe Extrusion

The pipe shall be extruded using a melt homogenizing/plasticating extruder and "appropriate" die. The extruder screw design should be customized for the HDPE being processed to minimize melt fracture of the molecular structure thus reducing the molecular weight and changing some physical properties from resin to pipe. The resin should be processed at its melt temperature of 500 degrees F to 525 degrees F. The die will have an internally cooled mandrel and an externally cooled bushing. This die will cool the pipe to its solidification point such that it exits the die to specification size, shape, and wall thickness with a polished surface for smooth flow offering a Hazen Williams "C" factor of C=155.

D. Pipe Schedule/Physical Properties

Unless otherwise indicated, HDPE piping shall be SDR-11 rated at 160 PSI at 73 degrees F, and shall have physical properties as noted below.

PROPERTY	SPECIFICATION	UNITS	NOMINAL VALUES
Material Designation	PPI/ASTM	-	PE3408/PE3608
Material Classification	ASTM D 1248	-	III C 5 P34
Cell Classification	ASTM D 3350	-	345464C
Density, Black	ASTM D 1505	gm/cm^3	0.955
Melt Flow	ASTM D 1238	gm/10 min	<0.15 @ 2.16 kg
Flex Modulus	ASTM D 790	psi	136,000
Tensile Str.	ASTM D 638	psi	3500
ESCR, PENT	ASTM F 1473	Hrs	>100
HDB @ 73 deg F	ASTM D 2837	psi	1600
U-V Stabilizer (C)	ASTM D 1603	%C	2.5
Hardness	ASTM D 2240	Shore "D"	64
Compressive Strength (Yield)	ASTM D 695	psi	1600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D 638 (2"/min)	psi	3500
Elongation @ Yield	ASTM D 638	%, min.	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D 638	psi	5000 psi
Elongation @ Break	ASTM D 638	%, min.	800
Modulus of Elasticity	ASTM D 638	psi	125,000
ESCR:			
Slow Crack Growth	Battelle Method	Days to Failure	>32 days
Impact Strength (IZOD) (.125" THK)	ASTM D 256	In-lb/in	144
(.250" THK)	(Method A)	Notch	84
Linear Thermal Expansion Coeff.	ASTM D 696	$in/in/^oF$	1.0×10^{-4}
Thermal Conductivity	ASTM C 177	BTU/in $Ft^2/hrs/^oF$	2.7
Brittleness Temp.	ASTM D 746	^oF	$<-180^oF$
Vicat Soft. Temp.	ASTM D 1525	^oF	+255
Heat Fusion Cond.	--	psi @ ^oF	150 @ 500^oF
NSF Listing	Standard #14	--	"Listed"

E. Fittings

Fittings shall be standard commercial products manufactured by injection molding or by extrusion and machining per ASTM D 1248 or shall be fabricated from PE pipe conforming to this specification. The fittings shall be fully pressure rated by the manufacturer to provide a working pressure equal to the pipe for 50 years service at 73 degrees F with an included 2:1 safety factor. The fittings shall be manufactured from the same resin type, grade, and cell classification as the pipe itself. The manufacture of the fittings shall be in accordance with good commercial practice to provide fittings homogeneous throughout and free from cracks, holes, foreign inclusions, voids, or other injurious defects. The fitting shall be as uniform as commercially practicable in color, opacity, density, and other physical properties. The minimum "quick-burst" strength of the fittings shall not be less than that of the pipe with which the fitting is to be used.

F. Pipe Performance

The pipe will be extruded from resin meeting specifications of ASTM D 3350 with a cell classification of PE-345464C; and ASTM D 1248 pipe grade resin type III, Class C, Category 5, grade P34 polyethylene compound. The pipe shall exhibit the short term tensile and compressive physical properties listed in the schedule and shall provide the long term endurance characteristics recognized by: the compressed pipe ring environmental stress crack resistance greater than 5,000 hrs; the slow crack growth resistance greater than 32 days; the impact strength (toughness) greater than 144 in-lb/in notch; and rotary fatigue endurance at +/- 1600 psi bending stress with Fo greater than 100,000 cycles.

Test results from the manufacturer's testing which show the pipe does not meet appropriate ASTM standards of manufacturer's representation will be cause for rejection of the pipe represented by the testing. These tests may include density and flow rate measurements from samples taken at selected locations within the pipe wall and thermal stability determinations according to ASTM D 3350, 10.1.9.

The Government may request certified lab data from the manufacturer to verify the physical properties of the materials supplied under this specification.

G. QA Deviations

If an approved supplier must supply material that does not meet all requirements of this specification, he must notify the specifying engineer via a written description of the deviation with data that shows the magnitude of the deviation, the justification for the deviation from this specification, and the worst case, long term impact of the deviation on the project. The decision, prior to shipment, to accept material deviating from this specification shall be the responsibility of the specifying engineer.

H. QA Verification

The owner may request certified lab data to verify the physical properties of the compounded materials supplied under this specification or may have random samples taken and have them tested by an independent laboratory.

I. QA Rejection

Polyethylene pipe and fittings may be rejected in whole or in part by the specifying engineer for failure to meet any of the requirements of this specification.

J. QA Records

QA/QC records shall be maintained intact for a minimum of one year from date of production.

K. Pipe Markings

During extrusion production, the HDPE pipe shall be continuously marked with durable printing following this format:

Nominal Size
Dimension Ratio
Pressure Rating
Type
Material Classification
Certification Basis (ASTM)
Pipe Test Category

2.03 UNINSULATED PIPING SYSTEMS

Uninsulated pipe and fittings shall meet all requirements specified herein for the carrier pipe in pre-insulated systems.

2.04 PRE-INSULATED piping systems

A. General

The pre-insulated piping system shall be a product of a manufacturer regularly engaged in providing prefabricated, pre-insulated piping systems. No underground piping system will be acceptable unless the manufacturer has been producing and field testing under actual conditions for a period of 5 years. The manufacturer shall furnish on-site technical instruction as specified herein.

Unless otherwise noted, the system manufacturer and the contractor shall jointly field measure the actual piping lengths and configuration required and shall jointly be responsible for the accuracy of those measurements.

All piping shall be installed as a factory prefabricated pre-insulated system. All pipe shall be insulated with polyurethane foamed-in-place and sealed within a full round HDPE jacket. The exposed ends of each unit shall be factory sealed.

Insulation and jacket may be omitted within 12 inches of fusion welded joints in carrier pipe, provided that exposed ends of insulation are sealed watertight in a manner approved by the piping manufacturer. With Engineering approval, greater than 12 inches may be allowed on larger piping for fusion welding machine placement.

B. Carrier Pipe

The carrier pipe and fittings shall be high density polyethylene (HDPE) as specified in this section.

All fittings shall have the same pressure rating as the carrier pipe. Fittings shall not be insulated or jacketed.

C. Jacket

The outer protective jacket shall be high density polyethylene to the same specifications as the carrier pipe. The jacket shall be manufactured to a minimum thickness of SDR 32.5.

The carrier pipe jacket and insulated system shall be capable of being field formed to a bending radius of 40 times the outer jacket diameter without damage to the carrier pipe, insulation, or jacket.

D. Insulation

The insulation shall be rigid, closed cell polyurethane with a density of 1.9 to 2.1 pounds per cubic foot. The coefficient of thermal conductivity (k) shall be 0.14 BTU/hour-square foot-F/inch at 73 degrees F. The insulation shall be foamed-in-place and shall completely fill the annular space between the carrier pipe and the jacket. Insulation to be 2 inches thick for all pipe sizes, unless otherwise indicated.

Each end of each length of pre-insulated pipe shall be furnished with a polyethylene disc welded between the service pipe and the jacket. The disk shall be recessed approximately 1/2 inch from the end of the pipe. Mastic or other noncompatible enclosures are not acceptable.

1. Underground HDPE chilled water piping shall be insulated only in sizes below 14" diameter. 14"diameter & greater shall not be insulated.

E. Field Joints

All field joints shall be thermal butt fusion welded.

Weld pressures, temperatures, and time shall be in accordance with the system manufacturer's recommendation. The system manufacturer shall furnish or approve all butt fusion welding equipment.

2.05 VALVES AND ACCESSORIES

Tapping/isolation valves at chilled water main tie-ins shall be Type GTV-1 gate valves or type BLV-2 full-port opening ball valve with roadway extensive type valve boxes per Section 23 05 23.

PART 3 EXECUTION

3.01 GENERAL

A. Construction and installation shall be performed in compliance with the manufacturer's Design Guidelines and Installation Guidelines, and this specification. Conflicts between the contract documents and the manufacturer's guidelines shall be brought to the attention of the COTR for resolution. In general, the manufacturer's guidelines will be given precedence.

B. Provide utility warning & identification tape in accordance with Section 23 05 53 for all buried piping.

3.02 MAIN TAPS

A. Connections to existing mains shall be made with piping manufacturer's recommended branch saddle fittings. Provide tapping/isolation valves at branch outlets and tap the mains using a hot tap machine, unless otherwise indicated.

B. Provide valve boxes and tee handles for all tapping/isolation gate valves.

C. Provide poured-in-place concrete supports under tapping/isolation valves.

3.03 TRENCH CONSTRUCTION

Trench construction, embedment materials, pipe bedding, haunching, and backfill shall be in accordance with Section 31 23 00, the drawing details, and the manufacturer's installation instructions.

In trench sections where flowable fill is to be used, the piping shall be anchored at intervals with poured concrete to prevent floating. Concrete shall be allowed to cure before application of flowable fill material.

Provide utility warning and identification tape in accordance with Section 23 05 53.

3.04 ANCHORING AND EXPANSION COMPENSATION

Provide anchors, thrust blocking, and expansion loops per the contract documents, installation drawings, and the manufacturer's recommendations.

3.05 FIELD JOINTS

A. Sections of polyethylene pipe shall be joined into continuous lengths on the job site. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 500 degrees F, alignment, and 150 psi interfacial fusion pressure.

Butt fusion joining shall be 100 percent efficient offering a joint weld strength equal to or greater than the tensile strength of the pipe. Socket fusion shall not be used. Extrusion welding or hot gas welding of HDPE shall not be used for pressure pipe joints, nor in fabrications where shear or structural strength is important. Flanges, unions, grooved-couplers, transition fittings, and some mechanical couplers may be used to mechanically connect HDPE pipe without butt fusion. Refer to the manufacturer's recommendations.

3.06 TESTING

A. HDPE pressure pipe shall be tested for leakage prior to being placed into service. Water shall be used as the test medium. If it becomes necessary to drain test water, it shall be discharged into storm sewers or open drainage ditches if possible.

B. If required in the contract documents, the Contractor shall provide the COTR with a detailed testing plan for approval 30 days prior to testing. The test plan shall indicate scope, method of section isolation, test procedure, safety precautions, flushing of distribution piping, and repair methods.

C. Prior to testing, the piping system shall be partially backfilled, leaving joints exposed. All concrete thrust blocks and anchors shall be cured for a minimum of 7 days.

<u>Caution:</u> Because of its high coefficient of expansion, temperature changes will affect internal pressures in HDPE systems differently than in steel pipe systems. A temperature rise will cause a decrease in system pressure, and a temperature decrease will cause a pressure increase. For this reason, hydrostatic testing should be performed during periods of stable temperature whenever possible.

Under no circumstances shall the piping remain under test pressure for a period longer than 8 hours. If testing cannot be completed within this time due to leakage, equipment failure, etc., test pressure shall be removed and piping shall be allowed to “relax” for 8 hours before testing is resumed.

All hydrostatic testing shall be witnessed by the Government Inspector and the piping manufacturer’s representative. Results of all testing, regardless of outcome, shall be documented, and shall become part of the project documentation.

Pipe sections which fail to meet the acceptance criteria shall be removed and replaced with new sections of pipe. Tests shall be repeated until criteria are met.

3.07 HYDROSTATIC TEST PROCEDURE

The hydrostatic test procedure shall be as follows, or shall be an approved alternative procedure recommended by the piping manufacturer. The test shall consist of an initial expansion phase and a final test phase. The test phase may be performed by either of the two methods described below, unless otherwise noted.

A. Initial Expansion Phase

Fill the piping with water and purge all free air from the test section. Venting of air may be accomplished by providing high-point bleed valves or by temporarily loosening flanges.

Pressurize the test section to 100 PSI for a duration of 4 hrs, with no drop in test pressure after the system has stabilized, unless otherwise noted. Add make-up water each hour for three hours to return the system to test pressure. The final test phase starts after adding make-up water at the end of the third hour.

B. Final Test - Monitored Make-Up Water Method

The hydrostatic test equipment shall include an in-line water meter or other means for measuring required make-up volume and determining test compliance.

The final test duration shall be 2 hours, unless otherwise noted. The test section shall be visually examined for leakage or abnormal deformation during, and at the conclusion of, the test period.

If pressure in the test section has fallen during the test period, and no visible leakage has been detected, add water as required to restore test pressure. Record the amount of make-up water required, and relieve the test pressure.

Piping shall be considered acceptable if it meets the following criteria:

No visible leakage.

No abnormal or permanent deformation.

Quantity of make-up water required to restore test pressure does not exceed the amount listed in the Plastics Pipe Institute (PPI) Technical Report TR 31, Table 16.

C. Final Test – Non-Monitored Make-Up Water Method

Adjust system pressure to 10 psig below the initial expansion phase pressure.

Test duration shall be one hour, unless otherwise noted. The test section shall be visually examined for leakage or abnormal deformation during, and at the conclusion of, the test period.

Record the final pressure, and relieve system test pressure.

Piping shall be considered acceptable if it meets the following criteria:

No visible leakage.

No abnormal or permanent deformation.

Test pressure holds within 5% of initial setting.

3.08 SYSTEM FLUSHING

After successful completion of testing, flush the system with water to remove dirt, trash, and debris prior to placing in service.

If local system pumps are used to circulate the flush water, temporary strainers shall be provided at pump suction inlets, and pump suction pressure shall be monitored to prevent cavitation.

3.09 MANUFACTURER’S REPRESENTATIVE

A. Unless otherwise noted, the services of a factory trained field service instructor, a full time employee of the manufacturer, shall be required. He shall be present during critical stages of installation and tests including, but not limited to, unloading and storing of piping, butt fusion welding, and hydrostatic testing.

B. The field service instructor shall submit a report to the COTR at each visit to the job site certifying that the underground piping is being installed in accordance with the manufacturer's recommendation. He shall immediately report to the Government Inspector any deviation from accepted installation procedures.

C. Upon completion of the installation, the Contractor shall furnish to the Contracting Officer certification that the system was installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 33 63 13

UNDERGROUND STEAM & CONDENSATE DISTRIBUTION PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Provide pre-insulated underground steam and condensate systems as indicated on the drawings, and as specified herein.

B. Contract Drawings indicate general pipe route only. Contractor is responsible for submitting a detailed design layout prepared by the system supplier, as noted below.

1.02 RELATED SECTIONS

A. Section 23 05 00 Common Work Results for HVAC

B. Section 23 05 53 Identification for HVAC Piping & Equipment

C. Section 31 23 00 Excavation and Fill

1.03 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, "Submittals", in sufficient detail to show full compliance with the specification:

A. Steam Distribution and Condensate Return System Drawings

Submit a detailed design layout of the system (plan and elevation views) showing size, type, elevations, and location of each component to be used in the system. Include, if applicable, transition point design to aboveground or other type systems.

B. Work Plan

Submit a proposed schedule of activities indicating when various items of work and tests are to be carried out, and when quality control inspectors of the pre-insulated system supplier will be present at the job site.

C. System Compliance Certification

Upon completion of work, and before final acceptance, submit a notarized statement (Certification of Compliance) signed by a principal officer of both the manufacturing and contracting firms, certifying that the system has been installed satisfactorily and in accordance with the Contract Documents and the system supplier's design.

D. Representative's Reports

1. Whenever the system supplier’s representative is required to be on the job site, he shall submit a daily written report. The report shall be checked for accuracy, and the original presented, no later than the next working day after the work has been performed. One copy shall be forwarded to the system supplier's main office.

2. The report shall be signed by the representative, and shall state whether or not the condition and quality of the materials used, and the installation of the system are in accordance with the drawings and specifications.

3. If anything connected with the installation is unsatisfactory, the report shall state what corrective action has been taken, or shall contain the system supplier's recommendations for corrective action.

4. The report shall identify any conditions that could result in an unsatisfactory installation, including such items as open conduit ends left in the trench overnight, improper valve manhole entries, etc.

E. Operation and Maintenance Manuals

The operation and maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Manuals shall include piping and equipment layout of the system installed.

F. As-Built Drawings

At the completion of installation, the Contractor shall submit shop drawings to the COTR which accurately depict the final “as-built” conditions. These drawings will be incorporated into the record facility drawing files. The “as-built” shop drawings shall be submitted in both

electronic and paper (hard copy) formats and shall comply with the format requirements described below.

1. Electronic files shall be submitted in either Tiff (tg4) or Cals (cals4) image format. Drawings prepared using Computer Aided Design (CAD) software are acceptable substitutes and shall be delivered in dxf, dwg or dgn format only. All Computer Aided Design (CAD) files shall be self-contained and stand-alone. All cross-referenced or reference files shall be electronically merged into the contract drawing such that each drawing file shall be a completely stand-alone document. All levels and/or layers shall be turned on.

   All electronic files of drawings shall be delivered on a CD-ROM. All media shall be formatted so that it is compatible with Microsoft Windows XP (or above) operating system.

2. For paper (hard copy) drawings, the required drawing size shall be “E” size (40” x 28”) and shall be drawn and lettered to permit reproduction at half size. Lettering shall not be less than 1/8” in height. The AE will properly identify, size, detail, and dimension all the items and conditions on the drawings.

1.04 DEFINITIONS

A. Pre-insulated System

1. A complete underground steam distribution and condensate return system, including all required components such as conduit, carrier pipes and fittings, anchors, pipe supports, and insulation.

2. The pre-insulated system shall include all piping and components to a point six inches above grade or inside a building or steam pit.

3. The pre-insulated system does not include steam pits and the piping and equipment inside them.

B. System Supplier

The system supplier is the company responsible for the manufacture of the pre-insulated system. This company is also responsible for directing the installation of their system, and for having a representative on the job site as required.

C. System Supplier's Representative

The system supplier's representative shall be a person who regularly performs the duties specified herein, is certified in writing by the system supplier to be technically qualified and experienced in the installation of the system, and is authorized by the supplier to make and sign the daily reports specified herein.

D. Contractor

The company responsible for the installation of the pre-insulated system and all other components of the underground steam and condensate systems, including the steam pits and the piping and equipment in them. This responsibility includes all of the site work, purchase of the pre-insulated system from the system supplier, and installation of the system in accordance with the Contract Documents and the system supplier's instructions.

PART 2 PRODUCTS

2.01 STEAM DISTRIBUTION SYSTEM

The steam distribution system shall be one of the following:

A. A fiberglass reinforced resin conduit, with an annular air space of at least 1 inch, and insulated Schedule 40 black steel carrier piping.

B. A fiberglass reinforced resin conduit, with insulated black steel Schedule 40 carrier piping, and factory applied conduit seals at the ends of each piping segment (not to exceed 20 feet).

2.02 CONDENSATE RETURN SYSTEM

The condensate return system shall consist of one of the following:

A. A fiberglass reinforced resin or PVC conduit, with an annular air space of at least 1 inch, and insulated Schedule 80 black steel carrier piping.

B. A fiberglass reinforced resin or PVC conduit, with insulated Schedule 80 black steel carrier piping, and factory applied conduit seals at the ends of each piping segment (not to exceed 20 feet).

2.03 APPURTENANCES

A. Both systems shall consist of piping as indicated, plus all fittings, anchors, seals, and appurtenances necessary for a complete and operable system.

B. The design, manufacture, fabrication, installation, and testing of the system and its components shall be in accordance with the contract specifications and the system manufacturer's recommendations.

2.04 SYSTEM REQUIREMENTS

A. Site Classification

The system provided shall be approved for continuous contact between conduit and groundwater.

B. Operating Characteristics

Unless otherwise noted on drawings, the following operating characteristics shall apply.

1. The steam system shall be designed for a supply temperature of 353 degrees F and an operating pressure of 125 psig.

2. The condensate return system shall be designed for an operating temperature of 180 degrees F and an operating pressure of 20 psig.

C. Underground Connections

1. Except as noted below, all field fabricated underground connections shall be welded. Piping 2-1/2" and larger shall be butt welded. Piping 2" and smaller may be socket welded.

2. If other than welded connections are to be made between underground piping sections, the methods of joining shall be the manufacturer's standard method as evidenced by catalog cuts or other engineering literature, and shall be submitted for approval.

D. Insulation Thickness

1. The minimum thickness of insulation for the steam distribution and condensate return systems shall be as shown in the following tables.

2. The notation N/A indicates that the system is not available in the indicated pipe size.

3. The composite insulation system described in Table 1 is commonly used by Thermal Pipe Systems, Inc.

4. Epitherm Delta is a V-grooved mineral wool board insulation as provided by NOVA Group.

TABLE 1
MINIMUM PIPE INSULATION THICKNESS IN INCHES
FOR STEAM (16 PSIG TO 250 PSIG)

	INSULATIONS				COMPOSITE SYSTEMS	
Nominal Pipe Size (Inches)	Paroc	Epitherm Delta	Kaylo-10 Thermo-12 Super Caltemp	Foamglas	Calcium Silicate +	Polyur-ethane
1.0	2.0	2.5	4.0	4.5	N/A	N/A
1.5	2.0	2.5	4.0	4.5	N/A	N/A
2.0	2.5	3.5	4.5	5.0	N/A	N/A
2.5	2.5	3.5	4.5	5.0	N/A	N/A
3.0	3.0	4.0	5.0	6.0	1.0 +	1.646
4.0	3.0	4.0	5.0	6.0	1.0 +	1.625
5.0	3.0	4.0	5.0	6.0	N/A	N/A
6.0	3.5	4.5	5.5	6.0	1.5 +	1.797

TABLE 2
MINIMUM PIPE INSULATION THICKNESS IN INCHES
FOR CONDENSATE RETURN (LESS THAN 250 DEGREES F)

Nominal Pipe Size (inches)	Paroc	Epitherm	Foamglass Kaylo-10 Thermo-12 Super Caltemp	Polyurethane
1.0	1.5	2.0	3.0	N/A
1.5	1.5	2.0	3.0	N/A
2.0	1.5	2.0	3.0	1.024
2.5	1.5	2.0	3.0	N/A
3.0	2.0	2.5	3.5	1.376
4.0	2.0	2.5	3.5	1.401
5.0	2.0	2.5	3.5	N/A
6.0	2.5	3.0	4.5	1.770

E. Factory Testing

Each section of carrier piping shall be hydrostatically tested at the factory in accordance with ANSI B31.1.

PART 3 EXECUTION

3.01 INSTALLATION, INSPECTION, AND TESTING

A. The pre-insulated system shall be installed, inspected, and tested in accordance with the contract drawings and specifications, and directions given by the system supplier's representative.

B. The system supplier's representative shall be present at the job site when the following types of work are being performed:

1. Inspection and unloading of pre-insulated piping sections.

2. Inspection of trench prior to laying of conduit.

3. Inspection of concrete thrust blocks prior to cold springing.

4. Cold springing.

5. Hydrostatic testing of all service lines.

6. Field joint closure work.

7. Air testing of conduit.

8. Patching and repair of conduit required for branch line connections to mains.

9. Initial backfill up to 10 inches above the top of the casing.

10. Verification of the slope of the system. Elevation readings required by paragraph 3.04 shall be witnessed and recorded.

The Contractor shall not perform any of this work in the absence of the system supplier's representative.

C. The system supplier's representative shall take prompt action to return to the factory all damaged or defective material, and to order prompt replacement of such material.

D. Anchors shall be installed at each change of direction, at each high point in the system, at each point of connection to the condensate return line, and where otherwise indicated on the drawings.

E. After installation all carrier piping shall be hydrostatically tested for 2 hours (minimum) in accordance with ANSI B31.1.

F. The conduit for systems with annular air spaces shall be tested for 1 hour (minimum) at 8 psig with dry nitrogen.

3.02 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

Provide utility warning and identification tape in accordance with Section 23 05 53.

3.03 RADIOGRAPHIC INSPECTION

Provide a 10 percent radiographic examination of field welds in the carrier piping in accordance with Section 23 05 00.

3.04 VERIFICATION OF FINAL ELEVATIONS

A. Prior to covering the top of the casing with backfill material,but after all temporary supports have been removed and initial backfilling of the conduit system has been accomplished, the Contractor shall measure and record the elevation of the top of the casing in the trench.

B. Elevations shall be taken at every completed field joint and elbow top. These measurements shall be checked against the contract drawings, and shall confirm that the conduit system has been installed to the elevations shown.

C. The measurements shall be recorded by the Contractor and given to the Contracting Officer prior to covering the casing with backfill material.

3.05 GENERAL CLEANING REQUIREMENTS

A. All gross contamination shall be removed by mechanical processes, flushing, or high velocity blowdown prior to final cleaning. Mechanical testing shall be accomplished after precleaning and before final cleaning. All lengths of pipe, fittings, and piping system components shall be precleaned prior to welding and assembly.

B Assemblies not suitable for cleaning as assembled shall have component parts cleaned prior to assembly; or shall be disassembled, cleaned, and reassembled. This shall apply to assemblies from which cleaning solutions cannot be adequately drained.

C. Flanged and flared joints shall be loosened as required during the cleaning procedure to assure complete drainage of cleaning and rinsing solutions.

D. Components may be provided factory-cleaned if the manufacturer's cleaning and handling procedures are submitted and approved in advance.

E. The Contractor is responsible for maintaining the cleanliness of all cleaned systems and components. Any system or component that becomes recontaminated shall be recleaned at no additional cost to the Government.

3.06 QUALITY ASSURANCE PROVISIONS

A. The Contractor is responsible for the performance of all inspection requirements. Except as otherwise noted, he may use his own, or any other, inspection facilities and services approved by the COTR.

B. Records of the examinations and tests shall be kept complete, and shall be available for inspection by the COTR.

C. At the completion of the project, submit copies of all inspection reports to the COTR for his records.

D. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to insure that the work conforms to the prescribed requirements.

END OF SECTION

SECTION 41 22 00

HOISTS AND CRANES

PART 1 GENERAL

1.01 SUMMARY

A. This section establishes general requirements for lifting devices and equipment used in support of MSFC lifting operations. This specification section will be supplemented due to unique requirements of each project.

B. Included in this section are overhead and gantry cranes (including top running monorail, underhung, and jib cranes), mobile cranes, derricks, hoists, and special hoist supported personnel lifting devices. (Note: Elevators, ground supported personnel lifts, and powered platforms are not included in this section.)

1.02 RELATED SECTIONS

A. Section 05 12 00 - Structural Metal Framing

B. Section 09 90 00 - Painting and Coating

1.03 REFERENCES

A. NASA-STD-8719.9 – 05/09/2002 – Standard for Lifting Devices and Equipment

B. ASME NUM-1-2000 - Rules for Construction of Cranes, Monorails, and Hoists With Bridge Trolley or Hoist, Underhung Type

C. ASME B30.11-1998 - Monorails and Underhung Cranes

D. ASME B30.16-1999 - Overhead Hoists (Underhung)

E. ASME B30.17-1998 - Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)

F. ANSI BSR MH27.1-1996 - Patented Track Underhung Cranes and Monorail Systems - Specifications

G. NEMA BU 1-1999 - Busways

H. OSHA Regulations 29 CFR 1910.179 - Overhead and Gantry Crane

I. UL 857-2001 - UL Standard for Busways

J. CMAA 70 (2000) Specifications for Top Running Bridge & GantryType Multiple Girder Electric Overhead Traveling Cranes

K. CMAA 74 (2000) Specifications for Top Running & Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoist.

1.04 SUBMITTALS

A. Submit for approval: Items listed in the Schedule of Submittals in accordance with Section 01 33 00, Submittals

B. In addition, submit 3 copies of the Operation and Maintenance (O & M) manuals 30 days prior to testing the hoist or crane system. If changes to the system are required after installation, update O & M data and resubmit for final approval no later than 10 days prior to contract completion.

1.05 QUALITY ASSURANCE

A. Comply with all applicable standards listed in Article 1.03 of this section.

B. Unless noted otherwise, each hoist or crane system shall be equipped for critical lift operations, as defined in Article 1.5 of NASA-STD-8719.9. Notable specific requirements for critical lift operations include, but may not be limited to, the following:

- Two independent means of braking which will bring a rated load to a full stop and hold it, with or without power, verifiable by testing each brake independently.
- Geared upper and lower limits.
- Dual upper limit switches.
- Operator controlled red emergency “STOP” button.
- Remote emergency “STOP” button (where applicable).
- Pendant station with a sliding festoon system over the entire length of the bridge (where applicable).
- Volumetric test results of the hook provided to the Government for approval.

- Manufacturer name and identification number for the hook placed on the hoist housing.

Refer to NASA-STD-8719.9 for detailed requirements relative to NASA critical lifts for the hoist or crane system specified.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in the manufacture of products specified in this section with a minimum of three years experience.

B. Installer: Company specializing in applying the work of this Section with a minimum of three years experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Section 01 60 00.

B. Store and protect products under provisions of Section 01 60 00.

PART 2 PRODUCTS

2.01 CRANES AND HOISTS

Cranes and hoists, and their components, shall conform to applicable sections of CMAA 70 and 74.

2.02 CRANES

Provide cranes and their component hoists, electrical system components, parts, attachments, and accessories (standard, newly fabricated products of the manufacturer or its supplier) having size, design, and quality to meet requirements specified on the drawing.

2.03 HOISTS

Provide hoist components, including electrical system, attachments, and accessories (standard, newly fabricated products of the manufacturer or its supplier) having size, design, and quality to meet requirements specified on the drawing.

PART 3 EXECUTION

3.01 GENERAL

A. Assemble crane or hoist at the factory, properly wired, and tested without load. Disassemble only as required for shipment or erection. Match-mark each disassembled part for field assembly.

B. Provide adequate and safe erection equipment and tackle as required to mount crane or hoist assembly on appropriate support system.

3.02 ERECTION PROCEDURE

Erect/install cranes or hoists in accordance with the manufacturer's printed instructions and as directed by the manufacturer's erection superintendent and in his presence.

3.03 CRANE RAILS AND RUNWAYS

A. Runways shall be level, in straight alignment, and true to span within tolerances given in CMAA 70 or 74, Section 1.4.

B. Joints shall be smooth, level, and in true alignment to offer no obstruction to end truck movement. Welded joints shall be ground smooth.

3.04 FACTORY TESTS BEFORE SHIPMENT

A. Crane manufacturer shall assemble, wire, and test each overhead crane assembly at the point of manufacture in accordance with the requirements of the referenced documents.

B. The crane manufacturer shall notify the COTR as to the final factory testing schedule to allow the COTR the option to witness the final testing. All costs for the COTR to witness final factory testing will be the responsibility of the Government.

3.05 CRANE TESTS AFTER ERECTION

Completed crane complex, erected, adjusted, lubricated, and made ready for operation, shall be tested by the Contractor in the presence of the COTR in accordance with the referenced documents.

3.06 MONORAIL HOIST OPERATION TESTS

Operation tests shall be performed in accordance with the referenced documents.

3.07 CRANE ELECTRICAL SYSTEM FACTORY TESTS

A. Factory tests on crane electrical systems and associated fittings shall be made in accordance with the applicable provisions of the referenced standards.

B. Temperature, mechanical, and dielectric tests shall be in accordance with UL 857. Voltage-drop and short-circuit tests shall be in accordance with "Testing Standards" of NEMA BU 1.

C. Routine tests shall include dielectric tests on crane electrical system. Certification of dielectric tests shall be submitted and shall show compliance with the referenced standard.

3.08 ON-SITE COMPLEX ELECTRICAL SYSTEM TESTS

A. Crane complex electrical system shall be given continuity and insulation tests after the installation has been completed but before equipment is energized.

B. Contractor shall provide necessary test equipment, labor, and personnel to perform the tests as herein specified. Insulation testing instruments shall consist essentially of a direct-reading ohmmeter and a motor-driven dc generator. Continuity tests shall be conducted using a dc device with bell or buzzer.

C. Electrical-system equipment shall be completely isolated from all extraneous electrical connections. Substation and switchboard feeder breakers, circuit breakers in panelboards, and other disconnecting devices shall be used to isolate the equipment under test.

D. Insulation tests on 480-volt equipment shall be conducted using a 1,000-volt, insulation-testing instrument. Readings shall be recorded every minute and until three equal and consecutive readings are obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

E. Insulation tests on equipment, 300 volts or less, shall be conducted using a 500-volt, insulation-testing instrument. Readings shall be

recorded after 1 minute or 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.

F. Test data shall be recorded and shall include location and identification of busway and megohm readings versus time.

G. Final acceptance shall depend upon satisfactory performance under test. No electrical system shall be energized until recorded test data are approved.

END OF SECTION

TSRC-7 TO TSRC-8 CROSS REFERENCE TABLE

Cross Reference Division	TSRC 8 Section #	TSRC 8 Section Title	TSRC 7 Section and Title
1 General Requirements	01 10 00	General Requirements	01011 General Condition
	01 33 00	Submittals	01330 Submittals
	01 35 23	General Safety Requirements	01061 General Safety Requirements
	01 35 43	Environmental Procedures	01350 Environmental Compliance
	01 42 00	References	01420 Refrence Standards and Definitions
	01 45 00	Quality Assurance/Quality Control	01450 Contractor's Quality Assurance/Quality Control
	01 60 00	Product Requirements	01600 Product Requirements
2 Existing Conditions	02 41 00	Demolition	02220 Demolition and Removal
	02 82 00	Asbestos Remediation	01355 Asbestos Procedurs
	02 83 00	Lead Remediation	09970 Surface Prep of Exterior Steel
3 Concrete	03 30 00	Cast-In-Place Concrete	03300 Cast-In-Place Concrete
	03 80 00	Concrete Core Drilling	03085 Core-Drilling Suspended Concrete Slabs
4 Masonry	04 20 00	Unit Masonry	04200 Masonry
5 Metals	05 12 00	Structural Steel Framing	05100 Structural Metal Framing
	05 21 00	Steel Joist Framing	05210 Steel Joists
	05 31 13	Non-Composite Steel Form Deck	05311 Non-Composite Steel Form Deck
	05 31 23	Steel Roof Deck	05313 Steel Roof Deck
	05 36 00	Composite Steel Deck	05312 Composite Steel Deck
	05 40 00	Cold-Formed Metal Framing	05400 Cold Formed Metal Framing
	05 50 00	Metal Fabrications	05500 Metal Fabrications
	05 52 13	Pipe and Tube Railings	05521 Pipe and Tube Railings
6 Wood, Plastics, and Composites	06 10 00	Rough Carpentry	06100 Rough Carpentry
	06 20 00	Finish Carpentry	06200 Finish Carpentry
	06 41 00	Architectural Wood Casework	06400 Custom Architectural Casework

Cross Reference Division	TSRC 8 Section #	TSRC 8 Section Title	TSRC 7 Section and Title
7 Thermal and Moisture Protection	07 41 13	Metal Roof Panels	07412 Manufactured Steel Roof System
	07 42 13	Metal Wall Panels	07414 Manufactured Steel Siding
	07 51 00	Built-Up Modified Bituminous Roofing	07510 SBS-Modified Bitumen Roofing
	07 84 00	Firestopping	07270 Firestopping
	07 90 00	Joint Protection	07920 Joint Sealers
8 Openings	08 11 13	Hollow Metal Doors and Frames	08110 Steel Doors and Frames
	08 14 00	Wood Doors	08210 Wood Doors
	08 71 00	Door Hardware	08710 Door Hardware
	08 74 00	Access Control Hardware	08715 Electronic Access Control
9 Finishes	09 29 00	Gypsum Board	09250 Gypsum Drywall
	09 30 13	Ceramic Tiling	09312 Ceramic Tile Wall Finish
	09 30 13	Ceramic Tiling	09313 Ceramic Tile Floor Finish
	09 51 00	Acoustical Ceilings	09510 Acoustical Ceilings
	09 65 00	Resillient Flooring	09650 Resilient Flooring
	09 68 00	Carpeting	09680 Carpet
	09 69 00	Access Flooring	10270 Access Floor System
	09 90 00	Painting and Coating	09900 Architectural Painting
10 Specialties	10 14 00	Signage	10426 Signage
	10 21 13	Toilet Compartments	10160 Toilet Partitions
	10 28 00	Toilet, Bath, and Laundry Accessories	10800 Toilet and Bath Accessories
11 Equipment	Not Used		
12 Furnishings	Not Used		
13 Special Construction	13 34 19	Fabricated Engineered Metal Building Structure	13120 Pre-Engineered Building
	13 34 24	Pre-Engineered Retrofit Roof System	13124 Pre-Engineered Retrofit Roof System
14 Conveying Equipment	Not Used		
15	Reserved for Future Expansion		
16	Reserved for Future Expansion		

Cross Reference Division	TSRC 8 Section #	TSRC 8 Section Title	TSRC 7 Section and Title
17	Reserved for Future Expansion		
18	Reserved for Future Expansion		
19	Reserved for Future Expansion		
20	Reserved for Future Expansion		
21 Fire Suppression			
	21 05 00	Common Work Results for Fire Suppression	15050 Basic Mech. Materials and Methods
	21 05 00	Common Work Results for Fire Suppression	15051 Welding for Mechanical Utility Piping
	21 05 00	Common Work Results for Fire Suppression	15052 Weld Radiographic Inspection of Welded Piping
	21 05 29	Hangers and Supports for Fire Suppression Piping and Equipment	15060 Hangers and Supports
	21 05 53	Identification for Fire Suppression Piping and Equipment	15075 Mechanical Identification
	21 10 00	Water-Based Fire-Suppression Systems	13925 Automatic Fire Sprinkler Systems
22 Plumbing	22 05 00	Common Work Results for Plumbing	15050 Basic Mech. Materials and Methods
	22 05 00	Common Work Results for Plumbing	15051 Welding for Mechanical Utility Piping
	22 05 00	Common Work Results for Plumbing	15052 Weld Radiographic Inspection of Welded Piping
	22 05 00.01	Laser Alignment for Plumbing Pumps and Rotating Equipment	15955 Laser Alignment for Pumps and Rotating Equipment
	22 05 19	Gages for Plumbing Piping	15125 Gages
	22 05 23	General-Duty Valves for Plumbing Piping	15110 Valves
	22 05 29	Hangers and Supports for Plumbing Piping and Equipment	15060 Hangers and Supports
	22 05 33	Electrical Heat Tracing for Plumbing Piping	New Section
	22 05 48	Vibration Controls for Plumbing Pumps and Rotating Equipment	15960 Vibration Specification for Pumps and Rotating Equipment
	22 05 53	Identification for Plumbing Piping and Equipment	15075 Mechanical Identification
	22 07 19	Plumbing Piping Insulation	15080 Mechanical Insulation

Cross Reference Division	TSRC 8 Section #	TSRC 8 Section Title	TSRC 7 Section and Title
	22 10 00	Plumbing Pumps	15140 Pumps
	22 11 00	Facility Water Distribution	15405 Plumbing
	22 13 00	Faciltity Sanitary Sewage	15405 Plumbing
	22 14 29.16	Submersible Sump Pumps	15180 Heating and Cooling Piping
	22 15 13	General Service Compressed Air/Gas Piping	15210 Process Air and Gas Piping and
	22 15 13.01	Cleaning for Compressed Air/Gas Piping	15215 Cleaning for Process Air and Gas Piping Systems
	22 21 23.23	Vertical Turbine Plumping Pumps	15140 Pumps
	22 40 00	Plumbing Fixtures & Equipment	15405 Plumbing
	23 05 00	Common Work Results for HVAC	15050 Basic Mech. Materials and Methods
	23 05 00	Common Work Results for HVAC	15051 Welding for Mechanical Utility Piping
	23 05 00	Common Work Results for HVAC	15052 Weld Radiographic Inspection of Welded Piping
	23 05 00.01	Laser Alignment for HVAC Pumps and Rotating Equipment	15955 Laser Alignment for Pumps and Rotating Equipment
	23 05 19	Gages for HVAC Piping	15125 Gages
	23 05 23	General-Duty Valves for HVAC Piping	15110 Valves
	23 05 29	Hangers and Supports for HVAC Piping and Equipment	15060 Hangers and Supports
	23 05 33	Electrical Heat Tracing for HVAC Piping	New Section
	23 05 48	Vibration Controls for HVAC Pumps and Rotating Equipment	15960 Vibration Specification for Pumps and Rotating Equipment
	23 05 53	Identification for HVAC Piping and Equipment	15075 Mechanical Identification
	23 05 93	Testing, Adjusting and Balancing for HVAC (Air and Hydronic)	15950 Testing, Adjusting and Balancing

Cross Reference Division	TSRC 8 Section #	TSRC 8 Section Title	TSRC 7 Section and Title
23 HVAC	23 07 13	Duct Insulation	15080 Mechanical Insulation
	23 07 19	HVAC Piping Insulation	15080 Mechanical Insulation
	23 08 00	Commissioning of HVAC	15995 Commisssioning of HVAC Systems
	23 09 00	Instrumantation and Control for HVAC	15900 HVAC Instrumentation and Controls
	23 09 23	Direct Digital Control/Utility Control System	15901 DDC/UCS
	23 12 13	Facility Fuel Oil Pumps	15140 Pumps
	23 21 13	Above Ground Hydronic Piping	15180 Heating and Cooling Piping
	23 21 23.16	Base-Mounted Centrifugal Hydroninc Pumps	15140 Pumps
	23 21 23.23	Vertical Turbine Hydronic Pumps	15140 Pumps
	23 22 13	Above Ground Steam and Condensate Heating Piping	15180 Heating and Cooling Piping & 15215(?)
	23 22 23	Steam Condensate Pumps	15140 Pumps
	23 23 00	Refrigerant Piping	15180 Heating and Cooling Piping
	23 30 00	HVAC Air Distribution	15810 Ducts
	23 33 00	Air Duct Accessories	15820 Duct Accessories
	23 34 00	HVAC Fans	15830 Fans
	23 37 00	Air Outlets and Inlets	15850 Air Outlets and Inlets
	23 70 00	Central Station Air Handling Equipment	15720 Air Handling Units
	23 81 00	Decentralized Unitary HVAC Equipment	15730 Unitary Air Conditioning Equipment
	23 83 00	Radiant Heating Units/Electric Duct Heaters	15765 Electric Duct Heaters
	23 84 00	Humidity Control Equipment	15750 Humidity Control Equipment
24	Reserved for Future Expansion		
25	Not Used		

Cross Reference Division	TSRC 8 Section #	TSRC 8 Section Title	TSRC 7 Section and Title
26 Electrical	26 05 00	Common Work Results for Electrical	16050 Basic Electrical Materials and Methods
	26 05 13	Medium Voltage Cable	16124 Medium Voltage Cable
	26 05 19	Conductors and Cables	16120 Conductors and Cables
	26 05 26	Grounding and Bonding	16060 Grounding and Bonding
	26 05 29	Hangers and Supports	16070 Hangers and Support
	26 05 33	Raceways and Boxes	16130 Raceways and Boxes
	26 05 53	Electrical Identification	16075 Electrical Identification
	26 08 00	Commissioning of Electrical Systems	16995 Commissioning of Electrical Systems
	26 22 13	Low Voltage Transformers	16460 Low Voltage Transformers
	26 24 16	Panelboards	16440 Panelboards
	26 26 00	Power Distribution Unit	16470 Power Distribution Unit
	26 27 26	Wiring Devices	16140 Wiring Devices
	26 28 16	Enclosed Switches and Circuit Breakers	16410 Enclosed Switches and Circuit Breakers
	26 29 13	Enclosed Controllers	16420 Enclosed Controllers
	26 29 23	Variable-Frequency Motor Controllers	New Section
	26 43 13	Transient Voltage Surge Suppression (TVSS)	16450 Transient Voltage Surge Suppression (TVSS)
	26 51 00	Interior Lighting	16510 Interior Lighting
	26 56 00	Exterior Lighting	16520 Exterior Lighting
27 Communications	Not Used		
28 Electronic Safety and Security			
	28 31 00	Fire Detection and Alarm Systems	16921 Fire Alarm and Detection Systems
	28 33 00	Fuel-Gas Detection Alarm	16922 Combustable Gas Detection and O2 Deficiency Monitoring Systems
29	Reserved for Future Expansion		
30	Reserved for Future Expansion		
	31 10 00	Site Clearing	02200 Site Preparation

Cross Reference Division	TSRC 8 Section #	TSRC 8 Section Title	TSRC 7 Section and Title
31 Earthwork	31 20 00	Earth Moving	02300 Earthwork
	31 23 00	Excavation and Fill	02500 Utility Excavation and Backfill
	31 23 23	Flowable Fill	02315 Ready Mixed Flowable Fill
	31 31 16	Termite Control	02282 Termite Control
	31 35 19	Geosynthetic Slope Protection	02370 Geotextile Sedimentationa nd Erosin Control
32 Exterior Improvements	32 11 16	Aggregate Subbase Courses	02720 Crushed Aggregate Base Course
	32 12 00	Flexible Paving	02740 Bituminous Treatments and Pavements
	32 31 13	Steel Chain-Link Fences and Gates	02820 Steel Chain-Link Fences and Gates
	32 92 00	Turf and Grasses	02920 Sodding and Seeding
	32 93 00	Plants	02900 Landscaping
33 Utilities	33 12 16	Water Utility Distribution Valves	15110 Valves
	33 40 00	Storm Drainage Utilities	02630 Storm Drains
	33 46 13	Foundation Drainage Piping	02621 Foundation Drainage Piping
	33 61 13	Underground Hydronic Energy Distribution Piping	02552 HDPE Piping for Underground Utilities
	33 63 13	Underground Steam and Condensate Distribution Piping	02550 Pre-Insulated Underground Steam Distribution System
34 Transportation	Not Used		
35 Waterways and Marine Construction	Not Used		
36	Reserved for Future Expansion		
37	Reserved for Future Expansion		
38	Reserved for Future Expansion		
39	Reserved for Future Expansion		
40 Process Integration	Not Used		

Cross Reference Division	TSRC 8 Section #	TSRC 8 Section Title	TSRC 7 Section and Title
41 Material Processing and Handling Equipment	41 22 00	Hoists and Cranes	14600 Hoists and Cranes
42 Process Heating, Cooling, and Drying Equipment	Not Used		
43 Process Gas and Liquid Handing Purification, and Storage Equipment	Not Used		
44 Pollution Control Equipment	Not Used		
45 Industry-Specific Manufacturing Equipment	Not Used		
46	Reserved for Future Expansion		
47	Reserved for Future Expansion		
48 Electric Power Generation	Not Used		
49	Reserved for Future Expansion		