Attachment A

SPECIFICATIONS FOR

SHOP ADDITION TO BUILDING 11

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GLENN RESEARCH CENTER
21000 BROOKPARK ROAD, CLEVELAND, OHIO 44135

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SECTION 00 01 15

LIST OF DRAWINGS
01/07

PART 1 GENERAL

1.1 SUMMARY

This section lists the drawings for the project pursuant to contract clause "DFARS 252.236-7001, Contract Drawings, Maps and Specifications."

1.2 CONTRACT DRAWINGS

Contract drawings are as follows:

DRAWING NO.	TITLE
CD_0011-WON10905-GI001	TITLE SHEET
CD_0011-WON10905-CD101	SITE DEMOLITION PLAN
CD_0011-WON10905-CD102	UTILITY DEMOLITION PLAN
CD_0011-WON10905-CD103	ENVIRONMENTAL DEMOLITION FLOOR PLAN
CD_0011-WON10905-C-001	STORM WATER POLLUTION PREVENTION PLAN
CD_0011-WON10905-C-002	STORM WATER POLLUTION PREVENTION PLAN
CD_0011-WON10905-C-003	STORM WATER POLLUTION PREVENTION PLAN
CD_0011-WON10905-C-101	EXISTING CONDITIONS
CD_0011-WON10905-C-102	SITE PLAN
CD_0011-WON10905-C-103	GRADING PLAN
CD_0011-WON10905-C-104	UTILITY PLAN
CD_0011-WON10905-C-105	STORM WATER POLLUTION PREVENTION PLAN
CD_0011-WON10905-C-301	STORM SEWER PROFILE
CD_0011-WON10905-C-501	DETAILS
CD_0011-WON10905-C-502	DETAILS
CD_0011-WON10905-C-503	DETAILS
CD_0011-WON10905-AD101	ARCHITECTURAL DEMOLITION FLOOR PLAN & ELEVATIONS
CD_0011-WON10905-A-001	ARCHITECTURAL GENERAL INFORMATION
CD_0011-WON10905-A-101	ARCHITECTURAL OVERALL FLOOR PLAN
CD_0011-WON10905-A-201	ARCHITECTURAL BUILDING ELEVATIONS
CD_0011-WON10905-A-301	ARCHITECTURAL BUILDING SECTIONS
CD_0011-WON10905-A-401	ARCHITECTURAL ENLARGED FLOOR PLAN
CD_0011-WON10905-A-402	ARCHITECTURAL ENLARGED EQUIPMENT LAYOUT PLAN
CD_0011-WON10905-A-403	ARCHITECTURAL ENLARGED REFLECTED CEILING PLAN
CD_0011-WON10905-A-404	ARCHITECTURAL ENLARGED ROOF PLAN
CD_0011-WON10905-A-501	ARCHITECTURAL WALL SECTION & WALL DETAILS
CD_0011-WON10905-A-502	ARCHITECTURAL ROOF SECTIONS & DETAILS
CD_0011-WON10905-A-601	ARCHITECTURAL ROOM FINISH SCHEDULE, DOOR SCHEDULE, WINDOW SCHEDULE, & DETAILS
CD_0011-WON10905-S-001	STRUCTURAL GENERAL NOTES
CD_0011-WON10905-S-002	STRUCTURAL GENERAL NOTES
CD_0011-WON10905-S-101	STRUCTURAL ROOF FRAMING & FOUNDATION PLAN
CD_0011-WON10905-S-301	STRUCTURAL SECTIONS
CD_0011-WON10905-S-501	STRUCTURAL TYPICAL DETAILS
CD_0011-WON10905-S-502	STRUCTURAL TYPICAL DETAILS
CD_0011-WON10905-MD101	MECHANICAL HVAC FLOOR PLAN - DEMOLITION

DRAWING NO.	TITLE
CD_0011-WON10905-M-001	MECHANICAL TESTING & IDENTIFICATION TABLES, SYMBOLS, ABBREVIATIONS, & NOTES
CD_0011-WON10905-M-101	MECHANICAL HVAC FLOOR PLAN
CD_0011-WON10905-M-201	MECHANICAL HVAC SECTIONS
CD_0011-WON10905-M-501	MECHANICAL HVAC DIAGRAMS & DETAILS
CD_0011-WON10905-M-502	MECHANICAL HVAC DIAGRAMS & DETAILS
CD_0011-WON10905-M-601	MECHANICAL HVAC SCHEDULES
CD_0011-WON10905-M-801	MECHANICAL HVAC CONTROL DIAGRAMS - HVAC-5
CD_0011-WON10905-M-802	MECHANICAL HVAC WIRING DIAGRAMS - HVAC-5
CD_0011-WON10905-ED101	ELECTRICAL FLOOR PLAN - DEMOLITION
CD_0011-WON10905-E-001	ELECTRICAL FIXTURE SCHEDULE & SYMBOL LIST
CD_0011-WON10905-E-101	ELECTRICAL FLOOR PLAN - LIGHTING
CD_0011-WON10905-E-102	ELECTRICAL FLOOR PLAN - POWER
CD_0011-WON10905-E-103	ELECTRICAL FLOOR PLAN - GROUNDING
CD_0011-WON10905-E-501	ELECTRICAL DETAILS
CD_0011-WON10905-E-502	ELECTRICAL WIRING DIAGRAM
CD_0011-WON10905-E-503	ELECTRICAL DETAILS
CD_0011-WON10905-E-601	ELECTRICAL PANEL SCHEDULE
CD_0011-WON10905-E-801	ELECTRICAL ONE-LINE DIAGRAM

-- End of Document --

SECTION 01 11 00.98

SUMMARY OF WORK
04/06

PART 1 GENERAL

1.1 SUMMARY

The work to be performed under this project consists of providing the labor, equipment, and materials to complete the work as follows:

The project is located at Building 11 within the NASA GRC complex. The addition is located on the east side of the building.

BASE BID

Base bid items are listed as follows and include all supportive work required to complete the base bid work.

Single story shop addition to the east of the existing shop area, to match building standard materials.

All related site/civil work.

The work includes general trades, mechanical trades, electrical trades and plumbing trades.

Base bid is the entire addition as shown on the drawings with the exception of the options listed below.

ADD OPTIONS

Add option items are listed as follows and include all supportive work required to complete the base bid work.

Option 1

Replace existing shop area room 100 lighting with new pendant mounted lights.

Option 2

Provide a new unit heater at the new shop addition overhead coiling door.

Option 3

Paint the existing shop area walls, ceiling, mechanical equipment, ducts, etc.

Option 4

Grind and resurface the existing shop area concrete floor.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Upon receipt of Government Furnished Equipment, the Contractor shall submit records in accordance with the paragraph entitled, "Government Furnished Property," of this section.

Submit the following items to the Contracting Officer:

Site Specific Health and Safety Plan (HASP) G
Utility Outages G
Confined Space Permits G
Connection Requests G
Borrow Permits G
Excavation Permits G
Welding Permits G
Burning Permits G

1.3 CONTRACT DRAWINGS

See Section 00 01 15 for a list of drawings which are a part of this contract.

Drawings are available from local vender. Contractors shall purchase drawings from vendor. Reference publications will not be furnished.

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

1.4 WORK RESCHEDULING

Normal duty hours for work shall be from 7:00 a.m. to 5:00 p.m., Monday through Friday. Requests for additional work shall require written approval from the Contracting Officer 7 days in advance of the proposed work period. Special permission will be given in other circumstances on a case by case basis.

1.5 OCCUPANCY OF PREMISES

Building(s) will be occupied during performance of work under this Contract. Occupancy notifications will be posted in a prominent location in the work area.

The Icing Wind Tunnel will be in operation during construction. This will require moving models in and out of the facility via the existing coiling door. THe existing shop area will also be in use during construciton. The contractor will have to coordinate operations with the user.

Before work is started, the Contractor shall arrange with the Contracting Officer a sequence of procedure, means of access, space for storage of materials and equipment, and use of approaches, corridors, and stairways.

1.6 ON-SITE PERMITS

1.6.1 Utility Outages and Connection Requests

Work shall be scheduled to hold outages to a minimum.

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

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

Requests for utility outages and connections shall be made in writing to the Contracting Officer at least 10 working days in advance of the time required. Each request shall state the system involved, area involved, approximate duration of outage, and the nature of work involved.

1.6.2 Hot Work, Excavation and Confined Space Permits

ACTIVITY	SUBMISSION DATE	SUBMISSION FORM
Hot Work Permits	7 days prior to work	NASA Form C-7A & NASA Form C-7B
Confined Space	7 days prior to work	NASA Form C-199
Excavation Permit	21 days prior to work	NASA Form C-927

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

Burning of trash or rubbish is not permitted.

1.7 SALVAGE MATERIAL AND EQUIPMENT

Items of material designated by the Contracting Officer to be salvage shall remain the property of the Government.

It shall be segregated, itemized, delivered, and off-loaded at the Government designated storage area located within 3miles of the construction site.

Contractor shall maintain property control records for material or equipment designated as salvage. Contractor's system of property control may be used if approved by the Contracting Officer. Contractor shall be responsible for storage and protection of salvaged materials and equipment until disposition by the Contracting Officer.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 31 19.98

PROJECT MEETINGS
04/06

PART 1 GENERAL

1.1 SUMMARY

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

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

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

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

1.3 PRECONSTRUCTION CONFERENCE

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

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

1.4 PROJECT MEETINGS

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

Prepare a Two-Week Planning Schedule for each weekly project meeting. highlighting utility outages, material deliveries, subcontractors onsite, equipment on site, coordination issues and updates to the master schedule described in Section 01 33 00, "Submittal Procedures".

Meeting Minutes shall be kept by the Contractor and distributed after concurrence by the Construction Manager.

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

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

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 32 01.00 10

PROJECT SCHEDULE
07/07

PART 1 GENERAL

1.1 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.

U.S. ARMY CORPS OF ENGINEERS (USACE)

ECB 2005-10	(2005) Scheduling Requirements for Testing of Mechanichal Systems in Construction
ER 1-1-11	(1995) Progress, Schedules, and Network Analysis Systems

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Project Schedule; G

1.3 QUALIFICATIONS

Designate an authorized representative to be responsible for the preparation of the schedule and all required updating (activity status) and preparation of reports. The authorized representative shall have previously developed, created, and maintained at least 2 electronic schedules for projects similar in nature and complexity to this project and shall be experienced in the use of the scheduling software that meets the requirements of this specification.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Prepare for approval a Project Schedule, as specified herein, pursuant to the Contract Clause, SCHEDULE FOR CONSTRUCTION CONTRACTS. Show in the schedule the sequence in which the Contractor proposes to perform the work and dates on which the Contractor contemplates starting and completing all schedule activities. The scheduling of the entire project, including the design and construction sequences, is required. The scheduling of construction is the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers working on the project shall also contribute

in developing and maintaining an accurate Project Schedule. The schedule must be a forward planning as well as a project monitoring tool.

3.1.1 Approved Poject Schedule

Use the approved Project Schedule to measure the progress of the work and to aid in evaluating time extensions. Make the schedule cost loaded and activity coded. The schedule will provide the basis for all progress payments. If the Contractor fails to submit any schedule within the time prescribed, the Contracting Officer may withhold approval of progress payments until the Contractor submits the required schedule.

3.1.2 Schedule Status Reports

Provide a Schedule Status Report on at least a monthly basis. If, in the opinion of the Contracting Officer, the Contractor falls behind the approved schedule, the Contractor shall take steps necessary to improve its progress including those that may be required by the Contracting Officer, without additional cost to the Government. In this circumstance, the Contracting Officer may require the Contractor to increase the number of shifts, overtime operations, days of work, and/or the amount of construction plant, and to submit for approval any supplementary schedule or schedules as the Contracting Officer deems necessary to demonstrate how the approved rate of progress will be regained.

3.1.3 Default Terms

Failure of the Contractor to comply with the requirements of the Contracting Officer shall be grounds for a determination by the Contracting Officer that the Contractor is not prosecuting the work with sufficient diligence to ensure completion within the time specified in the contract. Upon making this determination, the Contracting Officer may terminate the Contractor's right to proceed with the work, or any separable part of it, in accordance with the default terms of the contract.

3.2 BASIS FOR PAYMENT AND COST LOADING

Use the schedule as the basis for determining contract earnings during each update period and therefore the amount of each progress payment. Lack of an approved schedule update or qualified scheduling personnel will result in an inability of the Contracting Officer to evaluate contract earned value for the purposes of payment. Failure of the Contractor to provide all required information will result in the disapproval of the preliminary, initial and subsequent schedule updates. In the event schedule revisions are directed by the Contracting Officer and those revisions have not been included in subsequent revisions or updates, the Contracting Officer may hold retainage up to the maximum allowed by contract, each payment period, until such revisions to the Project Schedule have been made. Activity cost loading shall be reasonable, as determined by the Contracting Officer. The aggregate value of all activities coded to a contract CLIN shall equal the value of the CLIN on the Schedule.

3.3 PROJECT SCHEDULE DETAILED REQUIREMENTS

The computer software system utilized to produce and update the Project Schedule shall be capable of meeting all requirements of this specification. Failure of the Contractor to meet the requirements of this specification will result in the disapproval of the schedule. Scheduling software that meets the activity coding structure defined in the Standard

Data Exchange Format (SDEF) in ER 1-1-11 are Primavera Project Planner (P3) by Primavera, and Open Plan by Deltek

3.3.1 Critical Path Method

Use the Critical Path Method (CPM) of network calculation to generate the Project Schedule. Prepare the Project Schedule using the Precedence Diagram Method (PDM).

3.3.2 Level of Detail Required

Develop the Project Schedule to an appropriate level of detail. Failure to develop the Project Schedule to an appropriate level of detail, as determined by the Contracting Officer, will result in its disapproval. The Contracting Officer will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail:

3.3.2.1 Activity Durations

Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods. Less than 2 percent of all non-procurement activities shall have Original Durations (OD) greater than 20 work days or 30 calendar days. Procurement activities are defined herein.

3.3.2.2 Procurement Activities

The schedule must include activities associated with the submittal, approval, procurement, fabrication and delivery of long lead materials, equipment, fabricated assemblies and supplies. Long lead procurement activities are those with an anticipated procurement sequence of over 90 calendar days. A typical procurement sequence includes the string of activities: submit, approve, procure, fabricate, and deliver.

3.3.2.3 Mandatory Tasks

The following tasks must be included and properly scheduled:

a. Submission, review and acceptance of design packages.

b. Submission of mechanical/electrical/information systems layout drawings.

c. Submission and approval of O & M manuals.

d. Submission and approval of as-built drawings.

e. Submission and approval of 1354 data and installed equipment lists.

f. Submission and approval of testing and air balance (TAB).

g. Submission of TAB specialist design review report.

h. Submission and approval of fire protection specialist.

i. Submission and approval of testing and balancing of HVAC plus commissioning plans and data. Develop the schedule logic associated with testing and commissioning of mechanical systems to a level of detail consistent with ECB 2005-10.

j. Air and water balancing.

k. HVAC commissioning.

l. Controls testing plan submission.

m. Controls testing.

n. Performance Verification testing.

o. Other systems testing, if required.

p. Contractor's pre-final inspection.

q. Correction of punchlist from Contractor's pre-final inspection.

r. Government's pre-final inspection.

s. Correction of punch list from Government's pre-final inspection.

t. Final inspection.

3.3.2.4 Government Activities

Show Government and other agency activities that could impact progress. These activities include, but are not limited to: approvals, inspections, utility tie-in, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements.

3.3.2.5 Activity Responsibility Coding (RESP)

Assign responsibility Code for all activities to the Prime Contractor, Subcontractor or Government agency responsible for performing the activity. Activities coded with a Government Responsibility code include, but are not limited to: Government approvals, Government design reviews, environmental permit approvals by State regulators, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements. Code all activities not coded with a Government Responsibility Code to the Prime Contractor or Subcontractor responsible to perform the work. Activities shall not have more than one Responsibility Code. Examples of acceptable activity code values are: DOR (for the designer of record); ELEC (for the electrical subcontractor); MECH (for the mechanical subcontractor); and GOVT (for USACE). Unacceptable code values are abbreviations of the names of subcontractors.

3.3.2.6 Activity Work Area Coding

Assign Work Area code to activities based upon the work area in which the activity occurs. Define work areas based on resource constraints or space constraints that would preclude a resource, such as a particular trade or craft work crew, from working in more than one work area at a time due to restraints on resources or space. Examples of Work Area Coding include different areas within a floor of a building, different floors within a building, and different buildings within a complex of buildings. Activities shall not have more than one Work Area Code. Not all activities are required to be Work Area coded. A lack of Work Area coding will indicate the activity is not resource or space constrained.

3.3.2.7 Contract Changes/Requests for Equitable Adjustment (REA) Coding (MODF)

Assign Activity code to any activity or sequence of activities added to the schedule as a result of a Contract Modification, when approved by the Contracting Officer, with a Contract Changes/REA Code. Key all Code values to the Government's modification numbering system. Any activity or sequence of activities added to the schedule as a result of alleged constructive changes made by the Government may be added to a copy of the current schedule, subject to the approval of the Contracting Officer. Assign Activity codes for these activities with a Contract Changes/REA Code. Key the code values to the Contractor's numbering system. Approval to add these activities does not necessarily mean the Government accepts responsibility and therefore liability for such activities and any associated impacts to the schedule, but rather the Government recognizes such activities are appropriately added to the schedule for the purposes of maintaining a realistic and meaningful schedule. Such activities shall not be Responsibility Coded to the Government unless approved. An activity shall not have more than one Contract Changes/REA Code.

3.3.2.8 Contract Line Item (CLIN) Coding (BIDI)

Code all activities to the CLIN on the Contract Line Item Schedule to which the activity belongs. An activity shall not contain more than one CLIN Item Code. CLIN Item code all activities, even when an activity is not cost loaded.

3.3.2.9 Phase of Work Coding (PHAS)

Assign Phase of Work Code to all activities based upon the phase of work in which the activity occurs. Code activities to a Construction Phase. Code fast track construction phases proposed by the Contractor to allow filtering and organizing the schedule by fast track design and construction packages. If the contract specifies construction phasing with separately defined performance periods, identify a Construction Phase Code to allow filtering and organizing the schedule accordingly. Each activity shall be identified with a single project phase and have only one Phase of Work code.

3.3.2.10 Category of Work Coding (CATW)

Assign Category of Work Code to all Activities based upon the category of work to which the activity belongs. Category of Work Code must include, but is not limited to: construction submittal approvals, Acceptance, Procurement, Fabrication, Delivery, Weather Sensitive Installation, Non-Weather Sensitive Installation, Start-Up, Test and Turnover. Assign a Category of Work Code to each activity. Each activity shall have only one Category of Work Code.

3.3.2.11 Definable Features of Work Coding (FOW1, FOW2, FOW3)

Assign a Definable Feature of Work Code to appropriate activities based on the definable feature of work to which the activity belongs. An activity shall not have more than one Definable Feature of Work Code. Not all activities are required to be Definable Feature of Work Coded.

3.3.3 Scheduled Project Completion and Activity Calendars

The schedule interval shall extend from NTP date to the required contract completion date. The contract completion activity (End Project) shall

finish based on the required contract duration in the accepted contract proposal, as adjusted for any approved contract time extensions. The first scheduled work period shall be the day after NTP is acknowledged by the Contractor. Schedule activities on a calendar to which the activity logically belongs. Activities may be assigned to a 7 day calendar when the contract assigns calendar day durations for the activity such as a Government Acceptance activity. If the Contractor intends to perform physical work less than seven days per week, schedule the associated activities on a calendar with non-work periods identified including weekends and holidays. Assign the Category of Work Code - Weather Sensitive Installation to those activities that are weather sensitive. Original durations must account for anticipated normal adverse weather. The Government will interpret all work periods not identified as non-work periods on each calendar as meaning the Contractor intends to perform work during those periods.

3.3.3.1 Project Start Date

The schedule shall start no earlier than the date on which the NTP was acknowledged. Include as the first activity in the project schedule an activity called "Start Project"(or NTP). The "Start Project" activity shall have an "ES" constraint date equal to the date that the NTP was acknowledged, and a zero day duration.

3.3.3.2 Schedule Constraints and Open Ended Logic

Constrain completion of the last activity in the schedule by the contract completion date. Schedule calculations shall result in a negative float when the calculated early finish date of the last activity is later than the contract completion date. Include as the last activity in the project schedule an activity called "End Project". The "End Project" activity shall have an "LF" constraint date equal to the contract completion date for the project, and with a zero day duration or by using the "project must finish by" date in the scheduling software. The schedule shall have no constrained dates other than those specified in the contract. The use of artificial float constraints such as "zero fee float" or "zero total float" are typically prohibited. There shall only be 2 open ended activities: Start Project (or NTP) with no predecessor logic and End Project with no successor logic.

3.3.3.3 Early Project Completion

In the event the Preliminary or Initial project schedule calculates an early completion date of the last activity prior to the contract completion date, the Contractor shall identify those activities that it intends to accelerate and/or those activities that are scheduled in parallel to support the Contractor's "early" completion. The last activity shall have a late finish constraint equal to the contract completion date and the schedule will calculate positive float. The Government will not approve an early completion schedule with zero float on the longest path. The Government is under no obligation to accelerate activities for which it is responsible to support a proposed early contract completion.

3.3.4 Interim Completion Dates

Constrain contractually specified interim completion dates to show negative float when the calculated early finish date of the last activity in that phase is later than the specified interim completion date.

3.3.4.1 Start Phase

Include as the first activity for a project phase an activity called "Start Phase X" where "X" refers to the phase of work. The "Start Phase X" activity shall have an "ES" constraint date equal to the date on which the NTP was acknowledged, and a zero day duration.

3.3.4.2 End Phase

Include as the last activity for a project phase an activity called "End Phase X" where "X" refers to the phase of work. The "End Phase X" activity shall have an "LF" constraint date equal to the specified completion date for that phase and a zero day duration.

3.3.4.3 Phase "X" Hammock

Include a hammock type activity for each project phase called "Phase X" where "X" refers to the phase of work. The "Phase X" hammock activity shall be logically tied to the earliest and latest activities in the phase.

3.3.5 Default Progress Data Disallowed

Do not automatically update Actual Start and Finish dates with default mechanisms that may be included in the scheduling software. Activity Actual Start (AS) and Actual Finish (AF) dates assigned during the updating process shall match those dates provided from Contractor Quality Control Reports. Failure of the Contractor to document the AS and AF dates on the Daily Quality Control report for every in-progress or completed activity, and failure to ensure that the data contained on the Daily Quality Control reports is the sole basis for schedule updating shall result in the disapproval of the Contractor's updated schedule and the inability of the Contracting Officer to evaluate Contractor progress for payment purposes. Updating of the percent complete and the remaining duration of any activity shall be independent functions. Disable program features which calculate one of these parameters from the other.

3.3.6 Out-of-Sequence Progress

Activities that have progressed before all preceding logic has been satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case basis subject to approval by the Contracting Officer. Propose logic corrections to eliminate all out of sequence progress or justify not changing the sequencing for approval prior to submitting an updated project schedule. Correct out of sequence progress that continues for more than two update cycles by logic revision, as approved by the Contracting Officer.

3.3.7 Negative Lags and Start to Finish Relationships

Lag durations contained in the project schedule shall not have a negative value. Do not use Start to Finish (SF) relationships.

3.3.8 Calculation Mode

Schedule calculations shall retain the logic between predecessors and successors even when the successor activity starts and the predecessor activity has not finished. Software features that in effect sever the tie between predecessor and successor activities when the successor has started and the predecessor logic is not satisfied ("progress override") will not be allowed.

3.3.9 Milestones

The schedule must include milestone activities for each significant project event including but not limited to: milestone activities for each fast track design package released for construction; design complete; foundation/substructure construction complete; superstructure construction complete; building dry-in or enclosure complete to allow the initiation of finish activities; permanent power complete; and building systems commissioning complete.

3.4 PROJECT SCHEDULE SUBMISSIONS

Provide the submissions as described below. The data CD, reports, and network diagrams required for each submission are contained in paragraph SUBMISSION REQUIREMENTS.

3.4.1 Preliminary Project Schedule Submission

Submit the Preliminary Project Schedule, defining the Contractor's planned operations for the first 90 calendar days for approval within 15 calendar days after the NTP is acknowledged. The approved Preliminary Project Schedule will be used for payment purposes not to exceed 90 calendar days after NTP. Completely cost load the Preliminary Project Schedule to balance the contract award CLINS shown on the Price Schedule. Detail it for the first 90 calendar days. It may be summary in nature for the remaining performance period. It must be early start and late finish constrained and logically tied as previously specified. The Preliminary Project Schedule forms the basis for the Initial Project Schedule specified herein and must include all of the required Plan and Program preparations, submissions and approvals identified in the contract (for example, Quality Control Plan, Safety Plan, and Environmental Protection Plan) as well as design activities, the planned submissions of all early design packages, permitting activities, design review conference activities and other non-construction activities intended to occur within the first 90 calendar days. Schedule aAny construction activities planned for the first 90 calendar days after NTP. Constrain planned construction activities by Government acceptance of the associated design package(s) and all other specified Program and Plan approvals. Activity code any activities that are summary in nature after the first 90 calendar days with Responsibility Code (RESP) and Feature of Work code (FOW1, FOW2, FOW3).

3.4.2 Initial Project Schedule Submission

Submit the Initial Project Schedule for approval within 42 calendar days after NTP. The schedule shall demonstrate a reasonable and realistic sequence of activities which represent all work through the entire contract performance period. The Initial Schedule shall be at a reasonable level of detail as determined by the Contracting Officer.

3.4.3 Design Package Schedule Submission

With each design package submitted to the Government, submit a frag-net schedule extracted from the then current Preliminary, Initial or Updated schedule which covers the activities associated with that Design Package including construction, procurement and permitting activities.

3.4.4 Periodic Schedule Updates

Based on the result of the meeting, specified in PERIODIC SCHEDULE UPDATE MEETINGS, submit periodic schedule updates. These submissions will enable the Contracting Officer to assess Contractor's progress. If the Contractor fails or refuses to furnish the information and project schedule data, which in the judgement of the Contracting Officer or authorized representative is necessary for verifying the Contractor's progress, the Contractor shall be deemed not to have provided an estimate upon which progress payment may be made.

3.4.5 Standard Activity Coding Dictionary

Use the activity coding structure defined in the Standard Data Exchange Format (SDEF) in ER 1-1-11, Appendix A. This exact structure is mandatory, even if some fields are not used. A template SDEF compatible schedule backup file (sdef.prx) is available on the QCS website: www.rmssupport.com. The SDEF format is as follows:

Field	Activity Code	Length	Description
1	WRKP	3	Workers per Day
2	RESP	4	Responsible Party (e.g. GC, subcontractor, USACE)
3	AREA	4	Area of Work
4	MODF	6	Modification or REA number
5	BIDI	6	Bid Item (CLIN)
6	PHAS	2	Phase of Work
7	CATW	1	Category of Work
8	FOW1	10	Feature of Work (used up to 10 characters in length)
9	FOW2	10	Feature of Work (used up to 20 characters in length)
10	FOW3	10	Feature of Work (used up to 30 characters in length)

3.5 SUBMISSION REQUIREMENTS

Submit the following items for the Preliminary Schedule, Initial Schedule, and every Periodic Schedule Update throughout the life of the project:

3.5.1 Data CD's

Provide two sets of data CD's containing the project schedule in the backup format. Each CD shall also contain all previous update backup files. File medium shall be CD. Label each CD indicating the type of schedule (Preliminary, Initial, Update), full contract number, Data Date and file name. Each schedule shall have a unique file name as determined by the Contractor.

3.5.2 Narrative Report

Provide a Narrative Report with the Preliminary, Initial, and each Periodic Update of the project schedule, as the basis of the progress payment request. The Narrative Report shall include: a description of activities along the 2 most critical paths where the total float is less than or equal to 20 work days, a description of current and anticipated problem areas or delaying factors and their impact, and an explanation of corrective actions taken or required to be taken. The narrative report is expected to communicate to the Government, the Contractor's thorough analysis of the schedule output and its plans to compensate for any problems, either current or potential, which are revealed through that analysis. Identify

and explain why any activities that, based their calculated late dates, should have either started or finished during the update period but did not.

3.5.3 Approved Changes Verification

Include only those project schedule changes in the schedule submission that have been previously approved by the Contracting Officer. The Narrative Report shall specifically reference, on an activity by activity basis, all changes made since the previous period and relate each change to documented, approved schedule changes.

3.5.4 Schedule Reports

The format, filtering, organizing and sorting for each schedule report shall be as directed by the Contracting Officer. Typically reports shall contain: Activity Numbers, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float, Actual Start Date, Actual Finish Date, and Percent Complete. The following lists typical reports that will be requested. One or all of these reports may be requested for each schedule submission.

3.5.4.1 Activity Report

A list of all activities sorted according to activity number.

3.5.4.2 Logic Report

A list of detailed predecessor and successor activities for every activity in ascending order by activity number.

3.5.4.3 Total Float Report

A list of all incomplete activities sorted in ascending order of total float. List activities which have the same amount of total float in ascending order of Early Start Dates. Do not show completed activities on this report.

3.5.4.4 Earnings Report by CLIN

A compilation of the Contractor's Total Earnings on the project from the NTP to the data date. This report shall reflect the earnings of specific activities based on the agreements made in the schedule update meeting defined herein. Provided that the Contractor has furnished a complete schedule update, this report shall serve as the basis of determining progress payments. Group activities by CLIN item number and sort by activity number. This report shall: sum all activities coded to a particular CLIN and provide a CLIN item percent earned value; and complete and sum CLIN items to provide a total project percent complete. The printed report shall contain, for each activity: the Activity Number, Activity Description, Original Budgeted Amount, Total Quantity, Quantity to Date, Percent Complete (based on cost), and Earnings to Date.

3.5.5 Network Diagram

The network diagram is required for the Preliminary, Initial and Periodic Updates. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer will use, but is not limited to, the

following conditions to review compliance with this paragraph:

3.5.5.1 Continuous Flow

Diagrams shall show a continuous flow from left to right with no arrows from right to left. Show the activity number, description, duration, and estimated earned value on the diagram.

3.5.5.2 Project Milestone Dates

Show dates on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

3.5.5.3 Critical Path

Clearly show the critical path.

3.5.5.4 Banding

Organize activities as directed to assist in the understanding of the activity sequence. Typically, this flow will group activities by category of work, work area and/or responsibility.

3.5.5.5 S-Curves

Earnings curves showing projected early and late earnings and earnings to date.

3.6 PERIODIC SCHEDULE UPDATE MEETINGS

Conduct periodic schedule update meetings for the purposes of reviewing the Contractor's proposed out of sequence corrections, determining causes for delay, correcting logic, maintaining schedule accuracy and determining earned value. Meetings shall occur at least monthly within five days of the proposed schedule data date and after the Contractor has updated the schedule with Government concurrence respecting actual start dates, actual finish dates, remaining durations and percent complete for each activity it intend to status. Provide a computer with the scheduling software loaded and a projector during the meeting which allows all meeting participants to view the proposed schedule update during the meeting. The meeting and resultant approvable schedule update shall be a condition precedent to a formal submission of the update as described in SUBMISSION REQUIREMENTS and to the submission of an imvoice for payment. The meeting will be a working interactive exchange which will allow the Government and the Contractor the opportunity to review the updated schedule on a real time and interactive basis. The Contractor's authorized scheduling representative will organize, sort, filter and schedule the update as requested by the Government. The meeting will last no longer than 8 hours. A rough draft of the proposed activity logic corrections and narrative report shall be provided to the Government 48 hours in advance of the meeting. The Contractor's Project Manager and Authorized Scheduler shall attend the meeting with the Authorized Representative of the Contracting Officer.

3.6.1 Update Submission Following Progress Meeting

Submit a complete update of the project schedule containing all approved progress, revisions, and adjustments, pursuant to paragraph SUBMISSION REQUIREMENTS not later than 4 working days after the periodic schedule update meeting, reflecting only those changes made during the previous

update meeting.

3.6.2 Status of Activities

Update information, including Actual Start Dates (AS), Actual Finish Dates (AF), Remaining Durations (RD), and Percent Complete shall be subject to the approval of the Government prior to the meeting. As a minimum, address the following items on an activity by activity basis during each progress meeting.

3.6.2.1 Start and Finish Dates

Accurately show the status of the AS and/or AF dates for each activity currently in-progress or completed since the last update. The Government may allow an AF date to be assigned with the percent complete less than 100% to account for the value of work remaining but not restraining successor activities. Only assign AS dates when actual progress occurs on an activity.

3.6.2.2 Remaining Duration

Update the estimated RD for all incomplete activities independent of Percent Complete. Remaining Durations may exceed the activity OD or may exceed the activity's prior update RD if the Government considers the current OD or RD to be understated based on current progress, insufficient work crews actually manning the job, unrealistic OD or deficiencies that must be corrected that restrain successor activities.

3.6.2.3 Percent Complete

Update the percent complete for each activity started, based on the realistic assessment of earned value. Activities which are complete but for remaining minor punch list work and which do not restrain the initiation of successor activities may be declared 100 percent complete. To allow for proper schedule management, cost load the correction of punch list from Government pre-final inspection activity(ies) not less than 1 percent of the total contract value, which activity(ies) may be declared 100 percent complete upon completion and correction of all punch list work identified during Government pre-final inspection(s).

3.6.2.4 Logic Changes

Specifically identify and discuss all logic changes pertaining to NTP on change orders, change orders to be incorporated into the schedule, Contractor proposed changes in work sequence, corrections to schedule logic for out-of-sequence progress, and other changes that have been made pursuant to contract provisions. The Government will only approve logic revisions for the purpose of keeping the schedule valid in terms of its usefulness in calculating a realistic completion date, correcting erroneous logic ties, and accurately sequencing the work.

3.6.2.5 Other Changes

Other changes required due to delays in completion of any activity or group of activities include: 1) delays beyond the Contractor's control, such as strikes and unusual weather. 2) delays encountered due to submittals, Government Activities, deliveries or work stoppages which make re-planning the work necessary. 3) Changes required to correct a schedule that does not represent the actual or planned prosecution and progress of the work.

3.7 REQUESTS FOR TIME EXTENSIONS

In the event the Contractor believes it is entitled to an extension of the contract performance period, completion date, or any interim milestone date, furnish the following for a determination by the Contracting Officer: justification, project schedule data, and supporting evidence as the Contracting Officer may deem necessary. Submission of proof of excusable delay, based on revised activity logic, duration, and costs (updated to the specific date that the delay occurred) is a condition precedent to any approvals by the Government. In response to each Request For Proposal issued by the Government, the Contractor shall submit a schedule impact analysis demonstrating whether or not the change contemplated by the Government impacts the critical path.

3.7.1 Justification of Delay

The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. The Contracting Officer's determination as to the number of allowable days of contract extension shall be based upon the project schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in a calculated schedule delay, will not be a cause for an extension to the performance period, completion date, or any interim milestone date.

3.7.2 Submission Requirements

Submit a justification for each request for a change in the contract completion date of less than 2 weeks based upon the most recent schedule update at the time of the NTP or constructive direction issued for the change. Such a request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

a. A list of affected activities, with their associated project schedule activity number.

b. A brief explanation of the causes of the change.

c. An analysis of the overall impact of the changes proposed.

d. A sub-network of the affected area.

Identify activities impacted in each justification for change by a unique activity code contained in the required data file.

3.7.3 Additional Submission Requirements

The Contracting Officer may request an interim update with revised activities for any requested time extension of over 2 weeks. Provide this disk within 4 days of the Contracting Officer's request.

3.8 DIRECTED CHANGES

If the NTP is issued for changes prior to settlement of price and/or time, submit proposed schedule revisions to the Contracting Officer within 2 weeks of the NTP being issued. The Contracting Officer will approve proposed revisions to the schedule prior to inclusion of those changes

within the project schedule. If the Contractor fails to submit the proposed revisions, the Contracting Officer may furnish the Contractor with suggested revisions to the project schedule. The Contractor shall include these revisions in the project schedule until revisions are submitted, and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer, advise the Contracting Officer within 2 weeks of receipt of the revisions. Regardless of the objections, the Contractor shall continue to update the schedule with the Contracting Officer's revisions until a mutual agreement in the revisions is reached. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer's proposed revisions, the Contractor will be deemed to have concurred with the Contracting Officer's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work.

3.9 WEEKLY PROGRESS MEETINGS

a. The Government and the Contractor shall meet weekly (or as otherwise mutually agreed to) between the meetings described in paragraph PERIODIC SCHEDULE UPDATE MEETINGS for the purpose of jointly reviewing the actual progress of the project as compared to the as planned progress and to review planned activities for the upcoming two weeks. The then current and approved schedule update shall be used for the purposes of this meeting and for the production and review of reports. The Contractor's Project Manager and the Authorized Representative of the Contracting Officer shall attend. The weekly progress meeting will address the status of RFI's, RFP's and Submittals.

b. Provide a bar chart produced by the scheduling software, organized by Total Float and Sorted by Early Start Date, and a two week "look-ahead" schedule by filtering all schedule activities to show only current ongoing activities and activities schedule to start during the upcoming two weeks, organized by Work Area Code (AREA) and sorted by Early Start Date.

c. The Government and the Contractor shall jointly review the reports. If it appears that activities on the longest path(s) which are currently driving the calculated completion date (driving activities), are not progressing satisfactorily and therefore could jeopardize timely project completion, corrective action must be taken immediately. Corrective action includes but is not limited to: increasing the number of work crews; increasing the number of work shifts; increasing the number of hours worked per shift; and determining if Government responsibility coded activities require Government corrective action.

3.10 OWNERSHIP OF FLOAT

Float available in the schedule, at any time, shall not be considered for the exclusive use of either the Government or the Contractor.

3.11 TRANSFER OF SCHEDULE DATA INTO RMS/QCS

The Contractor shall download and upload the schedule data into the Resident Management System (RMS) prior to RMS databases being transferred to the Government and is considered to be additional supporting data in a form and detail required by the Contracting Officer pursuant to FAR 52.232-5 - Payments under Fixed-Price Construction Contracts. The receipt of a proper payment request pursuant to FAR 52.232-27 - Prompt Payment for

Construction Contracts is contingent upon the Government receiving both acceptable and approvable hard copies and electronic export from QCS of the application for progress payment.

-- End of Section --

SECTION 01 33 00

SUBMITTAL PROCEDURES
10/06

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Submittal Descriptions (SD)

Submittals requirements are specified in the technical sections. Submittals are identified by SD numbers and titles as follows.

SD-01 Preconstruction Submittals

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

Certificates of insurance.
Surety bonds.
List of proposed subcontractors.
List of proposed products.
Construction Progress Schedule.
Submittal register.
Schedule of prices.
Health and safety plan.
Work plan.
Quality control plan.
Environmental protection plan.

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. (Testing must have been within three years of date of contract award for the project.)

Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports.

Daily logs and checklists.

Final acceptance test and operational test procedure.

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a manufacturer, supplier, installer or subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

Confined space entry permits.

Text of posted operating instructions.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and Material Safety Data sheets concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must be signed by an authorized official of a testing laboratory or agency and must state the test results; and indicate whether the material, product, or system has passed or failed the test.

Factory test reports.

SD-10 Operation and Maintenance Data

Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

This Data is intended to be incorporated in an operations and maintenance manual or control system.

SD-11 Closeout Submittals
Special requirements necessary to properly close out a construction contract. For example, Record Drawings, 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.

1.1.2 Approving Authority

Office or designated person authorized to approve submittal.

1.1.3 Work

As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submittal register; G

1.3 PREPARATION

1.3.1 Marking

Prepare, review and stamp with Contractor's approval all specified submittals.

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

1.3.2 Drawing Format

Drawing submittals shall be prepared on translucent, reproducible sheets, not less than 8-1/2 by 11 inches nor larger than 30 by 42 inches in size, except for full size patterns or templates. Drawings shall be prepared to accurate size, with scale indicated, unless other form is required. Drawing reproducibles shall be suitable for microfilming and reproduction on the Diazo or Ozalid machines and shall be of a quality to produce clear, distinct lines and letters. Drawings shall have dark lines on a white background.

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

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

b. Date of the drawings and revisions.

c. Name of Contractor.

d. Name of Subcontractor.

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

f. Submittal number (e.g., first submittal to last submittal) in a uniform location adjacent to the title block.

g. Specification section to which submittal applies.

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

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

A blank space, no smaller than 3 inches shall be reserved on the right hand side of each sheet for the Government disposition stamp.

1.3.3 Data Format

Required data submittals for each specific material, product, unit of work, or system shall be collected into a single submittal and marked for choices, options, and portions applicable to the submittal. Marking of each copy of product data submitted shall be identical. Partial submittals will be accepted for expedition of construction effort.

1.3.4 Samples

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

1.4 SUBMISSION REQUIREMENTS

1.4.1 Schedules

Within 15 calendar days of notice to proceed, provide, for approval by the Contracting Officer, the following schedule of submittals:

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

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

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

d. Re-submit copies of both schedules and annotate monthly by the Contractor with actual submission and approval dates. When all items on a schedule have been fully approved, no further re-submittal of the schedule is required.

1.4.2 Data Submittals

Submit Five complete sets of indexed and bound product data. three sets, marked with review notations by the Contracting Officer, will be returned to the Contractor.

1.4.3 Samples

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

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

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

1.5 GOVERNMENT'S REVIEW

1.5.1 Review Notations

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

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

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

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

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

e. Contractor shall make corrections required by the Contracting Officer. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes" shall be given to the Contracting Officer. Approval of the submittals by the Contracting Officer shall not be

construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. Contractor shall be responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Government requiring rejection and removal of such work at the Contractor's expense.

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

1.5.2 Sample Approval

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

Each sample shall have a label indicating:

a. Name of project

b. Name of Contractor

c. Material or equipment

d. Place of origin

e. Name of producer and brand

f. Specification section to which samples applies

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

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

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

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

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

unsatisfactory in service.

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

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

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

1.6 PROGRESS SCHEDULE

1.6.1 Bar Chart

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

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

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

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

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

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

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

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

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

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

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 35 26.98

GENERAL SAFETY REQUIREMENTS
04/06

PART 1 GENERAL

1.1 SUMMARY

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

1.2 REFERENCES

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

CODE OF FEDERAL REGULATIONS (CFR)

10 CFR 20	(1991) Standards for Protection Against Radiation
29 CFR 1910	(1996) Occupational Safety and Health Standards
29 CFR 1926	(1996) Safety and Health Regulations for Construction

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA NHB 1700.1	(1993) (V1-B) NASA Safety Policy and Requirements Documents
GRC-MQSA.001	Glenn Safety Manual

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

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

SD-07 Certificates

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

Site Specific Health and Safety Plan G
Protection Plan G

License Certificates for radiation materials and equipment shall be submitted by the Contracting Officer prior to the start of work.

1.3.1 Site Specific Health and Safety Plan

Contractor shall submit a site specific safety plan to the Contracting Officer for approval within 10 working days after award of contract and it must be approved prior to notice to proceed. Compliance to the safety plan is mandatory. A copy of this approved plan shall be maintained in the Contractor's field office. This document will be made available upon request from the Contracting Officer's Technical Representative and the Safety Branch Office.

The Site Specific Health and Safety plan shall include, as a minimum, the following:

a. Safety program objectives.

b. Methods to attain safety objectives.

c. Responsibility of key personnel for the Contractor.

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

e. Identification of safety hazards and mitigation plan to allow for safe conduct of work.

f. Disaster and emergency programs.

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

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

i. Methods to comply with the requirement for immediate reporting of mishaps to the Contracting Officer in accordance with NPD 8621.1G.

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

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

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

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

1.3.2 Protection Plan

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

1.4 GENERAL SAFETY PROVISIONS

The GRC Safety Manual, GRC-MQSA.001, is available online at http://smad-ext.grc.nasa.gov/gso/manual/chapter_index.shtml

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

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

1.5 SAFETY LOCKOUT/TAGOUT PROCEDURES

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

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

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

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

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

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

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

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

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

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

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

1.5.1 Tag Placement and Removal

Lockout/tagout tags shall be completed in accordance with the regulations in Chapter 9 of the GRC Safety Manual, GRC-MQSA.001 and attached to any device which, if operated, could cause an unsafe condition to exist.

1.6 ACCIDENT TREATMENT AND RECORDS

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

Emergency response shall require the Contractor to call 911 on a NASA phone or 216 433-8888 on an outside line.

1.7 FIRE PREVENTION AND PROTECTION

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

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

1.8 USE OF EXPLOSIVES

Explosives shall not be used.1.9 ELECTRICAL

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

1.10 UNDERGROUND UTILITIES

Safety clearance from the Contracting Officer is required before any Contractor personnel enters a manhole. Contractor shall contact the Contracting Officer for support services.

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

1.11 RADIATION SAFETY REQUIREMENTS

License Certificates for radiation materials and equipment shall be submitted by the Contracting Officer for all specialized material and equipment that could cause fatal harm to construction personnel or to the construction project.

Workers shall be protected from radiation exposure in accordance with 10 CFR 20. Standards for Protection Against Radiation

Loss of radioactive material shall be reported immediately to the Contracting Officer.

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

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 Contracting Officer 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. Submit plan to radiation office for approval.

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 Contracting Officer.

1.13 PROTECTION OF WORK

Prior to performing any excavation work or any surface penetrations 6 inches or deeper (such as driving stakes more than 6 inches in the ground) on any ground surface, the Contractor shall obtain from the inspection office the current subsurface utility drawing of the particular area to be worked on. Contractor shall stake out subsurface high voltage cables, communication cables, and pipe lines indicated within the scope of the work contemplated. After exposure, the Contractor shall obtain agreement from the Contracting Officer on how much closer to cable or pipe the excavations can be permitted.

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

After obtaining clearance from the Contracting Officer, the Contractor shall proceed with excavating work, or other surface penetration work. Contractor, however, shall temporarily halt any machine excavation work or other surface penetration when approaching within 10 feet 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 GAS PROTECTION

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

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

Special requirements, coordination, and precautions will apply to areas that contain a hazardous atmosphere or, by virtue of their use or physical

character, may be oxygen deficient. A check by Government is required prior to entering confined space. Surveillance and monitoring shall be required in these types of work spaces by both Contractor and Government personnel.

1.15 ROOFING AND COATING

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

1.16 WELDING, FLAME CUTTING, AND MELTING

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

Contractor shall discontinue burning, welding, or cutting operations 1 hour prior to the end of the normal work day. A workman shall remain at the site for 1 hour after discontinuing these operations to make thorough inspection of the area for possible sources of latent combustion. He shall be equipped with two full 15-pound carbon dioxide fire extinguishers. Any unsafe conditions shall be reported to the Safety Branch. (Telephone: (216) 433-8888)

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

1.17 HIGH NOISE LEVEL PROTECTION

Operations performed by the Contractor that involve the use of equipment with output of high noise levels (jackhammers, air compressors, and explosive device activated tools) shall be scheduled for after duty working hours during the hours 4 PM to 12 AM. Use of any such equipment shall be approved in writing by the Contracting Officer prior to commencement of work.

1.18 SEVERE STORM PLAN

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

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

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

c. Ensure that temporary erosion controls are adequate.

1.19 CONFINED SPACE

Comply with the requirements in Chapter 16 of the GRC Safety Manual, 29 CFR 1910.146 and NHS/IHS 1845.2. Any potential for a hazard in the confined space requires a permit system to be used. NHS/IHS 1845.2 is available on the internet at

a. Entry Procedures. Prohibit entry into a confined space by personnel for any purpose, including hot work, until the qualified person has conducted appropriate tests to ensure the confined or enclosed space is safe for the work intended and that all potential hazards are controlled or eliminated and documented. All hazards pertaining to the space shall be reviewed with each employee during review of the AHA.

b. Forced air ventilation is required for all confined space entry operations and the minimum air exchange requirements must be maintained.

c. Ensure the use of rescue and retrieval devices in confined spaces greater than 5 feet in depth.

d. Manholes and excavations require continuous atmosphere monitoring with audible alarm for toxic gas detection and low oxygen levels.

e. Include training information for employees who will be involved as entrant attendants for the work.

f. Entry Permit. Use C-199 , completed by the qualified person. Post the permit in a conspicuous place close to the confined space entrance.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 35 43.98

ENVIRONMENTAL PROTECTION PROCEDURES
04/06

PART 1 GENERAL

1.1 SUMMARY

The pollution prevention, environmental compliance, and sustainability provisions described in this section apply to all work under this contract.

1.2 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.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.120	(2002) Hazardous Waste Operations and Emergency Response
29 CFR 1910.1200	(1996) Hazard Communication
29 CFR 1910	(2001) Occupational Safety and Health Standards
40 CFR 82	(2003) Protection of Stratospheric Ozone
40 CFR 112	(2005) Subpart B Requirements for Petroleum Oils and Non-Petroleum Oils
40 CFR 261	(2005) Identification and Lists of Hazardous Wastes
40 CFR 265.16	(2003) Personnel Training
40 CFR 273.2	(2003) Batteries
40 CFR 273.3	(2003) Pesticides
40 CFR 273.4	(2003) Mercury Thermometers
40 CFR 273.5	(2003) Lamps
40 CFR 173	(2005) Shippers -- general requirements for shipments and packagings
40 CFR 177	(2005) Carriage by public highway
40 CFR 178	(2005) Specifications for packagings
40 CFR 761	(2005) Polychlorinated biphenyls (PCBs) manufacturing, processing, distribution in commerce, and use prohibitions

49 CFR 100-185	(2002) Transportation
50 CFR 17	(2002) Endangered and Threatened Wildlife and Plants

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00, "SUBMITTAL PROCEDURES," in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Environmental protection plan; G

Dirt and dust control plan; G

Hazardous Materials Inventories Statement (HMIS) and Material Safety Data Sheets (MSDS), at project commencement and as necessary to reflect changes in materials stored.

A copy of the Hazard Communication Written Program per 29 CFR 1910.1200(e).

MSDSs of all products before bringing these materials on-site.

List of Solid Waste, Hazardous Waste, Construction Debris (CD) and Commercial/Industrial Fill (CIF) Subcontractors four weeks prior to removal from site.

SD-06 Test Reports

Site Inspection Checklists, every week for projects handling hazardous materials.

RCRA 90-Day Waste Accumulation Site Inspection Checklists, weekly for all hazardous waste storage areas for the duration of the on-site project work.

Hazardous Waste Profiles, and supporting analytical data three weeks prior to disposal for NASA GRC Waste Management (WM) to review prior to signature.

Laboratory analysis

Disposal Requirements

SD-07 Certificates

TSDF Letter of Acceptance and Hazardous Waste Manifests one week prior to shipment and for review by NASA GRC WM and signature by NASA GRC Environmental Management Branch immediately prior to shipment.

Final, signed hazardous waste manifests completed by the contractor and disposal facility in accordance with 40 CFR 261.

The NASA GRC WM shall receive the final signed manifest directly from the disposal facility. In the event the contractor receives the final signed manifest, it shall be immediately forwarded to the NASA GRC WM. For Solid Waste/CD/CIF all documents shall be forwarded to the Contracting Officer by the Contractor.

SD-11 Closeout Submittals

Some of the records listed below are also required as part of other submittals. For the "Records" submittal, maintain on-site a separate three-ring Environmental Records binder and submit at the completion of the project. Make separate parts to the binder corresponding to each of the applicable sub items listed below.

Preconstruction survey

Waste determination documentation

Disposal documentation for solid, hazardous, and regulated waste

Contractor employee training records in compliance with 40 CFR 265.16, 29 CFR 1910.120, 29 CFR 1910.1200 and 40 CFR 82.

Regulatory notification

Erosion and sediment control inspection reports

Solid waste disposal report

Contractor Hazardous Material Inventory Log; G

Hazardous Waste/Debris Management

Reclamation of Equipment Containing Hazardous Waste Residues: The Contractor shall submit to the COTR the facility to which equipment containing hazardous material residues are shipped for reclamation, such as electrical wrapped with asbestos and electrical panels containing asbestos. The disclosure shall be documented on the Bill of Lading or by other written means. This process shall be managed by the WMT.

Disposal of Non-Hazardous Waste Containing Hazardous Material Residue: The Contractor shall submit to the COTR the facility to which equipment containing hazardous material residues are shipped for disposal, such as steel coated with lead paint. The disclosure shall be documented on the Bill of Lading or by other written means. Supporting analytical data shall be included to document the equipment is not hazardous waste.

1.4 GENERAL RESPONSIBILITIES

Conduct project activities in a manner that protects surface/ground water and air quality, conserves resources, and minimizes the use of toxic chemicals and hazardous materials.

Minimize environmental pollution and damage that may occur as the result of construction and demolition operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work shall be protected during the entire duration of this contract.

The Contracting Officer will notify the Contractor in writing of any observed noncompliance with Federal, State, or local environmental laws or regulations, permits, GRC Environmental Policy, and Federal Executive Orders. The Contractor shall, after receipt of such notice, inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer in consultation with the SHED. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extension shall be granted or equitable adjustments allowed to the Contractor for any such suspensions. This is in addition to any other actions the Contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation of Federal Law.

The Contractor shall be responsible for payment of all fines/fees for violation or non-compliance with Federal, State, Regional and local environmental laws and regulations.

1.5 CONSTRUCTION AND DEMOLITION DEBRIS (C&DD) MANAGEMENT

Any removed or demolished item that meets the definition of C&DD shall be evaluated for reuse and/or recycling. The Contractor shall reuse or recycle any item that can be segregated from the waste stream and reused or recycled in a cost effective manner. The NASA GRC WM manages the Construction Waste Management Program. All reuse, recycling and disposal activities shall be coordinated with the NASA GRC WM. The Contractor shall submit a manifest for any C&DD materials that will be reused off site, recycled or disposed of to the COTR, which will then be reviewed and approved by the NASA GRC WM for transportation off-site. Materials that will be reused or recycled shall be segregated and manifested individually. NASA has specifically targeted the following materials for reuse or recycling: Asphalt, Concrete, Gravel/Stone, Commercial/Industrial Fill Soil, Topsoil, Trees/Bushes, Ferrous and Non-Ferrous Metals, Concrete Block, Bricks, Carpeting, and Ceramic Tiles.

1.6 DEFINITIONS

Construction and Demolition Debris - Those materials resulting from the alteration, construction, destruction, rehabilitation, or repair of any manmade physical structure, including, without limitation, houses, buildings, industrial or commercial facilities, or roadways. "Construction and demolition debris" does not include materials identified or listed as solid wastes, infectious wastes, or hazardous wastes pursuant to Chapter 3734 of the Revised Code and rules adopted under it; or materials from mining operations, nontoxic fly ash, spent nontoxic foundry sand, and slag; or reinforced or non-reinforced concrete, asphalt, building or paving brick, or building or paving stone that is stored for a period of less than two years for recycling into a usable construction material. For the purpose of this definition, "materials resulting from the alteration, construction, destruction, rehabilitation, or repair of any manmade physical structure," are those structural and functional materials comprising the structure and surrounding site improvements, such as brick, concrete and other masonry materials, stone, glass, wall coverings, plaster, drywall, framing and finishing lumber, roofing materials, plumbing fixtures, heating equipment, electrical wiring and components containing no hazardous fluids or refrigerants, insulation, affixed carpeting, asphalt substances, metals incidental to any of the above, and weathered railroad ties and utility poles. "Materials resulting from the alteration, construction, destruction, rehabilitation, or repair" do not include

materials whose removal has been required prior to demolition, and materials which are otherwise contained within or exist outside the structure such as solid wastes, yard wastes, furniture, and appliances. Also excluded in all cases are liquids including containerized or bulk liquids, fuel tanks, drums and other closed or filled containers, tires, and batteries.

"Clean hard fill" - C&DD which consists only of reinforced or non-reinforced concrete, asphalt concrete, brick, block, tile, and/or stone which can be reutilized as construction material. Brick in clean hard fill includes but is not limited to refractory brick and mortar. Clean hard fill does not include materials contaminated with solid wastes, hazardous wastes, or infectious wastes.

Hazardous Material - Any material that poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. Common examples are oil, fuel, caustic and acid cleaners, mineral spirits, petroleum distillate based solvents, oil based paints, aerosol spray paints, coolants and antifreeze, and solvents/cleaners containing chlorinated compounds.

Hazardous Waste - As defined in 40 CFR 261.3.

Non-Hazardous Solid Waste - Includes rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, construction, and agricultural operations, and from community activities. Also includes soil with contaminant levels above Voluntary Action Program (VAP) commercial/industrial fill standards.

Non-Sewerable - Wastewater that contains at least one contaminant above the allowable discharge limit set by the Publicly Owned Treatment Works (POTWs) for discharge to the sanitary sewer.

Reclamation - A process to recover or regenerate a usable product. Examples are recovery of lead from spent batteries and regeneration of spent solvents.

Recycling - In general, the use of discarded materials and objects in original or changed form rather than disposing of them. Examples include paper, cardboard boxes, empty containers and certain elements of Construction and Demolition Debris, including but not limited to metal building materials, piping, electrical, wiring, concrete, and masonry building materials, gypsum products and various floor coverings.

Solid Waste - As defined in 40 CFR 261.2.

Surface Discharge - implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers, creeks, and/or "waters of the United States" and may require a permit to discharge water from the State of Ohio.

Universal Waste - Universal Waste means any of the following hazardous wastes that are subject to the universal waste requirements of 40 CFR part 273:

(1) Batteries as described in 40 CFR 273.2
(2) Pesticides as described in 40 CFR 273.3
(3) Thermostats as described in 40 CFR 273.4; and

(4) Lamps as described in 40 CFR 273.5.

1.7 NATURAL AND CULTURAL RESOURCES

The Contractor shall conduct activities in a manner that does not unnecessarily negatively impact fauna or flora, and in accordance with 50 CFR 17. The Contractor shall minimize interference with, disturbance to, and damage to all fish, wildlife, and plants including their habitat. The Contractor shall be responsible for the protection of threatened and endangered animal and plant species including their habitat in accordance with Federal, State, and local laws and regulations.

If during excavation or other construction activities any previously unidentified or unanticipated historical, archaeological, and cultural resources are discovered or found, all activities that may damage or alter such resources shall be temporarily suspended. Resources covered by this paragraph include but are not limited to any human skeletal remains or burials, artifacts, shell, midden (refuse heap), bone, charcoal, or other deposits, rock or coral alignments, pavings, wall, or other constructed features, and any indication of agricultural or other human activities. Upon such discovery or find, the Contractor shall immediately notify the Contracting Officer so that the appropriate authorities may be notified and a determination made as to their significance. The Contractor shall cease all activities that may result in impact to or the destruction of these resources. The Contractor shall secure the area and prevent employees or other persons form trespassing on, removing, or otherwise disturbing such resources. The Contractor may proceed with work in areas devoid of cultural resources.

1.8 WASTEWATER DISCHARGE PERMITS

In accordance with the Clean Water Act and State of Ohio regulations, a specific Incidental Sewer Discharge permit is required before discharging wastewaters to the sanitary sewer system from project activities such as excavation dewatering, cleaning operations, and decontamination water.

The Contractor shall complete and submit a Request for Incidental Sewer Discharge form to the Contracting Officer at least 7 days prior to the planned discharge of contaminated groundwater or other wastewater. The Contracting Officer will inform the SHED of this request and obtain approval for discharge. The request shall include the estimated discharge volume, discharge rate, source of the wastewater and the duration of discharge. Analyses may be needed to obtain discharge approval from EMB.

1.8.1 Wastewater Discharge

With the exception of non-contaminated groundwater from an excavation, wastewater from Contractor operations shall be containerized by the Contractor until the Contractor is notified of discharge approval.

The Contractor shall record and submit information specified in the discharge permit issued to the project including, but not limited to, the location of discharge, dates of discharge, quantity of water discharged, source of the wastewater, dates wastewater was sampled and analyzed (if required), and filtering method (if required).

Non-sewerable wastewater that is hazardous waste shall be managed and disposed of properly by the Contractor. Non-sewerable waastewater that is nonhazardous waste shall be treated, managed, and dsiposed of properly by

the Contractor.

1.9 AIR QUALITY

Construction operations and materials used on the project shall be in compliance with federal, state, and local air pollution standards, rules and regulations.

Chlorofluorocarbons (CFCs), Hydrochlorofluorocarbon (HCFC), Other Ozone Depleting Substances (ODS) and their substitutes.

Class I Ozone Depleting Substances shall not be used in the performance of this contract, nor be provided as part of the equipment without prior written permission from the SHED. This prohibition shall prevail over any other provision, specification, drawing, or referenced documents. A list of Class I ODS may be obtained from US EPA or their web page at http://www.epa.gov/ozone/ods.html.

Class II Ozone Depleting Substances shall not be used in the performance of this contract, nor be provided as part of the equipment without prior written permission from the Environmental Management Branch. This prohibition shall prevail over any other provision, specification, drawing, or referenced documents. A list of Class II ODS may be obtained from US EPA or their web page at http://www.epa.gov/ozone/ods2.html.

Chemicals used in lieu of ozone depleting substances (Substitutes or alternatives) must conform with US EPA's Significant New Alternatives Policy (SNAP) program. These rules are summarized on the US EPA web page at http://www.epa.gov/ozone/snap/lists/index.html.

Service, maintain, renovate, and demolish ODS and ODS Substitute containing equipment in accordance with 40 CFR 82. The Contractor shall ensure that ODS refrigerants and their substitutes are handled by a certified technician. The recovery equipment shall meet applicable EPA requirements and be certified with US EPA.

Hazardous Air Pollutants (HAPs).

The list of specific chemicals and compounds defined as HAPs in Section 112b of the 1990 Clean Air Act Amendments is available from Ohio EPA on-line at: http://www.epa.state.oh.us/dapc/general/haplist.html. This listing is subject to change and only the currently listed items require tracking.

The use of HAPs and materials containing HAPs is allowed at GRC however the airborne release of HAPs shall be minimized at all times.

Records of the use of HAPs and materials containing HAPs must be provided to the CO for forwarding to the SHED. At a minimum, this should include Material Safety Data Sheets and quantities of each HAP and materials containing HAPs used.

Product and waste HAPs and materials containing HAPs must be stored in such a way as to prevent their release to the atmosphere.

Prohibition of Air Pollution Nuisances

No air pollution generating activity shall be allowed if it is expected

to cause an air pollution nuisance.

No air pollution generating activity shall be allowed to continue if it is found to be an air pollution nuisance.

1.10 HAZARDOUS WASTE LIABILITY

Hazardous Waste Liability - For the purpose of this contract, the Contractor shall be responsible for any release or threatened release of the materials or substances handled under this contract, as well as any liabilities resulting or arising from or related to this contract, and shall bear all costs pertaining to such releases including, but not limited to, responses, remediation, testing, or disposal costs, and further shall defend and indemnify the Government for any costs including, but not limited to, any judgments, penalties, assessments, litigation, or attorney fees.

1.11 HAZARDOUS WASTE TRANSPORTATION

Certified Waste Haulers shall be utilized. Government directed waste shall be transported to the disposal facility or interim storage facility without delay, in accordance with Department of Transportation (DOT) manifest regulations. The Contractor shall notify the Government if 10 days or more have a elapsed during shipment.

1.12 SUSTAINABILITY

The Contractor shall conduct its activities in a manner that conserves resources and minimizes pollution in accordance with Executive Order 13101 "Greening the Government Through Waste Prevention, Recycling and Federal Acquisition" and Executive Order 13123 "Greening the Government Through Efficient Energy Management".

Minimize the amount of energy required during construction and operation by using resource efficient construction techniques, building systems (including HVAC, heating, electrical, water, lighting, heat-pumps and boilers), insulation, fixtures, appliances, and controls.

Whenever possible, utilize energy efficient office equipment through the Environmental Protection Agency's Energy Star labeling program (@ http://www.epa.gov/energystar/).

Use automated monitors and controls for energy, water, waste, temperature, moisture, and ventilation.

Conserve water with systems that reduce consumption and recycle water through reclamation and treatment systems.

Maximize the reduction, reuse, recycling or composting of waste and scrap materials.

Minimize waste, spillage, pilferage, spoil, and misuse of building materials.

Follow federal Comprehensive Procurement Guidelines (@ http://www.epa.gov/epaoswer/non-hw/procure/) for building materials and products, and select materials that have a long-life cycle; select least toxic materials; select recyclable materials; select materials

that are resource-efficient; select materials with the maximum recycled content; select materials harvested on a sustained yield basis; select products causing the least pollution during their manufacture, use and reuse.

1.13 TRAINING REQUIREMENTS

Personnel handling hazardous materials shall have received Hazard Communication Training per 29 CFR 1910.1200(h), and personnel handling hazardous waste shall have received appropriate DOT and Hazardous Waste and Emergency Response Operations (HAZWOPER) Emergency Response Awareness Level Ttraining per 29 CFR 1910.120. Employee training documents shall be kept at the jobsite.

Personnel containing spills or conducting cleanup of small spills shall have received First Responder Operators level training per 29 CFR 1910.120. (Note: Personnel with First Responder Operators level training can contain a spill to stop its spread from a safe distance. Their function is to contain the release from a safe distance, keep it from spreading, and prevent exposures.

Personnel generating hazardous waste shall have receive training on the proper management of hazardous waste per 40 CFR 265.16.

Personnel Handling Refrigerants shall have training in accordance with 40 CFR 82.

1.14 CHEMICAL USGAE, STORAGE, AND HANDLING

Hazardous material shall be used only as described on the Material Safety Data Sheet and/or Contractor's written instructions. The Contractor shall wear the protective equipment recommended by the manufacturer of the hazardous material. Containers of hazardous materials and hazardous wastes shall be kept closed except when in use. Containers of liquid hazardous materials shall be stored in secondary containment at the end of each work shift.

1.14.1 Hazardous Materials Storage

Hazardous materials storage shall be in accordance with Federal, State, and local regulations, and the General Storm Water Permit. Hazardous materials shall be handled in a manner that minimizes the potential for releases. All liquid hazardous materials must be secondarily contained. Adequate spill response equipment shall be readily available.

Hazardous materials and hazardous wastes shall be labeled, handled properly, and stored in secondary containment at the end of each work day. Secondary containment shall be of adequate size and compatible with the materials stored. Storage areas shall be properly labeled and secured.

At the beginning of the project, an accurate inventory of hazardous materials and hazardous wastes to be generated including the estimated maximum quantity of each hazardous material to be brought on-site shall be provided to the COTR. Material Safety Data Sheets (MSDSs) for hazardous materials shall be maintained by the Contractor so they are immediately available to assist emergency response personnel in the event of a hazardous materials incident. Copies of the MSDSs shall be provided in the Health and Safety Plan (HASP).

1.14.2 Refuse Bins

Refuse bins shall not be overloaded. Liquid materials shall not be placed in dumpsters or bins. Leaking dumpsters shall be replaced. Dumpsters and bins shall not be cleaned on-site. Dumpsters shall remain covered except when actively being loaded.

1.14.3 Site Inspections

The project site and storage areas shall be inspected weekly to ensure compliance. Compliance status shall be verified by the Contractor. The checklists shall be submitted to the COTR, within 48 hours following the inspection.

1.14.4 Labeling

Containers, drums, vessels, tanks, and associated piping containing hazardous materials shall be labeled in accordance with 29 CFR 1910.1200 (f).

Hazardous material labels must have a description of the contents (including percentages of components for compounds), an appropriate hazard warning and the name and address of the manufacturer or other responsible party.

Hazardous waste and solid waste containers shall be appropriately marked, pending analysis, in accordance with 40 CFR 262 with, at a minimum, accumulation start date and contents and documented during weekly inspections.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 SITE OPERATIONS AND MAINTENANCE

Site Operations shall be conducted in accordance with the Clean Water Act and GRC Storm Water Pollution Prevention Plan. For projects over 1 acre (total) in size, a Storm Water Pollution Prevention Plan must be submitted to the SHED 2 months prior to project commencement for review and approval.

Equipment Fueling and Maintenance - Equipment fluid changes and fueling shall be conducted over drip pans to prevent spilled materials from contacting the ground surface. The operator of leaking equipment shall contain and control the leak. The Contractor shall contact the NASA GRC WM through the Contracting Officer to coordinate proper disposal of waste materials generated during equipment maintenance.

3.1.1 Paint Clean-up

Painting operations must be conducted in accordance with GRC Storm Water Pollution Prevention Plan and applicable State of Ohio requirements.

Water Based Paints:

The Contractor shall paint out as much excess paint as possible from brushes, rollers, and equipment before starting clean up. Rinse

brushes, rollers, and other tools over a sink that drains to the sanitary sewer using water only. Tools and equipment shall not be cleaned into streets, gutters, storm drains, or creeks. Dispose of dry brushes, rollers, rags, and drop cloths as solid waste.

Disposal of containers with any liquids as a solid waste is prohibited. These materials must be used elsewhere or handled as a regulated waste and disposed of in accordance with paragraph entitled Contractor Disposal. Empty containers shall be turned over to NASA GRC WM for disposal. Surplus paint shall be turned over to the Government.

Oil Based Paints:

The Contractor shall paint out as much excess paint as possible from brushes, rollers, and equipment before starting clean up. Cleaning solution shall be containerized and disposed of as hazardous waste. Reuse thinners and solvents by pouring back into original container through a filter.

Dispose of waste thinners, solvents, paint sludge, and solutions from cleaning of equipment and tools as hazardous waste. Containers with residual product shall be managed as a hazardous waste and disposed of. Empty containers shall be turned over to NASA GRC WM for disposal. Surplus paint shall be turned over to the Government.

3.1.2 Concrete/Asphalt Cutting and Core Drilling

The Contractor shall prevent and not allow slurry run-off from saw cutting or core drilling to enter the storm or sanitary sewer collection systems. Catch basins and drains shall be protected.

Empty containers shall be turned over to NASA Waste Unit for disposal. surplus paint shall be turned over to the Government

3.1.3 Sweeping

Roadways and on-site paved areas impacted by the project shall be cleaned to the satisfaction of the COTR and swept at the end of each phase or at project completion. Hosing down paved areas and streets is prohibited.

3.1.4 Sewage Sludge

Sewage Sludge and Compost Materials containing human waste is prohibited from use at GRC.

3.1.5 Draining, Tanks, Piping, and Equipment

Tanks, piping, and equipment shall be drained as required. Devices to properly contain the product shall be provided by the Contractor. Storm drains in the vicinity shall be covered during drainage operations.

The Government will obtain the necessary sanitary sewer discharge permits if the discharge is sewerable. Non-sewerable water shall be treated to a level to allow discharge to the sanitary sewer or managed and disposed of properly by the Government.

3.1.6 Monitoring Wells

Monitoring Wells shall not be disturbed for any reason. If they are disturbed, inadvertently or not, the contractor shall incur all costs associated with the abandonment (i.e. removal) of the well in accordance with Ohio EPA requirements.

3.2 CONTAMINATED SOIL MANAGEMENT

The Contractor shall immediately stop work and notify the COTR if soil appears discolored or has an odor different from what is expected.

3.3 PCBs/PCB CONTAMINATED EQUIPMENT

All PCB-contaminated material shall be handled in accordance with 40 CFR 761.

The Contractor shall dial 911 from any NASA phone or 216-433-8888 from an outside phone to inform Emergency Dispatch of any spills or leaks of PCB-contaminated material.

The contractor shall notify the Contracting Officer of any PCB-contaminated material that needs disposal.

3.4 SPILL PREVENTION, CONTROL AND REPORTING

All liquid petroleum products must be secondarily contained in accordance with Annex Q of GRC's Emergency Preparedness Plan and 40 CFR 112. Spill clean-up materials (such as rags, absorbent booms/pads), and tools (such as shovels and brooms) shall be maintained at the project site and be readily accessible. Releases of hazardous materials to the environment shall be contained and measures implemented to prevent leaks and spills from entering storm drains.

Dial 911 from any NASA phone or 216-433-8888 from an outside phone to inform Emergency Dispatch of any spills or leaks

3.5 HAZARDOUS WASTE DISPOSAL

The Contractor shall label, package, and secondarily contain hazardous waste in accordance with 49 CFR 171, 40 CFR 173, 40 CFR 177, and 40 CFR 178.

Storage of hazardous waste shall not exceed 90 days from the date of generation in accordance with 40 CFR 262. Hazardous waste shall be shipped for disposal no later than 90 days from the date of generation/accumulation start date.

No hazardous material or waste shall remain at the worksite upon completion of the project unless specified otherwise.

3.5.1 Hazardous Waste Manifest

NASA Glenn Research Center shall be designated as the generator on the manifest and only approved SHED personnel shall sign any shipping documents, including Uniform Hazardous Waste Manifests.

NASA Glenn Research Center SHED shall be designated as the emergency contact.

The Contractor shall perform transportation services in compliance with

49 CFR 100-185.

The Contractor shall use only disposal facilities that have a valid permit to manage hazardous waste, and shall be responsible for determining that permit allows for the type of management and disposal intended for that waste. The Contractor shall be responsible for ensuring that any party handling hazardous waste, including subcontractors, transporters, and TSDFs are in compliance with applicable federal, state, and local regulations. GRC SHED shall have final approval of TSDFs.

3.5.2 Containerized Hazardous Waste

Hazardous wastes and other materials shipped by the Contractor with wastes from other facilities shall not be commingled.

3.5.3 Bulk Hazardous Waste

Bulk hazardous waste shipments shall be weighed to confirm shipping weight.

3.5.4 Miscellaneous Hazardous Waste

Fluorescent light tubes, mercury containing and PCB lighting ballasts, emergency lights/exit lights, batteries, and thermostats shall be turned over to the Governement for recycling.

-- End of Section --

SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS
07/06

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization, (e.g. ASTM B 564 Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the standards producing organization should be ordered from the source by title rather than by number.

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U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)
Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
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E-mail: info@ntis.gov
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1015 18th Street, NW, Suite 508
Washington, D.C. 20036
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Fax: 202-828-5110
E-mail: info@usbc.org
Internet: http://www.usgbc.org
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1800 F Street, NW
Washington, DC 20405
Ph: 202-501-1021
Internet: www.GSA.gov

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Arlington, VA 22202
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- - - - - Commercial Item Description Documents - - - - -

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
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College Park, MD 20740-6001
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-- End of Section --

SECTION 01 45 00.98

QUALITY CONTROL
04/06

PART 1 GENERAL

1.1 SUMMARY

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

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

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

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

SD-07 Certificates

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

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

Contractor's Quality Representative Qualifications
Special Certifications

1.2.1 Quality Assurance (QA) Plan

QA plan shall address the following:

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

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

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

Contractor's organization that handles construction contract activities.

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

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

Description of on-site personnel training.

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

Nondestructive testing requirements.

Identification of independent certifying and testing laboratories.

1.2.2 Records

Records shall include all quality control data; factory tests or

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

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

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

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

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

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

1.3 QUALITY ASSURANCE

1.3.1 Qualifications

Contractor's Quality Representative Qualifications shall be submitted to

the Contracting Officer for approval. Quality Representative may be assigned to more than one contract provided that the assigned contracts are located at the same site.

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

1.3.2 Quality Control Requirements

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

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

1.3.2.1 Management and Organization

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

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

1.3.2.2 Identification and Data Retrieval

Contractor shall have an identification and data retrieval system.

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

1.3.2.3 Procurement

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

1.3.2.4 Receiving Inspection System

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

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

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

1.3.2.5 Nonconforming Articles and Material Control

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

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

(1) A unique and traceable number.

(2) Identification of the nonconforming article or material.

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

(4) Cause or reason for the nonconformance.

(5) Remedial actions taken or recommended.

(6) Disposition of the nonconforming article or material.

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

c. The Contractor shall monitor and correct deficient operations.

1.3.2.6 Fabrication, Process, and Work Control

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

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

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

1.3.2.7 Quality Control Records

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

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

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

1.3.2.8 Drawings and Change Control

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

Drawing changes shall be clearly annotated. Implemented changes shall be clearly identified and associated drawings shall be revised accordingly.

Drawings that have been approved, or approved as noted, by the Contracting Officer shall be used for fabrication and inspection.

1.3.3 Quality Inspections

1.3.3.1 Government Inspections

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

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

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

1.3.3.2 Contractor's Quality Inspections

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

Contractor's quality assurance system shall include the following:

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

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

c. Receiving inspection system documenting inspections for each procurement.

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

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

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

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

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

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

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

1.3.4 Field Services

1.3.4.1 Responsibility for Inspection and Testing

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

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

1.3.4.2 Inspection and Test Records

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

Inspection records, test procedures, test results, and associated forms be verified by and provided to the Contracting Officer. Final test data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

1.4 HANDLING AND STORAGE

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

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

1.5 SEQUENCING AND SCHEDULING

Contractor shall notify the Government at least 5 working days prior to scheduled inspections and tests.

Contractor shall provide 5 working days notice to the Government of the date when the contract work will begin at the site.

When Contractor suspends work for 3 calendar days or longer prior to completion, the Contracting Officer shall be notified. Work shall not resume without notification of the Contracting Officer.

Contracting Officer shall be notified at least 2 working days in advance of backfilling or encasing any underground utility.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 50 00.98

TEMPORARY FACILITIES AND CONTROLS
04/06

PART 1 GENERAL

1.1 SUMMARY

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

1.2 REFERENCES

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

FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(Rev H; Change 1 - 2) Obstruction Marking and Lighting

1.3 SUBMITTALS

Not Used

PART 2 PRODUCTS

2.1 CONSTRUCTION SIGN

Contractor shall provide a construction identification sign.

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

2.2 CONSTRUCTION DETAILS

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

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES

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

Contractor shall provide a minimum of 2 aviation red or high intensity white obstruction lights on temporary structures (including cranes) over 100 feet above ground level. Light construction and installation shall comply with FAA AC 70/7460-1. Lights shall be operational during periods of reduced visibility, darkness, and as directed by the Contracting Officer.

3.1.1 Electricity

Contractor shall provide connections, sized to provide service required for power and lighting. Feeder and branch wiring with area distribution boxes shall be located so that power is available throughout the project site by use of power cords. 120/240 electrical volt feeder service is available. Lighting shall be provided by the Contractor. Electricity used will be furnished by the Government.

3.1.2 Water

Contractor shall make connections to existing facilities to provide water for construction purposes. Water used will not be furnished by the Government. Hose connections shall be fitted with anti-syphon devices. Domestic water shall not be discharged to the storm sewer.

3.1.3 Telephone Service

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

3.1.4 Sanitary Facilities

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

3.1.5 Fire Protection

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

3.2 SIGNS

3.2.1 Construction Sign

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

3.2.2 Other Signs and Advertisements

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

3.3 TRAFFIC PROVISIONS

3.3.1 Maintenance of Traffic

Contractor shall conduct his operations in a manner that will not close any thoroughfare or interfere in any way with traffic on railways or highways except with written permission of the Contracting Officer.

Work shall be conducted so as to minimize obstruction of traffic, and traffic shall be maintained on at least half of the roadway width at all times. Approval shall be obtained from the Contracting Officer prior to starting any activity that will obstruct traffic.

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

3.3.2 Rush Hour Restrictions

Contractor shall not interfere with the peak traffic flows preceding and during normal operations without notification to and approval by the Contracting Officer.

3.3.3 Dust Control

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

3.4 PROTECTION OF EXISTING SYSTEMS

3.4.1 Utility

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

3.4.2 Safety

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

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

-- End of Section --

SECTION 01 60 00.98

PRODUCT REQUIREMENTS
04/06

PART 1 GENERAL

1.1 SUMMARY

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

1.2 SUBMITTALS

Not Used

1.3 SHIPMENT AND PROTECTION OF MATERIAL AND EQUIPMENT

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

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

1.4 STORAGE AND PROTECTION OF MATERIAL

1.4.1 Salvage Material

Material to be salvaged and reinstalled by the Contractor shall be protected during removal and stored to prevent damage.

1.4.2 New Material and Construction Equipment

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

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment to be provided under this contract shall be standard catalogue products of manufacturers regularly engaged in the manufacture of the products. All material "cut sheets" and factory acceptance test data shall be provided to the Contracting Officer. Information and data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

Material and equipment shall be installed in accordance with the requirements of the contract drawings , contract specifications and referenced standards and specifications.

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 75 00.98

STARTING AND ADJUSTING
04/06

PART 1 GENERAL

1.1 SUMMARY

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

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

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

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

1.2.1 Tests Required

Tests shall be performed to verify proper functioning of fire protection, fire suppression, HVAC, compressed air, electrical switchgear, protective relaying, fluid and gas systems, pump/motor combinations, boiler systems, hydraulic and pneumatic control, condition/performance monitoring systems, energy control and monitoring systems, and other assemblies and components that need to be tested as an interrelated whole.

1.2.2 Factory Tests

Tests shall be performed at the factory to verify proper build. These test results will be used in the "Final Acceptance Test" section to verify no shipping damage and proper installation.

1.2.3 Functional Test

Contractor shall perform an "in-house" test to verify that the system and components have been properly installed and are functioning properly. Test shall be performed in the presence of the Contracting Officer. Test shall be completed and found acceptable when system has performed per other sections and referenced industry standards.

1.2.4 Final Acceptance Test

Contractor shall perform a formal test with full documentation using the approved recording form. Contracting Officer will witness this test and issue a written final acceptance. Final test data shall be provided to the Contracting Officer. Data shall have a cover letter/sheet clearly marked with the system name, date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for

inclusion in the Maintenance Database."

1.2.5 Test Procedures

Test procedure and recording forms that document the test steps shall be submitted for approval to the Contracting Officer 21 calender days prior to the proposed test date. Procedure shall consist of step by step instruction to verify system parameters, components, and functions.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 78 00.98

CLOSEOUT SUBMITTALS
04/06

PART 1 GENERAL

1.1 SUMMARY

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

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

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

Reproducible Drawings
CAD System Drawings

SD-02 Shop Drawings

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

SD-03 Product Data

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

SD-07 Certificates

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

SD-08 Manufacturer's Instructions

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

Preventative Maintenance and Condition Monitoring (Predictive Testing) and Inspection schedules shall be submitted by the Contractor with instructions that state when systems should be retested.

Schedule shall define the anticipated length of each test, test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements. Each test feature; e.g., gpm, rpm, psi, shall have a signoff blank for the Contractor and Contracting

Officer. A remarks column of the testing validation procedure shall include references to operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Procedures for preventative maintenance, condition monitoring (predictive testing) and inspection, adjustment, lubrication and cleaning necessary to prevent failure shall be delineated.

Posted Instructions

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted in accordance with paragraph entitled, "Operation and Maintenance," of this section. Equipment data sheets will be included for each piece of equipment purchased and/or installed, with specific model numbers and optional equipment or features listed. Equipment data shall be provided on NASA Form C-134: "CMMS Request for Modification" by the Contractor or their designated subcontractor.

All O&M data shall be submitted on CD in a Adobe Acrobat version 6.0 or greater, PDF Format. The COTR will provide the Contractor with a structured file format for the purposes of archiving PDF files on the CD.

1.3 GENERAL

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

Three reproducible copy(s) of each drawing, product data record, or log shall be submitted for historical record.

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

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

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

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

After completion of all construction and before final payment is made under this contract, the Contractor shall provide the Contracting

Officer with one complete set of full size blue line contract drawings with alterations shown in red pencil.

Preventative Maintenance and Condition Monitoring (Predictive Testing) and Inspection schedules shall be submitted by the Contractor with instructions that state when systems should be retested.

Schedule shall define the anticipated length of each test, test apparatus, number of personnel identified by responsibility, and a testing validation procedure permitting the record operation capability requirements. Each test feature; e.g., gpm, rpm, psi, shall have a signoff blank for the Contractor and Contracting Officer. A remarks column of the testing validation procedure shall include references to operating limits of time, pressure, temperature, volume, voltage, current, acceleration, velocity, alignment, calibration, adjustments, cleaning, or special system notes. Procedures for preventative maintenance, inspection, adjustment, lubrication and cleaning necessary to minimize corrective maintenance and repair shall be delineated.

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

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

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

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

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

1.4 WARRANTY OF CONSTRUCTION

In accordance with FAR clause 52.246-12 the Contractor shall provide a 1-year warranty from "acceptance of the work". NASA Glenn Research Center interprets this as 1-year from the completion date. Subcontracts or Supply Purchase Orders shall include these provisions. The following clarifications are made to assure complete understanding of warranty provisions:

The prime Contractor shall operate and maintain all equipment and systems installed until the contract completion date. This includes maintenance service inspections, filter replacements and other work as recommended by the manufacturer. Following completion, the Government will assume O&M responsibilities in accordance with the manufacturer's recommendations.

The prime Contractor shall provide a written 1 -year warranty from the contract completion date to the Government covering all materials, labor and workmanship. Warranty repairs may require the services of subcontractors or suppliers, but shall be managed and coordinated by the prime.

The prime COntractor shall provide a 1-year certificate of warranty from each supplier or provider for all purchased equipment or systems. Requests for warranty repairs shall be made will be made directly to the manufacturer or supplier.

This provision is not affected by the Government's benefical use or occupancy prior to the final completion. The waranty date may be adjusted throughout the course of his contract as required to include contract time extensions with an equitable adjustment to the contract. Should the contractor complete the work ahead of schedule, the warranty provisions will be revised to reflect the actual completion.

The warranty start date for this contract is calculated as the bid guarantee date plus the awarded period of performance.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 OPERATION AND MAINTENANCE

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

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

-- End of Section --

SECTION 02 41 00.98

DEMOLITION
04/06

PART 1 GENERAL

1.1 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 145	(1991; R 2003) Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T 180	(2001) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(Rev k; Change 1) Obstruction Marking and Lighting

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor shall record Existing Conditions prior to starting work in accordance with the paragraph entitled, "Existing Conditions," of this section.

Interruption of the following shall be submitted:

Utility Outages
Traffic Interruptions

SD-07 Certificates

Contractor shall submit a detailed Demolition Plan of the work procedures and safety precautions to be used prior to the beginning of work.

1.3 DEMOLITION PLAN

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

prior to beginning work, to discuss in detail the demolition plan.

1.4 EXISTING CONDITIONS

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

1.5 INTERRUPTION OF SERVICE

Written approval by the Contracting Officer for interruption of service Utility Outages and Traffic Interruptions shall be submitted at least 48 hours prior to work.

PART 2 PRODUCTS

2.1 FILL MATERIAL

Fill material shall conform to the definition of satisfactory soil material as defined in AASHTO M 145, Soil Classification Groups A-1, A-2-4, A-2-5 and A-3. In addition, fill material shall be free from roots and other organic matter, trash, debris, frozen materials, and stones larger than 2 inches in any dimension.

Proposed fill material shall be sampled and tested by an approved soil testing laboratory, as follows:

Soil classification	AASHTO M 145
Moisture-density relations	AASHTO T 180, Method B or D

PART 3 EXECUTION

3.1 DISCONNECTING EXISTING UTILITIES

Prior to the start of work, utilities serving each area of alteration or removal will be shut off by the Government and shall be disconnected and sealed by the Contractor.

3.2 TEMPORARY UTILITY SERVICES

Install temporary utility services before disconnecting existing utilities. Contractor shall provide a minimum of 2 aviation red or high intensity white obstruction lights on temporary structures (including cranes) over 100 feet above ground level. Light construction and installation shall comply with FAA AC 70/7460-1. Lights shall be operational during periods of reduced visibility, darkness, and as directed by the Contracting Officer. Maintain the temporary services during the period of construction and remove only after permanent services have been installed and tested and are in operation.

3.3 PRECAUTION AGAINST MOVEMENT

Contractor shall provide shoring and bracing or other supports to prevent movement, settlement, or collapse of facilities that are to remain which

are adjacent to areas of alteration and removal.

3.4 DEMOLITION AND REMOVAL WORK

3.4.1 Demolition

3.4.1.1 Concurrent Earth-Moving Operations

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

3.4.2 Protective Measures

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

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

3.4.3 Salvageable Materials and Equipment

Government will designate materials and equipment to be salvaged.

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

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

3.4.4 Scrap Metal

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

3.4.5 Buildings and Structures

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

Masonry:

Masonry construction shall be demolished as indicated on the drawings and removed from government property by the contractor.

Miscellaneous metals:

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

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

metal by the Contracting Officer.

3.4.6 Mechanical Equipment and Fixtures

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

Contractor shall remove all equipment NASA bar code or identification tags during demolition and forward the tags to the COTR.

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

Equipment shall not be removed until approved.

Disconnection from utilities:

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

Preparation for storage:

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

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

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

Piping:

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

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

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

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

Ducts:

Removed duct work shall be classified as scrap metal.

Fixtures:

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

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

Motor and machines:

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

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

Salvaged items shall be transported to designated storage area and stored as directed by the Contracting Officer.

3.4.7 Electrical Equipment and Fixtures

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

Contractor shall remove all equipment NASA bar code or identification tags during demolition and forward the tags to the COTR.

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

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

Fixtures:

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

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

Electrical devices:

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

Conductors:

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

Conduit:

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

Wiring ducts or troughs:

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

Miscellaneous items:

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

3.5 DISPOSAL OF REMOVED MATERIALS

3.5.1 General

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

3.5.2 Burning on Government Property

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

3.5.3 Removal to Spoil Areas on Government Property

Noncombustible materials removed from demolished structures shall be transported to designated spoil areas on Government property.

3.5.4 Removal from Government Property

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

3.6 REUSE OF SALVAGED ITEMS

Salvaged materials and equipment designated for reuse shall be reconditioned before installation. Items damaged during removal and salvage operations shall be repaired or replaced as necessary to restore them to usable condition.

-- End of Section --

SECTION 02 83 00.98

LEAD PAINT ABATEMENT
12/06

PART 1 GENERAL

1.1 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 Z9.2	(1979; R 1991) Fundamentals Governing the Design and Operation of Local Exhaust Systems
ANSI Z88.2	(1992) Respiratory Protection

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1926.21	Safety Training and Education
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts, and Mists
29 CFR 1926.59	Hazard Communication
29 CFR 1926.62	Lead Exposure in Construction
29 CFR 1926.65	Hazardous Waste Operations and Emergency Response
29 CFR 1926.103	Respiratory Protection
40 CFR 260	Hazardous Waste Management Systems: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Generators of Hazardous Waste
40 CFR 263	Transporters of Hazardous Waste
40 CFR 264	Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standard for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 745	Lead; Requirements for Lead-Based Paint Activities

49 CFR 172	Hazardous Materials, Tables, and Hazardous Materials Communications Regulations
49 CFR 178	Shipping Container Specification

UNDERWRITERS LABORATORIES INC. (UL)

UL 586	(1990) High-Efficiency, Particulate, Air Filter Units

1.2 DEFINITIONS

1.2.1 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 in an occupational/industrial environment.

1.2.2 Area Sampling

Sampling of lead concentrations within the lead control area and inside the physical boundaries which is representative of the airborne lead concentrations but is not collected in the breathing zone of personnel.

1.2.3 Competent Person (CP)

As used in this section, refers to a 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. An industrial hygienist or safety professional certified for comprehensive practice by the American Board of Industrial Hygiene or by the Board of Certified Safety Professionals is the best choice.

1.2.4 Contaminated Room

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

1.2.5 Decontamination Shower Facility

That facility that encompasses a clean clothing storage room, and a contaminated clothing storage and disposal rooms, with a shower facility in between.

1.2.6 Eight-Hour Time Weighted Average (TWA)

Airborne concentration of lead to which an employee is exposed, averaged over an 8 hour workday as indicated in 29 CFR 1926.62.

1.2.7 High Efficiency Particulate Air (HEPA) Filter Equipment

HEPA filtered vacuuming 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 or larger size particles.

1.2.8 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps.

1.2.9 Lead Based Paint (LBP)

Protective or decorative coating which contains lead.

1.2.10 Lead Control Area

An enclosed area or structure, constructed as a temporary containment equipped with HEPA filtered local exhaust, which prevents the spread of lead dust, paint chips, or debris existing as a condition of lead based paint removal operations. The lead control area is also isolated by physical boundaries to prevent unauthorized entry of personnel.

1.2.11 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 eight 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

1.2.12 Personal Sampling

Sampling of airborne 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 employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of six to nine inches and centered at the nose or mouth of an employee.

1.2.13 Physical Boundary

Area physically roped or partitioned off around an enclosed lead control area to limit unauthorized entry of personnel. As used in this section, "inside boundary" shall mean the same as "outside lead control area but inside boundary."

1.3 QUALITY ASSURANCE

1.3.1 Medical Examinations

Before exposure to lead-contaminated dust, provide workers with a comprehensive medical examination as required by 29 CFR 1926.62 and 29 CFR 1926.103. The examination will not be required if adequate records show that employees have been examined as required by 29 CFR 1926.62 within the last year.

1.3.1.1 Medical Records

Maintain complete and accurate medical records of employees for a period of at least 30 years or for the duration of employment plus 30 years, whichever is longer.

1.3.1.2 Medical Surveillance

Provide medical surveillance to all personnel exposed to lead as indicated in 29 CFR 1926.62.

1.3.2 Competent Person (CP) Responsibilities

a. Certify training as meeting all federal, State, and local requirements.

b. Review and approve lead based paint removal plan for conformance to the applicable referenced standards.

c. Continuously inspect lead based paint removal work for conformance with the approved plan.

d. Perform air and wipe sampling.

e. Ensure work is performed in strict accordance with specifications at all times.

f. Control work to prevent hazardous exposure to human beings and to the environment at all times.

g. Certify the conditions of the work as called for elsewhere in this specification.

1.3.3 Training

Train each employee performing paint removal, disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, and State and local regulations.

1.3.3.1 Training Certification

Submit a certificate for each employee, signed and dated by the approved training source, stating that the employee has received the required lead training.

1.3.4 Respiratory Protection Program

a. Furnish each employee required to wear a negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every six months thereafter as required by 29 CFR 1926.62.

b. Establish and implement a respiratory protection program as required by ANSI Z88.2, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55.

1.3.5 Hazard Communication Program

Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.

1.3.6 Hazardous Waste Management

The Hazardous Waste Management Plan shall comply with applicable requirements of federal, State, and local hazardous waste regulations and address:

a. Identification and classification of hazardous 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. Furnish two copies as applicable of State and local hazardous waste permit applications, permits, manifests, and EPA Identification numbers.

d. Names and qualifications (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 cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.

g. Work plan and schedule for waste containment, removal and disposal. Wastes shall be cleaned up and containerized daily.

h. Cost for hazardous waste disposal according to this plan.

1.3.7 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, storing, transporting, and disposing 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. The following local and State laws, ordinances, criteria, rules and regulations regarding removing, handling, storing, transporting, and disposing of lead-contaminated materials apply:

a. Ohio Department of Health, Lead Hazard Abatement, Chapter 3701-32, Ohio Administrative Code

b. Ohio Department of Health, Lead Training, Programs; Environmental Lead, analytical Laboratories, Chapter 3701-82, Ohio Administrative Code

c. Glenn Occupational Health Programs Manual, http://smad-ext.grc.nasa.gov/emo/pub/ohpm/ohpm5-lead(13).pdf

1.3.8 Pre-Construction Conference

Along with the CP, meet with the Contracting Officer to discuss in detail the hazardous waste management plan and the lead based paint removal plan, including work procedures and precautions for the removal plan.

1.4 DESCRIPTION OF WORK

The purpose of this project is not to conduct LBP abatement but to implement

appropriate lead hazard controls during renovation activities that will disturb lead-containing materials and to comply with all applicable requirements of NASA and with the OSHA Construction Standard for Lead (29 CFR 1926.62)

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

1.5.1 SD-02, Manufacturer's Catalog Data

a. Vacuum filters

b. Respirators

1.5.2 SD-06, Instructions

a. Chemicals and equipment

b. Materials

c. Material safety data sheets for all chemicals

1.5.3 SD-08, Statements

a. Qualifications of CP

b. Testing laboratory and consultant qualifications

c. Lead based paint removal plan including CP approval (signature, date, and certification number) (G)

d. Rental equipment notification

e. Respiratory protection program (G)

f. Hazard communication program (G)

g. EPA approved hazardous waste treatment or disposal facility for lead disposal (g)

h. Hazardous waste management plan (g)

1.5.3.1 Qualifications of CP

Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide previous experience of the CP. Submit proper documentation that the CP is trained and licensed in accordance with federal, State, and local laws.

1.5.3.2 Testing Laboratory and Consultant

Submit the name, address, and telephone number of the testing laboratory and consultant selected to perform the sampling, testing, and reporting of airborne concentrations of lead. Use a laboratory accredited under the EPA National Lead Laboratory Accreditation Program (NLLAP) by either the

American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis.

1.5.3.3 Lead Based Paint Removal Plan (LBPRP)

Submit a detailed job-specific plan of the work procedures to be used in the removal of LBP. The plan shall include a sketch showing the location, size, and details of lead control areas, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include in the plan, eating, drinking, smoking and sanitary procedures, interface of trades, sequencing of lead related work, collected waste water and paint debris disposal plan, air sampling plan, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that airborne lead concentrations of 30 micrograms per cubic meter of air and baseline lead dust concentrations are not reached or exceeded outside of the lead control area. Include occupational and environmental sampling, training and strategy, sampling methodology, frequency, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan.

1.5.4 SD-12, Field Test Reports

a. Sampling results

1.5.4.1 Occupational and Environmental Sampling Results

Submit occupational and environmental sampling results to the Contracting Officer within three working days of collection, signed by the testing laboratory employee performing the analysis, the employee that performed the sampling, and the CP.

1.5.5 SD-13, Certificates

a. Vacuum filters

1.5.6 SD-18, Records

a. Completed and signed hazardous waste manifest from treatment or disposal facility

b. Certification of medical examinations

c. Employee training certification

1.6 REMOVAL

1.6.1 Title to Materials

Materials resulting from demolition work, except as specified otherwise, shall become the property of the Contractor and shall be disposed of in accordance with federal, state & local regulations, except as specified herein.

1.7 EQUIPMENT

1.7.1 Respirators

Furnish appropriate respirators approved by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing lead dust. Respirators shall comply with the requirements of 29 CFR 1926.62.

1.7.2 Special Protective Clothing

Furnish personnel who will be exposed to lead-contaminated dust with proper disposable protective whole body clothing, head covering, gloves, and foot coverings as required by 29 CFR 1926.62. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.

1.7.3 Rental Equipment Notification

If rental equipment is to be used during lead based paint handling and disposal, notify the rental agency in writing concerning the intended use of the equipment. Furnish a copy of the written notification to the Contracting Officer.

1.7.4 Vacuum Filters

UL 586 labeled HEPA filters.

1.7.5 Equipment for Government Personnel

Furnish the Contracting Officer with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the paint removal work within the lead controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, and hand protection. PPE shall remain the property of the Contractor. Respiratory protection for the Contracting Officer will be provided by the Government.

PART 2 PRODUCTS

2.1 CHEMICALS

Submit applicable Material Safety Data Sheets for all chemicals used in paint removal work. Use the least toxic product approved by the Contracting Officer.

2.2 MATERIALS

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

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Notification

Notify the Contracting Officer 5 days prior to the start of any paint

removal work.

3.1.2 Lead Control Area Requirements

Establish a lead control area by completely enclosing with critical barriers the area or structure where lead based paint removal operations will be performed.

3.1.3 Protection of Existing Work to Remain

Perform paint removal work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better.

3.1.4 Boundary Requirements

Provide physical boundaries around the lead control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that airborne concentrations of lead will not reach 30 micrograms per cubic meter of air outside of the lead control area.

3.1.5 Furnishings

The Government will remove furniture and equipment from the building before lead based paint removal work begins.

3.1.6 Heating, Ventilating and Air Conditioning (HVAC) Systems

Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the lead control areas. Seal intake and exhaust vents in the lead control area with 6 mil plastic sheet and tape. Seal seams in HVAC components that pass through the lead control area. Provide temporary HVAC system for areas in which HVAC has been shut down outside the lead control area.

3.1.7 Decontamination Shower Facility

Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.

3.1.8 Mechanical Ventilation System

a. Use adequate ventilation to control personnel exposure to lead in accordance with 29 CFR 1926.62.

b. To the extent feasible, use fixed local exhaust ventilation connected to HEPA filters or other collection systems, approved by the CP. Local exhaust ventilation systems shall be designed, constructed, installed, and maintained in accordance with ANSI Z9.2.

c. Vent local exhaust outside the building only and away from building ventilation intakes.

d. Use locally exhausted, power actuated, paint removal tools.

3.1.9 Personnel Protection

Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been appropriately trained and provided with protective equipment.

3.1.10 Warning Signs

Provide warning signs at approaches to lead control areas. Locate signs at such a distance that personnel may read the sign and take the necessary precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62.

3.2 WORK PROCEDURES

Perform removal of lead based paint in accordance with approved lead based paint removal plan. Use procedures and equipment required to limit occupational and environmental exposure to lead when lead based paint is removed in accordance with 29 CFR 1926.62, except as specified herein. Dispose of removed paint chips and associated waste in compliance with Environmental Protection Agency (EPA), federal, State, and local requirements.

3.2.1 Personnel Exiting Procedures

Whenever personnel exit the lead-controlled area, they shall perform the following procedures and shall not leave the work place wearing any clothing or equipment worn during the work day:

a. Vacuum themselves off.

b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.

c. Wash hands and face

d. Change to clean clothes prior to leaving the physical boundary designated around the lead control area.

3.2.2 Air and Wipe Sampling

Air sample for lead in accordance with 29 CFR 1926.62 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.

a. The CP shall be on the job site directing the air and wipe sampling and inspecting the lead based paint removal work to ensure that the requirements of the contract have been satisfied during the entire lead based paint removal operation.

b. Collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least twenty-five percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.

c. Submit results of air samples, signed by the CP, within 72 hours after the air samples are taken. Notify the Contracting Officer immediately of exposure to lead at or in excess of the action level of 30 micrograms per cubic meter of air outside of the lead control area.

d. Before any work begins, collect and analyze baseline wipe samples in accordance with methods defined in federal, State, and local standards inside and outside of the physical boundary to assess the degree of dust contamination in the facility prior to lead based paint removal.

3.2.2.1 Air Sampling During Paint Removal Work

Conduct area air sampling daily, on each shift in which lead based paint removal operations are performed, in areas immediately adjacent to the lead control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above 30 micrograms per cubic meter of air. If 30 micrograms per cubic meter of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the Contracting Officer immediately. Determine if condition(s) require any further change in work methods. Removal work shall resume only after approval is given by the CP and the Contracting Officer. For outdoor operations, at least one sample on each shift shall be taken on the downwind side of the lead control area.

3.2.3 Lead Based Paint Removal

Manual or power sanding of interior and exterior surfaces is not permitted. Provide methodology for removing LBP in work plan. Remove paint within the areas designated on the drawings in order to completely expose the substrate. Take whatever precautions necessary to minimize damage to the underlying substrate.

Avoid flash rusting or other deterioration of the substrate. Provide surface preparations for painting in accordance with Section 09 90 00.00 40, "PAINT AND COATING".

Select paint removal processes to minimize contamination of work areas with lead-contaminated dust or other lead-contaminated debris/waste. Describe this paint removal process in the lead based paint removal plan. Perform manual wet sanding and scraping to the maximum extent feasible.

3.2.3.1 Indoor Lead Paint Removal

Perform manual or mechanical paint removal in lead control areas using negative pressure enclosures with HEPA filtered exhaust and power actuated locally exhausted paint removal tools. Collect paint residue for disposal in accordance with EPA, State, and local requirements.

3.2.3.2 Outdoor Lead Paint Removal

Perform outdoor LBP removal as indicated in federal, State, and local regulations and in the work plan.

3.2.3.3 Air and Wipe Sampling After Paint Removal

After the visual inspection, collect air samples inside and outside the lead control area to determine the airborne levels of lead inside and

outside the work area. Collect wipe samples according to the HUD protocol to determine the lead content of settled dust and dirt in micrograms per square foot of surface area.

3.2.4 Cleanup and Disposal

3.2.4.1 Cleanup

Maintain surfaces of the lead control area free of accumulations of paint chips and dust. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use compressed air to clean up the area. At the end of each shift and when the paint removal operation has been completed, clean the area of visible lead paint contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the CP. Reclean areas showing dust or residual paint chips or debris. After visible dust, chips and debris is removed, wet wipe and HEPA vacuum all surfaces in the work area. If adjacent areas become contaminated at any time during the work, clean, visually inspect, and then wipe sample all contaminated areas. The CP shall then certify in writing that the area has been cleaned of lead contamination before restarting work.

3.2.4.2 Certification

The CP shall certify in writing that the final air samples collected inside and outside the lead control area are less than 30 micrograms per cubic meter of air ; the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62 and 40 CFR 745; and that there were no visible accumulations of lead based paint and dust left in the work site. Do not remove the lead control area or roped off boundary and warning signs prior to the Contracting Officer's acknowledgement of receipt of the CP certification.

3.2.4.3 Not Used

3.2.4.4 Disposal

a. Collect lead-contaminated waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing which may produce airborne concentrations of lead particles. Label the containers in accordance with 29 CFR 1926.62 and 40 CFR 261. Dispose of lead-contaminated waste material at an EPA or State approved hazardous waste treatment, storage, or disposal facility off Government property.

b. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. The Contracting Officer or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.

c. Handle, store, transport, and dispose lead or lead-contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265. Comply with land disposal restriction notification requirements as required by 40 CFR 268.

3.2.5 Disposal Documentation

Submit written evidence that the hazardous waste treatment, storage, or disposal facility (TSD) is approved for lead disposal by the EPA and State or local regulatory agencies. Submit one copy of the completed manifest, signed and dated by the initial transporter in accordance with 40 CFR 262.

3.2.6 Payment for Hazardous Waste

Payment for disposal of hazardous waste will not be made until a signed copy of the manifest from the treatment or disposal facility certifying the amount of lead-containing materials delivered is returned and a copy is furnished to the Government.

-- End of Section --

SECTION 03 15 14.00 10

EXPANSION, CONTRACTION AND CONSTRUCTION JOINTS IN CONCRETE FOR CIVIL WORKS
04/06

PART 1 GENERAL

1.1 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.

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX	(2007) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A 1011/A 1011M	(2007) Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM A 109/A 109M	(2003) Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM A 167	(1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM B 152/B 152M	(2006ae1) Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 2628	(1991; R 2005) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
ASTM D 2835	(1989; R 2007) Lubricant for Installation

of Preformed Compression Seals in Concrete Pavements

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 513	(1974) Specifications for Rubber Waterstops
COE CRD-C 572	(1974) Specifications for Polyvinylchloride Waterstops

1.2 UNIT PRICES

1.2.1 Waterstops

1.2.1.1 Payment

Payment will be made for costs associated with waterstops, including labor, materials and use of all equipments and tools required to complete the waterstop work. No separate payment will be made for expansion and contraction joints which are included in the costs for the items to which work for expansion and contraction joints are incidental.

1.2.1.2 Measurement

Waterstops will be measured for payment by the linear foot in place. In computing the quantity of the waterstops, no allowance will be made for laps. No separate measurement will be made for expansion and contraction joints which are included in the costs for the items to which work for expansion and contraction joints are incidental.

1.2.1.3 Unit of Measure

Unit of measure: linear foot.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval.information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Splicing Waterstops; G; G, _____

Procedures for splicing waterstops shall be submitted for approval.

SD-04 Samples

Field Molded Sealants and Primer

One gallon of field-molded sealant and one quart of primer (when primer is recommended by the sealant manufacturer) shall be provided for testing.

Waterstops; G; G, _____

Waterstop materials and splice samples shall be submitted for inspection and testing and shall be identified to indicate manufacturer, type of material, size and quantity of material and shipment represented. Each materials sample shall be a piece not less than 12 inches long cut from each 200 feet of finished waterstop furnished, but not less than a total of 4 linear feet of each type and size furnished. For spliced segments of waterstops to be installed in the work, one spliced sample of each size and type for every 50 splices made in the factory and every 10 splices made at the job site shall be furnished for inspection and testing. The spliced samples shall be made using straight run pieces with the splice located at the mid-length of the sample and finished as required for the installed waterstop. The total length of each spliced sample shall be not less than 12 inches long.

SD-06 Test Reports

Premolded Expansion Joint Filler Strips
Compression Seals and Lubricant
Metallic Waterstops

Certified manufacturer's test reports shall be provided for premolded expansion joint filler strips, compression seals and lubricant, and metallic waterstops to verify compliance with applicable specification.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Premolded Expansion Joint Filler Strips

Premolded expansion joint filler strips shall conform to ASTM D 1751 or ASTM D 1752, Type I, or resin impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

2.1.2 Joint Seals and Sealants

2.1.2.1 Field Molded Sealants and Primer

Field molded sealants and primer shall conform to ASTM C 920, Type M, Grade NS orP, Class 25, Use T NT for horizontal joints and Type M, Grade NS, Class 25, Use NT for vertical joints. Except, the joint sealant will perform for the same life cycle when continuously underwater. The manufacturer shall certify and submit test results supporting durability under this environment. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The back-up material shall be compressible, nonshrink, nonreactive with sealant, and nonabsorptive material type such as extruded butyl or polychloroprene foam rubber.

2.1.2.2 Compression Seals and Lubricant

Compression seals shall conform to ASTM D 2628; lubricant for installation shall conform to ASTM D 2835.

2.1.3 Waterstops

2.1.3.1 Non-Metallic Waterstops

Rubber waterstops shall conform to COE CRD-C 513. Polyvinylchloride waterstops shall conform to COE CRD-C 572.

2.1.3.2 Metallic Waterstops

a. Flexible Metal Waterstops - Copper waterstops shall conform to ASTM B 152/B 152M, temper soft annealed, 20 oz weight sheet. Stainless steel waterstops shall conform to ASTM A 167, Type 304L, No. 1 Finish or equivalent, annealed, 0.0375 inch (20 Gage) strip.

b. Flat Steel Waterstops - Flat steel waterstops shall conform to ASTM A 109/A 109M, temper No. 2, No. 2 edge, No. 1 Finish or ASTM A 1011/A 1011M, Grade D.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Materials Tests

2.2.1.1 Field-Molded Sealants

Samples of sealant and primer, when use of primer is recommended by the manufacturer, as required in paragraph FIELD MOLDED SEALANTS AND PRIMER, shall be tested by and at the expense of the Government for compliance with paragraph FIELD MOLDED SEALANTS AND PRIMER. If the sample fails to meet specification requirements, new samples shall be provided and the cost of retesting will be deducted from payments due the Contractor at a rate of $ 100 per sample.

2.2.1.2 Non-Metallic Waterstops

Samples of materials and splices as required in paragraph WATERSTOPS shall be visually inspected and tested by and at the expense of the Government for compliance with COE CRD-C 513 or COE CRD-C 572 as applicable. If a sample fails to meet the specification requirements, new samples shall be provided and the cost of retesting will be deducted from payments due the Contractor at the rate of $100 per material sample retested and $100 per spliced sample retested.

2.2.2 Splicing Waterstops

2.2.2.1 Procedure and Performance Qualifications

Procedure and performance qualifications for splicing waterstops shall be demonstrated in the presence of the Contracting Officer.

2.2.2.2 Non-Metallic Waterstops

Procedure and performance qualifications for splicing non-metallic waterstops shall be demonstrated by the manufacturer at the factory and the Contractor at the job site by each making three spliced samples of each size and type of finished waterstop.

2.2.2.3 Metal Waterstops

Procedure and performance qualifications for splicing metal waterstops

shall be demonstrated at the job site by the Contractor. The brazing procedure, brazers and brazing operators for splicing copper waterstops shall be qualified in accordance with Part QB (Brazing), Article XI (Brazing, General Requirements), paragraph QB-170 (Peel Tests) and other applicable requirements of Articles XI, XII, and XIII of ASME BPVC SEC IX. The welding procedure and welders for splicing stainless steel waterstops shall be qualified in accordance with the manufacturer's recommendations.

PART 3 EXECUTION

3.1 INSTALLATION

Joint locations and details, including materials and methods of installation of joint fillers and waterstops, shall be as specified, as shown, and as directed. In no case shall any fixed metal be continuous through an expansion or contraction joint.

3.1.1 Expansion Joints

Premolded filler strips shall have oiled wood strips secured to the top thereof and shall be accurately positioned and secured against displacement to clean, smooth concrete surfaces. The wood strips shall be slightly tapered, dressed and of the size required to install filler strips at the desired level below the finished concrete surface and to form the groove for the joint sealant or seals to the size shown. Material used to secure premolded fillers and wood strips to concrete shall not harm the concrete and shall be compatible with the joint sealant or seals. The wood strips shall not be removed until after the concrete curing period. The groove shall be thoroughly cleaned of all laitance, curing compound, foreign materials, protrusions of hardened concrete and any dust which shall be blown out of the groove with oil-free compressed air.

3.1.1.1 Joints With Field-Molded Sealant

Joints shall not be sealed when the sealant, air or concrete temperature is less than 40 degrees F. Immediately prior to installation of field molded sealants, the joint shall be cleaned of all debris and further cleaned using water, chemical solvents or other means as recommended by the sealant manufacturer. The joints shall be dry prior to filling with sealant. Bond breaker and back-up material shall be installed where required. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendations.

3.1.1.2 Joints With Preformed Compression Seals

The joint seals shall be installed with equipment which shall be capable of installing joint seals to the prescribed depth without cutting, nicking, twisting, or otherwise distorting or damaging the seal and with no more than five percent stretching of the seal. The sides of the joint and, if necessary, the sides of the compression seal shall be covered with a coating of lubricant, and the seal shall be installed to the depth indicated with joint installation equipment. Butt joints shall be coated with liberal applications of lubricant.

3.1.2 Contraction Joints

Joints requiring a bond breaker shall be coated with curing compound or with bituminous paint. Waterstops shall be protected during application of bond breaking material to prevent them from being coated.

3.1.3 Waterstops

Waterstops shall be carefully and correctly positioned during installation to eliminate faulty installation that may result in joint leakage. The bottom of each waterstop shall be embedded a minimum of 6 inches in firm rock or sealed to other cut-off systems. All waterstops shall be installed so as to form a continuous watertight diaphragm in each joint. Adequate provision shall be made to support and protect the waterstops during the progress of work. Any waterstop punctured or damaged shall be replaced or repaired at the Contractor's expense. The concrete shall be thoroughly consolidated in the vicinity of the waterstop. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from damage when concrete placement has been discontinued.

3.1.3.1 Splices

Joints in waterstops shall be spliced together by qualified splicers using the approved splicing procedures to form a continuous watertight diaphragm. Splices shall be as followed:

a. Non-Metallic Waterstops - All splices shall be made on a bench in a temporary shop provided at the site of the installation or at the manufacturer's plant. A miter guide and portable power saw shall be used to cut the ends to be joined to insure good alignment and contact between joined surfaces. Continuity of the characteristic features of the cross section of the waterstop (ribs, tabular center axis, protrusions and the like) shall be maintained across the splice.

b. Rubber Waterstops - Splices shall be vulcanized in accordance with the approved procedure.

c. Polyvinylchloride Waterstops - Splices shall be made by heat sealing the adjacent surfaces in accordance with the approved procedure. A thermostatically controlled electrical heat source shall be used to make all splices. The correct temperature at which splices should be made will differ with the material concerned but the applied heat should be sufficient to melt but not char the plastic. Waterstops shall be reformed at splices with a remolding iron with ribs or corrugations to match the pattern of the waterstop. The spliced area, when cooled and bent by hand in as sharp an angle as possible, shall show no sign of separation.

d. Flexible Metal Waterstop - Splices in copper shall be lap joints made by the approved brazing procedure. Splices in stainless steel shall be made by the approved welding procedure. Damaged waterstops shall be repaired by removing damaged portions and patching. Patches shall overlap a minimum of 1 inch onto undamaged portion of the waterstop.

e. Flat Steel Waterstops - Splices shall be welded.

-- End of Section --

SECTION 03 30 00

CAST-IN-PLACE CONCRETE
01/08

PART 1 GENERAL

1.1 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.

ACI INTERNATIONAL (ACI)

ACI/MCP-1	(2007) Manual of Concrete Practice Part 1: ACI 104-71R-97 to 223-98
ACI/MCP-2	(2007) Manual of Concrete Practice Part 2 - ACI 224R-01 to ACI 313R-97
ACI/MCP-3	(2007) Manual of Concrete Practice Part 3 - ACI 315-99 to ACI 343R-95
ACI/MCP-4	(2006) Manual of Concrete Practice Part 4 - ACI 345R-05 to 355.2R-04

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4	(2004) Basic Hardboard

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2005; Errata 2005) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 185/A 185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 496/A 496M	(2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A 497/A 497M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for

	Concrete
ASTM A 615/A 615M	(2008) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 706/A 706M	(2006a) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 767/A 767M	(2005) Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A 82/A 82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 934/A 934M	(2007) Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM C 1017/C 1017M	(2007) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1107/C 1107M	(2007a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1260	(2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 143/C 143M	(2008) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 156	(2005) Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C 1567	(2007) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2007a) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173/C 173M	(2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192/C 192M	(2007) Standard Practice for Making and Curing Concrete Test Specimens in the

	Laboratory
ASTM C 231	(2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 233	(2007) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 295	(2003) Petrographic Examination of Aggregates for Concrete
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2008) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 311	(2007) Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete
ASTM C 33	(2007) Standard Specification for Concrete Aggregates
ASTM C 39/C 39M	(2005e1) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42/C 42M	(2004) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 494/C 494M	(2008) Standard Specification for Chemical Admixtures for Concrete
ASTM C 618	(2008) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM C 932	(2006) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering
ASTM C 94/C 94M	(2007) Standard Specification for Ready-Mixed Concrete
ASTM D 1190	(1997) Standard Specification for Concrete

	Joint Sealer, Hot-Applied Elastic Type
ASTM D 1557	(2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 2103	(2005) Standard Specification for Polyethylene Film and Sheeting
ASTM D 4397	(2002) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications
ASTM D 5759	(1995; R 2005) Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses
ASTM D 7116	(2005) Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types, for Portland Cement Concrete
ASTM E 329	(2007a) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM E 648	(2008) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2001; 27Ed) Manual of Standard Practice

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1	(2007) Construction and Industrial Plywood

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 572	(1974) Specifications for Polyvinylchloride Waterstops

U.S. DEPARTMENT OF COMMERCE (DOC)

PS1	(1995) Construction and Industrial Plywood (APA V995)

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS MMM-A-001993	(1978) Adhesive, Epoxy, Flexible, Filled (For Binding, Sealing, and Grouting)
FS SS-S-1614	(Rev A; Am 1) Sealants, Joint,Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Tar Concrete Pavements
FS SS-S-200	(Rev E; Am 2) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement
FS UU-B-790	(Rev A) Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant)

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.2 DEFINITIONS

a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings for concrete formwork must be submitted by the Contractor in accordance with paragraph entitled, "Shop Drawings," of this section, to include the following:

Reinforcing steel; G

Reproductions of contract drawings are unacceptable.

Provide erection drawings for concrete Formwork that show placement of reinforcement and accessories, with reference to the contract drawings.

SD-03 Product Data

Materials for curing concrete
Joint sealants;

Submit manufacturer's product data, indicating VOC content. Manufacturer's catalog data for the following items must include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders, waterstops, and liquid chemical floor hardeners.

Joint filler;
Portland Cement
Ready-Mix Concrete
Water-Vapor Barrier Subgrade Cover
Bonding Materials
Floor Finish Materials
Concrete Curing Materials
Reinforcement; (LEED)
Vapor barrier
Wood Forms
Local/Regional Materials; (LEED)

Submit documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

Biodegradable Form Release Agent

Submit documentation indicating type of biobased material in product and biobased content. Indicate relative dollar value of biobased content products to total dollar value of products included in project.

SD-04 Samples

Slab finish sample

Submit the following samples:

SD-05 Design Data

Concrete mix design; G

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, pozzolans, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which produce a range of strength encompassing those

required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted. Submit additional data regarding concrete aggregates if the source of aggregate changes. Submit copies of the fly ash, and pozzolan test results, in addition. The approval of fly ash and pozzolan test results must be within 6 months of submittal date. Obtain acknowledgement of receipt prior to concrete placement.

Calculations

SD-06 Test Reports

Concrete mix design; G

Fly ash

Pozzolan

Aggregates

Tolerance report

Compressive strength tests

Air Content

Slump

Air Entrainment

SD-07 Certificates

Curing concrete elements

Pumping concrete

Finishing plan

Form removal schedule

Biodegradable Form Release Agent

VOC Content for form release agents, curing compounds, and concrete penetrating sealers

Material Safety Data Sheets

Forest Stewardship Council (FSC) Certification

SD-08 Manufacturer's Instructions

Fly ash

Welding Procedures must be in accordance with AWS D1.4/D1.4M.

Submit mill certificates for Steel Bar according to the paragraph entitled, "Fabrication," of this section.

Provide certificates for concrete that are in accordance with the paragraph entitled, "Classification and Quality of Concrete," of this section. Provide certificates that contain project name and number, date, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer, brand name of manufactured materials, material name, values as specified for each material, and test results. Provide certificates for Welder Qualifications that are in accordance with the paragraph entitled, "Qualifications for Welding Work," of this section.

Welding Procedures

SD-11 Closeout Submittals

1.4 MODIFICATION OF REFERENCES

Accomplish work in accordance with ACI publications except as modified herein. Consider the advisory or recommended provisions to be mandatory. Interpret reference to the "Building Official," the "Structural Engineer," and the "Architect/Engineer" to mean the Contracting Officer.

1.5 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. ACI/MCP-2 for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.5.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.6 QUALITY ASSURANCE

1.6.1 Design Data
1.6.2 Drawings

1.6.2.1 Reinforcing Steel

ACI/MCP-4. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars.

1.6.3 Control Submittals

1.6.3.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.6.3.2 VOC Content for form release agents, curing compounds, and concrete penetrating sealers

Submit certification for the form release agent, curing compounds, and concrete penetrating sealers that indicate the VOC content of each product.

1.6.3.3 Material Safety Data Sheets

Submit Material Safety Data Sheets (MSDS) for all materials that are regulated for hazardous health effects. Prominently post the MSDS at the construction site.

1.6.4 Test Reports

1.6.4.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. Include mill test and all other test for cement, aggregates, and admixtures in the laboratory test reports. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the concrete mix design. Obtain approval before concrete placement.

1.6.4.2 Fly Ash and Pozzolan

Submit test results in accordance with ASTM C 618 for fly ash and pozzolan. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on fly ash use in concrete.

1.6.4.3 Aggregates

ASTM C 1260 for potential alkali-silica reactions, ASTM C 295 for petrographic analysis.

1.6.5 Field Samples

1.6.5.1 Slab Finish Sample

Install minimum of 10 foot by 10 foot slab. Finish as required by specification.

1.6.6 Special Finisher Qualifications

For 35 percent or more fly ash content as a percentage of cementitious materials, finisher must have a minimum of 3 years' experience finishing high-volume fly ash concrete.

1.7 ENVIRONMENTAL REQUIREMENTS

Provide space ventilation according to manufacturer recommendations, at a minimum, during and following installation of concrete curing compound and

sealer. Maintain one of the following ventilation conditions during the curing compound/sealer curing period or for 72 hours after installation:

a. Supply 100 percent outside air 24 hours a day.

b. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 84 degrees F and humidity is between 30 percent and 60 percent.

c. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.

1.7.1 Submittals for Environmental Performance

a. Provide data indication the percentage of post-industrial pozzolan (fly ash) cement substitution as a percentage of the full product composite by weight.

b. Provide data indicating the percentage of post-industrial and post-consumer recycled content aggregate.

c. Provide product data indicating the percentage of post-consumer recycled steel content in each type of steel reinforcement as a percentage of the full product composite by weight.

d. Provide product data stating the location where all products were manufactured

e. For projects using FSC certified formwork, provide chain-of-custody documentation for all certified wood products.

f. For projects using reusable formwork, provide data showing how formwork is reused.

g. Provide MSDS product information data showing that form release agents meet any environmental performance goals such as using vegetable and soy based products.

h. Provide MSDS product information data showing that concrete adhesives meet any environmental performance goals including low emitting, low volatile organic compound products.

1.8 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Perform concrete testing by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency must meet the requirements of ASTM E 329.

1.9 QUALIFICATIONS FOR WELDING WORK

Verify that Welder qualifications are in accordance with AWS D1.4/D1.4M or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

1.10 CONCRETE SAMPLING AND TESTING

Testing by the Contractor must include sampling and testing concrete materials proposed for use in the work and testing the design mix for each

class of concrete. Perform quality control testing during construction.

Sample and test concrete aggregate materials proposed for use in the work in accordance with ASTM C 33.

Sample and test portland cement in accordance with ASTM C 150.

Sample and test air-entraining admixtures in accordance with ASTM C 233.

Testing must be performed by a Grade I Testing Technician.

PART 2 PRODUCTS

2.1 MATERIALS FOR FORMS

Provide wood, plywood, plastic, carton, or steel. Use plywood or steel forms where a smooth form finish is required.

2.1.1 Wood Forms

Use lumber as follows. Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with PS1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining. Submit data verifying that composite wood products contain no urea formaldehyde resins. Virgin wood used must be FSC-certified.

2.1.1.1 Concrete Form Plywood (Standard Rough)

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

2.1.1.2 Overlaid Concrete Form Plywood (Standard Smooth)

Provide plywood that conforms to NIST PS 1, B-B, high density form overlay, not less than 5/8-inch thick.

2.1.2 Plastic Forms

Provide plastic forms that contain a minimum of 50 percent post-consumer recycled content, or a minimum of 50 percent post-industrial recycled content.

2.1.3 Carton Forms

Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete until initial set.

2.1.4 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.2 FORM TIES AND ACCESSORIES

The use of wire alone is prohibited. Provide form ties and accessories that do not reduce the effective cover of the reinforcement.

2.2.1 Polyvinylchloride Waterstops

COE CRD-C 572.

2.2.2 Dovetail Anchor Slot

Preformed metal slot approximately 1 by 1 inch of not less than 22 gage galvanized steel cast in concrete. Coordinate actual size and throat opening with dovetail anchors and provide with removable filler material.

2.3 CONCRETE

2.3.1 Contractor-Furnished Mix Design

ACI/MCP-1, ACI/MCP-2, and ACI/MCP-3 except as otherwise specified. Indicate the compressive strength (f'c) of the concrete for each portion of the structure(s) and as specified in the structural general notes. .

Maximum slump shown above may be increased 1 inch for methods of consolidation other than vibration. Slump may be increased to 8 inches when superplasticizers are used. Provide air entrainment using air-entraining admixture. Provide air entrainment within plus or minus 1.5 percent of the value specified. Note (a): Entrapped air must be 3% or less.

2.3.1.1 Mix Proportions for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified are the responsibility of the Contractor. Base mixture proportions on compressive strength as determined by test specimens fabricated in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 39/C 39M. Samples of all materials used in mixture proportioning studies must be representative of those proposed for use in the project and must be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Base trial mixtures having proportions, consistencies, and air content suitable for the work on methodology described in ACI/MCP-1. In the trial mixture, use at least three different water-cement ratios for each type of mixture, which must produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratio required must be based on equivalent water-cement ratio calculations as determined by the conversion from the weight ratio of water to cement plus pozzolan by weight equivalency method. Design laboratory trial mixture for maximum permitted slump and air content. Each combination of material proposed for use must have separate trial mixture, except for accelerator or retarder use can be provided without separate trial mixture. Report the temperature of concrete in each trial batch. For each water-cement ratio, at least three test cylinders for each test age must be made and cured in accordance with ASTM C 192/C 192M and tested in accordance with ASTM C 39/C 39M for 7 and 28 days. From these results, plot a curve showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, plot a curve showing the relationship between 7 and 28 day strengths.

2.3.1.2 Required Average Strength of Mix Design

The selected mixture must produce an average compressive strength exceeding the specified strength by the amount indicated in ACI/MCP-2. When a concrete production facility has a record of at least 15 consecutive tests,

the standard deviation must be calculated and the required average compressive strength must be determined in accordance with ACI/MCP-2. When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength must follow ACI/MCP-2 requirements.

2.3.2 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C 94/C 94M.

Ground granulated blast furnace slag shall not be used.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C 94/C 94M:

Type and brand cement

Cement content in 95-pound bags per cubic yard of concrete

Maximum size of aggregate

Amount and brand name of admixtures

Total water content expressed by water/cement ratio

2.3.3 Concrete Curing Materials

2.3.3.1 Absorptive Cover

Provide burlap cloth cover for curing concrete made from jute or kenaf, weighing 10 ounces plus or minus percent per square yard when clean and dry, conforming to ASTM C 171, Class 3; or cover may be cotton mats as approved.

2.3.3.2 Moisture-Retaining Cover

Provide waterproof paper cover for curing concrete conforming to ASTM C 171, regular or white, or polyethylene sheeting conforming to ASTM C 171, or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap must conform to ASTM C 171, Class 3, and polyethylene film must conform to ASTM C 171. When tested for water retention in accordance with ASTM C 156, weight of water lost 72 hours after application of moisture retaining covering material must not exceed 0.039 gram per square centimeter of the mortar specimen surface.

2.3.3.3 Membrane-Forming Curing Compound

Provide liquid type compound conforming to ASTM C 309, Type 1, clear, Type 1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

2.4 MATERIALS

2.4.1 Cement

ASTM C 150, Type I or II blended cement except as modified herein. Provide blended cement that consists of a mixture of ASTM C 150, Type II,

cement and one of the following materials: ASTM C 618 pozzolan or fly ash. For portland cement manufactured in a kiln fueled by hazardous waste, maintain a record of source for each batch. Supplier must certify that no hazardous waste is used in the fuel mix or raw materials. Supplier must certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants are discharged. For exposed concrete, use one manufacturer for each type of cement, fly ash, and pozzolan.

2.4.1.1 Fly Ash and Pozzolan

ASTM C 618, Type C If flyash is used Report the chemical analysis of the fly ash in accordance with ASTM C 311. Evaluate and classify fly ash in accordance with ASTM D 5759.

High contents of supplementary cementitious materials can have some detrimental effects on the concrete properties, such as slowing excessively the strength gain rate, and delaying and increasing the difficulty of finishing. The recommended maximum content (by weight of the total cementitious material) for these materials are:

1. For fly ash or natural pozzolan:25 percent

2.4.1.2 Portland Cement

Provide cement that conforms to ASTM C 150, Type I, or II. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.4.2 Water

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementitious materials (cement + pozzolans), and in general, improve workability by adjusting the grading rather than by adding water. Water must be fresh, clean; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.4.3 Aggregates

ASTM C 33, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement.

Fine and coarse aggregates must show expansions less than 0.08 percent at 16 days after casting when testing in accordance with ASTM C 1260. Should the test data indicate an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C 1567 using the Contractor's proposed mix design. In this case, include the mix design low alkali portland cement and one of the following supplementary cementitious materials:

2.4.3.1 Aggregates/Combined Aggregate Gradation (Floor Slabs Only)

ASTM C 33, uniformly graded and as follows: Nominal maximum aggregate size of 1 inch. A combined sieve analysis must indicate a well graded aggregate from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than

8 percent may be retained on coarsest sieve and on No. 50 (0.3mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50 (0.3mm). Provide sand that is at least 50 percent natural sand.

2.4.4 Nonshrink Grout

ASTM C 1107/C 1107M.

2.4.5 Admixtures

ASTM C 494/C 494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures.

2.4.5.1 Air-Entraining

ASTM C 260.

2.4.5.2 High Range Water Reducer (HRWR) (Superplasticizers)

ASTM C 494/C 494M, Type F and ASTM C 1017/C 1017M.

2.4.5.3 Pozzolan

Provide fly ash or other pozzolans used as admixtures that conform to ASTM C 618.

2.4.6 Vapor Retarder and Vapor Barrier

ASTM D 4397 polyethylene sheeting, minimum 10 mil thickness.

Waterproof Paper. Kraft paper, glass reinforcing fibers and layers of polyethylene laminated under heat and pressure to form a single layer meeting the requirements of FS UU-B-790, Type I, Grade A, Style 4; or waterproof paper, regular, conforming to ASTM C 171, consisting of two sheets of kraft paper cemented together with bituminous material in which are embedded cords or strands of fiber running in both directions not more than 1 1/4 inch apart.

Consider plastic vapor retarders and adhesives with a high recycled content, low toxicity low VOC (Volatile Organic Compounds) levels.

2.4.6.1 Water-Vapor Barrier Subgrade Cover

Provide cover that is water-resistant barrier paper, uncreped and reinforced, conforming to FS UU-B-790, Type I, Grade B, Style 4; or clear polyethylene sheeting, 6-mil, conforming to ASTM D 2103 and ASTM D 4397

2.4.7 Materials for Curing Concrete

Consider the use of water based or vegetable or soy based curing agents in lieu of petroleum based products. Consider agents that are not toxic and emit low or no Volatile Organic Compounds (VOC). Consider the use of admixtures that offer high performance to increase durability of the finish product but also have low toxicity and are made from bio-based materials such as soy, and emit low levels of Volatile Organic Compounds (VOC).

2.4.7.1 Impervious Sheeting

ASTM C 171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.4.7.2 Pervious Sheeting

AASHTO M 182.

2.4.7.3 Liquid Membrane-Forming Compound

ASTM C 309, white-pigmented, Type 2, Class B.

2.4.8 Liquid Chemical Sealer-Hardener Compound

Provide magnesium fluorosilicate compound which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Provide compound that does not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.4.9 Expansion/Contraction Joint Filler

ASTM D 1751, ASTM D 1752, cork or 100% post-consumer paper meeting ASTM D 1752 (subparagraphs 5.1 to 5.4). Material must be 1/2 inch thick, unless otherwise indicated.

2.4.9.1 Preformed Joint Filler Strips

Provide nonextruding and resilient bituminous type filler strips conforming to ASTM D 1751.

Povide nonextruding and resilient nonbituminous type filler strips conforming to ASTM D 1752, Type I or II.

2.4.10 Joint Sealants

Use concrete penetrating sealers with a low (maximum 100 grams/liter, less water and less exempt compounds) VOC content.

2.4.10.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D 1190 or ASTM C 920, Type M, Class 25, Use T. ASTM D 7116 for surfaces subjected to jet fuel.

2.4.10.2 Vertical Surfaces Greater Than 3 Percent Slope

ASTM C 920, Type M, Grade NS, Class 25, Use T. FS SS-S-1614 FS SS-S-200, no sag.

2.4.10.3 Joint Sealant Compound

Provide hot-poured, elastic type compound conforming to ASTM D 1190.

2.4.11 Epoxy Bonding Compound

ASTM C 881/C 881M. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use

in bonding skid-resistant materials to hardened concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if placement temperature is below 40 degrees F; Class B if placement temperature is between 40 and 60 degrees F; or Class C if placement temperature is above 60 degrees F.

2.5 REINFORCEMENT

Galvanize bars, fabrics, connectors, and chairs.

2.5.1 Reinforcing Bars

ACI/MCP-2 unless otherwise specified. ASTM A 615/A 615M A, S, W, Grade , . Galvanized, ASTM A 123/A 123M.

2.5.1.1 Galvanized Reinforcing Bars

Provide galvanized reinforcing bars that conform to ASTM A 767/A 767M, Class II with galvanizing before fabrication.

2.5.1.2 Weldable Reinforcing Bars

Provide weldable reinforcing bars that conform to ASTM A 706/A 706M and ASTM A 615/A 615M and Supplement S1, Grade 60, except that the maximum carbon content must be 0.55 percent.

2.5.2 Mechanical Reinforcing Bar Connectors

ACI/MCP-2. Provide 125 percent minimum yield strength of the reinforcement bar.

2.5.3 Wire

ASTM A 82/A 82M or ASTM A 496/A 496M.

2.5.3.1 Welded Wire Fabric

ASTM A 185/A 185M or ASTM A 497/A 497M.

2.5.3.2 Steel Wire

Wire must conform to ASTM A 82/A 82M.

2.5.4 Reinforcing Bar Supports

Provide bar ties and supports of coated or non corrodible material.

2.5.5 Supports for Reinforcement

Supports include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcing bars and wire fabric in place.

Provide wire bar type supports conforming to ACI/MCP-3 and CRSI 10MSP.

Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

2.6 BONDING MATERIALS

2.6.1 Concrete Bonding Agent

Provide aqueous-phase, film-forming, nonoxidizing, freeze and thaw-resistant compound agent suitable for brush or spray application conforming to ASTM C 932.

2.6.2 Epoxy-Resin Adhesive Binder

Provide two-component, epoxy-polysulfide polymer type binder with an amine-type curing-agent conforming to FS MMM-A-001993, Type I or ASTM C 881/C 881M.

2.7 FLOOR FINISH MATERIALS

2.7.1 Liquid Chemical Floor Hardener

Hardener must be a colorless aqueous solution containing a blend of magnesium fluorosilicate and zinc fluorosilicate combined with a wetting agent. Solution must contain not less than 1/2 pounds of fluorosilicates per gallon. An approved proprietary chemical hardener may be used provided hardener is delivered ready for use in manufacturer's original containers.

2.8 CLASSIFICATION AND QUALITY OF CONCRETE

2.8.1 Concrete Classes and Usage

Provide concrete classes, compressive strength, requirements for air entrainment, and usage as follows:

CONCRETE CLASS	MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER SQ. IN.	REQUIREMENT FOR AIR ENTRAINMENT	USAGE
3A	3,000	Air-entrained	For foundation concrete work exposed to freezing and thawing or subjected to hydraulic pressure, such as foundation walls, grade beams, pits, tunnels. For exterior concrete slabs, such as steps, platforms, walks
3N	3,000	Nonair-entrained	For foundation concrete work not exposed to freezing and thawing or subjected to hydraulic pressure, such as footings, pile caps, foundation mats. For interior slabs on ground to be covered with resilient flooring

CONCRETE CLASS	MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER SQ. IN.	REQUIREMENT FOR AIR ENTRAINMENT	USAGE
4A	4,000	Air-entrained	For structural concrete work exposed to freezing and thawing, unless otherwise indicated or specified, such as exterior columns and spandrels
4N	4,000	Nonair-entrained	For structural concrete work not exposed to freezing and thawing such as interior columns, beams, supported slabs and other structural members for interior slabs on ground subjected to foot traffic
2.5A	2,500	Air-entrained	For concrete not reinforced and not exposed to freezing and thawing
2.5N	2,500	Nonair-entrained	For concrete not reinforced and not exposed to freezing and thawing
5A	5,000	Air-entrained	For structural concrete work as indicated
5N	5,000	Nonair-entrained	For structural concrete work as indicated

2.8.2 Limits for Concrete Proportions

Provide limits for maximum water/cement ratio and minimum cement content for each concrete class as shown on the drawings

2.8.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, must be as follows:

MAXIMUM SIZE OF AGGREGATE	ASTM C 33 SIZE NUMBER	TYPE OF CONSTRUCTION
2 inches	357	Nonreinforced footings and other flat work having a depth of not less than 6 inches, and

MAXIMUM SIZE OF AGGREGATE	ASTM C 33 SIZE NUMBER	TYPE OF CONSTRUCTION
		nonreinforced walls and other formed sections having a dimension between forms of not less than 10 inches
3/4 inch	67	Reinforced walls formed sections having a dimension between forms of not less than 6 inches and clear distance between reinforcing bars or reinforcing bar and face of form of not less than 1 inch
3/4 inch	67	Monolithic concrete slabs and other flatwork having a depth of not less than 2-1/2 inches and a clear distance between reinforcing bars of not less than 1 inch
3/8 inch	8	Nonreinforced slabs and other flatwork having a depth of less than 2-1/2 inches

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

Specify gradation of aggregates for separate floor topping.

2.8.4 Slump

Provide slump for concrete at time and in location of placement as follows:

TYPE OF CONSTRUCTION	SLUMP
Footings	Not less than 1 inch nor more than 3 inches
monolithic slabs	than 4 inches

2.8.5 Total Air Content

Air content of exposed concrete and interior concrete must be in accordance with ASTM C 260 and/or as follows:

LIMITS CONCRETE EXPOSURE	REQUIREMENT FOR AIR ENTRAINMENT	MAXIMUM SIZE OF AGGREGATE	TOTAL AIR CONTENT BY VOLUME
Exposed to freezing and thawing or subjected to hydraulic pressure	Air-entrained	1-1/2 or 2 inches	to 6 percent
		3/4 inch	5 to 7 percent
		1/2 or 3/8 inch	6 to 8.5 percent

Provide concrete exposed to freezing and thawing or subjected to hydraulic pressure that is air-entrained by addition of approved air-entraining admixture to concrete mix.

PART 3 EXECUTION

3.1 EXAMINATION

Do not begin installation until substrates have been properly constructed; verify that substrates are plumb and true.

If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before processing.

Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Architect/Engineer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, seal subgrade surface by covering surface with specified water barrier subgrade cover; this may also be used over semiporous, dry subgrade material instead of water sprinkling.

3.2.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

Previously constructed subgrade or fill must be cleaned of foreign materials and inspected by the Contractor for adequate compaction and

surface tolerances as specified.

Actual density of top 12 inches of subgrade soil material-in-place must not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D 1557.

SOIL MATERIAL	PERCENT MAXIMUM DENSITY
Drainage fill	100
Cohesionless soil material	100
Cohesive soil material	95

Finish surface of drainage fill under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

Cover drainage fill surface under interior slabs on ground with specified water-vapor barrier subgrade cover immediately prior to placing reinforcement. Install subgrade cover to avoid puncture or tear. Patch punctures or tears over 12 inches with separate sheets lapped not less than 6 inches. Seal all punctures or tears less than 12 inches with pressure-sensitive vapor barrier tape not less than 2-inches wide. Seal lapped joints with vapor barrier adhesive or pressure-sensitive vapor barrier tape not less than 2-inches wide. Lay subgrade cover sheets with not less than a 6-inch lap at edges and ends and in direction in which concrete is to be placed.

Prepare subgrade or fill surface under exterior slabs on ground as specified for subgrade under foundations and footings.

3.2.4 Formwork

Complete and approve formwork. Remove debris and foreign material from interior of forms before start of concrete placing.

3.2.5 Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.6 Reinforcement and Other Embedded Items

Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

3.3 FORMS

ACI/MCP-2. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade. Chamfer

above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Provide formwork with clean-out openings to permit inspection and removal of debris. Forms submerged in water must be watertight.

3.3.1 General

Construct forms to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms must be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

3.3.2 Design and Construction of Formwork

Provide formwork design and construction that conforms to and ACI/MCP-2, Chapter 4.

Provide forms that are tight to prevent leakage of cement paste during concrete placing.

Support form facing materials by structural members spaced close to prevent deflection of form facing material. Fit forms placed in successive units for continuous surfaces to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, camber formwork for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Chamfer exposed joints, edges, and external corners a minimum of 3/4 inch by moldings placed in corners of column, beam, and wall forms.

Provide shores and struts with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations. Obtain adjustment with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, provide trussed supports.

Provide temporary openings in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Provide forms that are readily removable without impact, shock, or damage to concrete.

3.3.3 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.3.4 Reshoring

Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, reshore slabs and beams over 10 feet in span and cantilevers over 4 feet for the remainder of the specified time period in accordance with paragraph entitled "Removal of Forms." Perform

reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Provide reshoring elements with the same load-carrying capabilities as original shoring and spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.3.5 Reuse

Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

3.3.6 Forms for Standard Rough Form Finish

Give rough form finish concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish must be the specified concrete form plywood or other approved form facing material that produces concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 1-inch nominal thickness lumber may be used. Provide horizontal joints that are level and vertical joints that are plumb.

3.3.7 Forms for Standard Smooth Form Finish

Give smooth form finish concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish must be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales must not exceed 0.0025 times the span.

Provide arrangement of form facing sheets that are orderly and symmetrical, and sheets that are in sizes as large as practical.

Arrange panels to make a symmetrical pattern of joints. Horizontal and vertical joints must be solidly backed and butted tight to prevent leakage and fins.

3.3.8 Form Ties

Provide ties that are factory fabricated metal, adjustable in length, removable or snap-off type that do allow form deflection or do not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts must be at least 1-1/2 inches back from concrete surface. Provide form ties that are free of devices that leave a hole larger than 7/8 inch or less than 1/2 inch in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.3.9 Tolerances for Form Construction

Construct formwork to ensure that after removal of forms and prior to patching and finishing of formed surfaces, provide concrete surfaces in accordance with tolerances specified in ACI/MCP-1 and ACI/MCP-2.

3.3.10 Removal of Forms and Supports

After placing concrete, forms must remain in place for the time periods specified in ACI/MCP-4. Do not remove forms and shores (except those used for slabs on grade and slip forms) until the client determines that the concrete has gained sufficient strength to support its weight and superimposed loads. Base such determination on compliance with one of the following:

a. The plans and specifications stipulate conditions for removal of forms and shores, and such conditions have been followed, or

b. The concrete has been properly tested with an appropriate ASTM standard test method designed to indicate the concrete compressive strength, and the test results indicate that the concrete has gained sufficient strength to support its weight and superimposed loads.

Prevent concrete damage during form removal. Clean all forms immediately after removal.

3.3.10.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if ASTM C 39/C 39M test results of field-cured samples from a representative portion of the structure indicate that the concrete has reached a minimum of 85 percent of the design strength.

3.4 FORMED SURFACES3.4.1 Tolerances

ACI/MCP-4 and as indicated.

3.4.2 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Do not use material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which can impair the texture of the concrete surface.

3.5 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI/MCP-2. Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

3.5.1 General

Provide details of reinforcement that are in accordance with, and ACI/MCP-4 and as specified.

3.5.2 Vapor Barrier

Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches and tapejoints. Remove torn, punctured, or damaged vapor barrier material and provide with new vapor barrier prior to placing concrete. Concrete placement must not damage vapor barrier material.

3.5.3 Reinforcement Supports

Place reinforcement and secure with galvanized or non corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use concrete or other non corrodible material, having a compressive strength equal to or greater than the concrete being placed.

3.5.4 Splicing

As indicated. For splices not indicated ACI/MCP-2. Do not splice at points of maximum stress. Overlap welded wire fabric the spacing of the cross wires, plus 2 inches.

3.5.5 Future Bonding

Plug exposed, threaded, mechanical reinforcement bar connectors with a greased bolt. Provide bolt threads that match the connector. Countersink the connector in the concrete. Calk the depression after the bolt is installed.

3.5.6 Cover

ACI/MCP-2 for minimum coverage, unless otherwise indicated.

3.5.7 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.5.8 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.5.9 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool,

to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.5.10 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

Provide fabrication tolerances that are in accordance with ACI/MCP-1, ACI/MCP-2 and ACI/MCP-3.

Provide hooks and bends that are in accordance with and ACI/MCP-3.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Tolerance on nominally square-cut, reinforcing bar ends must be in accordance with ACI/MCP-3.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances

b. Bends or kinks not indicated on drawings or approved shop drawings

c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.5.11 Placing Reinforcement

Place reinforcement in accordance withACI/MCP-4.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire fabric on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

Contractor must cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor must notify the Contracting Officer so that conflicts may be reconciled before placing concrete. Anchors and embedded items must be positioned and supported with appropriate accessories.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Provide supports for reinforcing bars that are sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI/MCP-4 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

Equip supports on ground and similar surfaces with sand-plates.

Support welded wire fabric as required for reinforcing bars.

Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

With the exception of temperature reinforcement, tied to main steel approximately 24 inches on center, reinforcement must be accurately placed, securely tied at intersections with 18-gage annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to ACI/MCP-3.

Bending of reinforcing bars partially embedded in concrete is permitted only as specified inand ACI/MCP-4.

3.5.12 Spacing of Reinforcing Bars

Spacing must be as indicated. If not indicated, spacing must be in accordance with theACI/MCP-3.

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to approval.

3.5.13 Concrete Protection for Reinforcement

Concrete protection must be in accordance with the ACI/MCP-4, ASTM E 648,and ACI/MCP-3.

3.5.14 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.6 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C 94/C 94M, and ACI/MCP-2, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.6.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

3.6.2 Mixing

ASTM C 94/C 94M and ACI/MCP-2. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.6.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.7 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

3.7.1 General Placing Requirements

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation.

Concrete to receive other construction must be screeded to proper level to avoid excessive skimming or grouting.

Do not use concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Use of retempered concrete is permitted. Remove rejected concrete from the site.

3.7.2 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

3.7.3 Vibration

ACI/MCP-2 and ASTM A 934/A 934M. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Insert and withdraw vibrators approximately 20 inches apart. Penetrate the previously placed lift with the vibrator when more than one lift is required. Place concrete in 20 inch maximum vertical lifts. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

3.7.4 Application of Epoxy Bonding Compound

Apply a thin coat of compound to dry, clean surfaces. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is stringy. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

3.7.5 Pumping

ACI/MCP-2. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.7.6 Cold Weather

ACI/MCP-2. Do not allow concrete temperature to decrease below 50 degrees F Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

3.7.7 Hot Weather

Maintain required concrete temperature using Figure 2.1.5 in ACI/MCP-2 to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh

concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.7.8 Follow-up

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

3.7.9 Placing Concrete in Forms

Deposit concrete placed in forms in horizontal layers not exceeding 24 inches.

Remove temporary spreaders in forms when concrete placing has reached elevation of spreaders.

Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Design vibrators to operate with vibratory element submerged in concrete and maintain a speed of not less than 9,000 impulses per minute when submerged in concrete. Provide vibrating equipment adequate in number of units and power of each unit to properly consolidate concrete. Vibration of forms and reinforcement is not be permitted. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Do not insert vibrator into lower courses of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Do not start placing of concrete in supporting elements until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

3.7.10 Placing Concrete Slabs

Place and consolidate concrete for slabs in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, consolidate concrete by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground by mechanical vibrators as specified. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other approved method. Limit consolidation operations to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated must be as dry as practical and surfaces thereof must not be manipulated prior to finishing operations. Bring concrete correct level with a straightedge and struck-off. Use bull floats or darbies to smooth surface, leaving it free

of humps or hollows. Sprinkling of water on plastic surface is not permitted.

Provide finish of slabs as specified.

3.7.11 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Apply such bonding material to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

3.8 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.8.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 1 square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI/MCP-4. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise specified.

3.8.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

3.8.3 Formed Surfaces

3.8.3.1 Tolerances

ACI/MCP-1 and as indicated.

3.8.3.2 As-Cast Rough Form

Provide for surfaces not exposed to public view. Patch these holes and defects and level abrupt irregularities. Remove or rub off fins and other projections exceeding 0.25 inch in height.

3.8.3.3 Standard Smooth Finish

Finish must be as-cast concrete surface as obtained with form facing material for standard smooth finish. Repair and patch defective areas as specified; and all fins and remove other projections on surface.

3.8.4 Surface Finish Samples

Provide a minimum of three sample concrete panels for each finish for each mix design, 3 by 3 feet, 3 inches thick. Use the approved concrete mix design(s). Provide sample panels on-site at locations directed. Once approved, each set of panels must be representative of each of the finishes specified and of the workmanship and finish(es) required. Do not remove or destroy samples until directed by the Contracting Officer.

3.8.5 Grout Finish

Provide finish that is standard, smooth coated with grout as specified.

Give finish to interior and exterior concrete vertical surfaces that are to be exposed to view.

Grout is required consisting of one part portland cement to 1-1/2 parts fine aggregate by volume, mixed with water to produce a consistency of thick paint. Portland cement portion must be a blend of standard portland cement and white portland cement, proportioned as determined by trial mixes so that final color of grout when dry approximates color of surrounding concrete. Fine aggregate must pass No. 30 mesh sieve.

Surface of concrete is required to be wetted, and grout must be applied immediately to wetted surfaces. Spread grout over surface with clean burlap pads or sponge-rubber floats to fill pits, air bubbles, and surface holes. Remove excess grout by scraping, then rubbing surface with clean burlap to remove visible grout film. Keep grout damp by means of fog spray during setting period. Complete finish the day it is started, and make limits of a finished area at natural breaks in finished surface.

3.9 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

ACI/MCP-2, unless otherwise specified. Slope floors uniformly to drains where drains are provided. Steel trowel and fine-broom finish concrete slabs that are to receive quarry tile, ceramic tile, or paver tile . Where straightedge measurements are specified, Contractor must provide straightedge.

3.9.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.9.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. After the concrete has been placed, consolidated, struck off, and leveled to a Class C tolerance as defined below,roughen the surface with stiff brushes of rakes before final set.

3.9.1.2 Floated

After the concrete has been placed, consolidated, struck off, and leveled, do not work the concrete further, until ready for floating. Whether floating with a wood, magnesium, or composite hand float, with a bladed power trowel equipped with float shoes, or with a powered disc, float must begin when the surface has stiffened sufficiently to permit the operation. During or after the first floating, check surface with a 10 foot straightedge applied at no less than two different angles, one of which is perpendicular to the direction of strike off. Cut down high spots and fill low spots during this procedure to produce a surface level within 1/4 inch in 10 feet.

3.9.1.3 Steel Troweled

Use for floors intended as walking surfaces, for reception of floor coverings. First, provide a floated finish. Next, the finish must be power troweled two times, and finally hand troweled. The first troweling after floating needs to produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings done by hand after the surface has hardened sufficiently. The final troweling is done when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate the surface by the hand troweling operations. The finished surface must be essentially free of trowel marks and uniform in texture and appearance. The finished surface must produce a surface level to within 1/4 inch in 10 feet. On surfaces intended to support floor coverings, remove any defects of sufficient magnitude to show through the floor covering by grinding.

3.9.1.4 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.9.1.5 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as

necessary. Obtain final finish by Round edges and joints with an edger having a radius of 1/8 inch.

3.9.2 Concrete Walks

Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet unless otherwise indicated. Cut contraction joints one inch deep with a jointing tool after the surface has been finished. Provide 0.5 inch thick transverse expansion joints at changes in direction where sidewalk abuts curb, steps, rigid pavement, or other similar structures; space expansion joints every 50 feet maximum. Give walks a broomed finish. Unless indicated otherwise, provide a transverse slope of 1/48. Limit variation in cross section to 1/4 inch in 5 feet.

3.9.3 Pits and Trenches

Place bottoms and walls monolithically or provide waterstops and keys.

3.9.4 Curbs and Gutters

Provide contraction joints spaced every 10 feet maximum unless otherwise indicated. Cut contraction joints 3/4 inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2 inch thick and spaced every 100 feet maximum unless otherwise indicated. Perform pavement finish.

3.10 CURING AND PROTECTION

ACI/MCP-2 unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs,

3.10.1 General

Protect freshly placed concrete from premature drying and cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Start initial curing as soon as free water has disappeared from surface of concrete after placing and finishing. Keep concrete moist for minimum 72 hours.

Final curing must immediately follow initial curing and before concrete has dried. Continue final curing until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in

contact with the concrete is above 50 degrees F has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Prevent rapid drying at end of final curing period.

3.10.2 Moist Curing

Remove water without erosion or damage to the structure. Prevent water run-off.

3.10.2.1 Ponding or Immersion

Continually immerse the concrete throughout the curing period. Water must not be more than 50 degrees F less than the temperature of the concrete. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.10.2.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.10.2.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6 inches over adjacent sheeting. Provide sheeting that is at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3.10.2.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.10.3 Liquid Membrane-Forming Curing Compound

Seal or cover joint openings prior to application of curing compound. Prevent curing compound from entering the joint. Apply in accordance with the recommendations of the manufacturer immediately after any water sheen which may develop after finishing has disappeared from the concrete surface. Provide and maintain compound on the concrete surface throughout the curing period. Do not use this method of curing where the use of Figure 2.1.5 in ACI/MCP-2 indicates that hot weather conditions cause an evaporation rate exceeding 0.2 pound of water per square foot per hour.

3.10.3.1 Application

Unless the manufacturer recommends otherwise, apply compound immediately after the surface loses its water sheen and has a dull appearance, and before joints are sawed. Mechanically agitate curing compound thoroughly during use. Use approved power-spraying equipment to uniformly apply two coats of compound in a continuous operation. The total coverage for the two coats must be 200 square feet maximum per gallon of undiluted compound unless otherwise recommended by the manufacturer's written instructions. The compound must form a uniform, continuous, coherent film that does not check, crack, or peel. Immediately apply an additional coat of compound to areas where the film is defective. Re-spray concrete surfaces subjected to rainfall within 3 hours after the curing compound application.

3.10.3.2 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.10.4 Liquid Chemical Sealer-Hardener

Apply sealer-hardener to interior floors not receiving floor covering and floors located under access flooring. Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. Do not apply the sealer hardener until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

3.10.5 Curing Periods

ACI/MCP-2 except 10 days for retaining walls, pavement or chimneys, 21 days for concrete that is in full-time or intermittent contact with seawater, salt spray, alkali soil or waters. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.10.6 Curing Methods

Accomplish curing by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified.

Moist curing:

Accomplish moisture curing by any of the following methods:

Keeping surface of concrete wet by covering with water

Continuous water spraying

Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Place absorptive cover to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Accomplish moisture-retaining cover curing by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Place cover directly on concrete in widest practical width, with sides and ends lapped at least 3 inches. Weight cover to prevent displacement; immediately repair tears or holes appearing during curing period by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Accomplish membrane curing by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Apply curing compound uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Apply second coat in a direction at right angles to direction of first coat. Total coverage for two coats must be not more than 200 square feet per gallon of curing compound. Respray concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied by method and at rate specified. Maintain continuity of coating for entire curing period and immediately repair damage to coating during this period.

Membrane-curing compounds must not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, painting, and other coatings and finish materials.

3.10.7 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.10.8 Curing Unformed Surfaces

Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

Unless otherwise specified, accomplish final curing of unformed surfaces by any of curing methods specified above, as applicable.

Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.10.9 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.10.10 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.10.11 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.11 FIELD QUALITY CONTROL

3.11.1 Sampling

ASTM C 172. Collect samples of fresh concrete to perform tests specified. ASTM C 31/C 31M for making test specimens.

3.11.2 Testing

3.11.2.1 Slump Tests

ASTM C 143/C 143M. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

3.11.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.11.2.3 Compressive Strength Tests

ASTM C 39/C 39M. Make five test cylinders for each set of tests in accordance with ASTM C 31/C 31M. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. Take samples for strength tests of each mix design of concrete placed each day not less than once a day, nor less than once for each 160 cubic yards of concrete, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same

concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 450 psi, take a minimum of three ASTM C 42/C 42M core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core test is considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Retest locations represented by erratic core strengths. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.11.2.4 Air Content

ASTM C 173/C 173M or ASTM C 231 for normal weight concrete . Test air-entrained concrete for air content at the same frequency as specified for slump tests.

3.11.2.5 Ion Concentration

ACI/MCP-3. Determine water soluble ion concentration. Perform test once for each mix design.

3.11.2.6 Strength of Concrete Structure

Compliance with the following is considered deficient if it fails to meet the requirements which control strength of structure in place, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

3.11.2.7 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C 42/C 42M, and as follows:

Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

Test cores after moisture conditioning in accordance with ASTM C 42/C 42M if concrete they represent is more than superficially wet under service.

Air dry cores, (60 to 80 degrees F with relative humidity less than 60 percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.12 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows.

3.12.1 Mixing Equipment

Before concrete pours, designate A Company-owned site meeting environmental standards or an on-site area to be paved later in project for cleaning out concrete mixing trucks. Minimize water used to wash equipment.

3.12.2 Hardened, Cured Waste Concrete

Crush and reuse hardened, cured waste concrete as fill or as a base course for pavement. or Use hardened, cured waste concrete as aggregate in concrete mix if approved by Contracting Officer.

3.12.3 Reinforcing Steel

Collect reinforcing steel and place in designated area for recycling.

3.12.4 Other Waste

Identify concrete manufacturer's or supplier's policy for collection or return of construction waste, unused material, deconstruction waste, and/or packaging material. Return excess cement to supplier. Institute deconstruction and construction waste separation and recycling for use in manufacturer's programs. When such a program is not available, seek local recyclers to reclaim the materials.

3.13 JOINTS

3.13.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Locate construction joints as follows:

a. In walls at not more than 60 feet in any horizontal direction; at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural

details; and at underside of deepest beam or girder framing into wall

b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier

d. In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

Joints must be perpendicular to main reinforcement. Reinforcement must be continued across construction joints.

3.13.2 Isolation Joints in Slabs on Ground

Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

3.13.3 Control Joints in Slabs on Ground

Provide joints to form panels as indicated.

Under and on exact line of each control joint, cut 50 percent of welded wire fabric reinforcement before placing concrete.

Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface or by cutting the concrete with a saw after the concrete has set. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.

In Hawaii, sawcutting will be limited to within 12 hours after set and at 1/4 slab depth.

3.13.4 Sealing Joints in Slabs on Ground

Isolation and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

Sealing is not required for isolation and control joints to be covered with finish flooring material. Groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.14 INSTALLATION OF ANCHORAGE DEVICES

3.14.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, set and build in cast-in-place concrete as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

3.14.2 Placing Anchorage Devices

Anchorage devices and embedded items must be positioned accurately and supported against displacement. Fill openings in anchorage devices such as slots and threaded holes with an approved, removable material to prevent entry of concrete into openings.

3.15 CONCRETE CONVEYING

3.15.1 Transfer of Concrete At Project Site

Handle concrete from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which prevent segregation and loss of concrete mix materials.

3.15.2 Mechanical Equipment for Conveying Concrete

Equipment must ensure a continuous flow of concrete at delivery end, as approved. Provide runways for wheeled concrete-conveying equipment from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment must be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

-- End of Section --

SECTION 04 20 00

MASONRY
10/07

PART 1 GENERAL

1.1 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.

ACI INTERNATIONAL (ACI)

ACI 530	(2005) Building Code Requirements for Masonry Structures Commentaries
ACI 530.1	(2005) Specification for Masonry Structures

ASTM INTERNATIONAL (ASTM)

ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 167	(1999; R 2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 615/A 615M	(2008) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 641/A 641M	(2003) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A 82/A 82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM B 370	(2003) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM C 1019	(2008) Standard Test Method for Sampling and Testing Grout
ASTM C 1072	(2006) Standard Test Method for Measurement of Masonry Flexural Bond Strength
ASTM C 1142	(1995; R 2007) Standard Specification for Extended Life Mortar for Unit Masonry
ASTM C 1289	(2007) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board

ASTM C 129	(2006) Standard Specification for Nonloadbearing Concrete Masonry Units
ASTM C 144	(2004) Standard Specification for Aggregate for Masonry Mortar
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 207	(2006) Standard Specification for Hydrated Lime for Masonry Purposes
ASTM C 270	(2007a) Standard Specification for Mortar for Unit Masonry
ASTM C 476	(2007) Standard Specification for Grout for Masonry
ASTM C 494/C 494M	(2008) Standard Specification for Chemical Admixtures for Concrete
ASTM C 578	(2007) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 593	(2006) Fly Ash and Other Pozzolans for Use with Lime
ASTM C 62	(2005) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 641	(2007) Staining Materials in Lightweight Concrete Aggregates
ASTM C 652	(2007) Hollow Brick (Hollow Masonry Units Made from Clay or Shale)
ASTM C 67	(2007a) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C 780	(2007a) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C 90	(2006b) Loadbearing Concrete Masonry Units
ASTM C 91	(2005) Masonry Cement
ASTM C 94/C 94M	(2007) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2006) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 2000	(2008) Standard Classification System for Rubber Products in Automotive Applications
ASTM D 2240	(2005) Standard Test Method for Rubber

	Property - Durometer Hardness
ASTM D 2287	(1996; R 2001) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Environmental Data
Concrete Masonry Units (CMU) G
Cement G
Insulation G
FlashingG
Cold Weather Installation G

Cold weather construction procedures.

SD-04 Samples

Stone Items G
Clay or Shale Brick G

Color samples of three stretcher units and one unit for each type of special shape. Units shall show the full range of color and texture. Submit sample of colored mortar with applicable masonry unit.

Insulation G

One piece of board type insulation, not less than 16 by 24 inches in size, containing the label indicating the rated permeance and R-values.

SD-05 Design Data

Pre-mixed Mortar G
Unit Strength Method G

Pre-mixed mortar composition. Calculations and certifications of masonry unit and mortar strength.

SD-07 Certificates

Clay or Shale Brick

Concrete Masonry Units (CMU)

Masonry Cement
Mortar Coloring
Insulation

Admixtures for Masonry Mortar
Admixtures for Grout

Certificates of compliance stating that the materials meet the specified requirements.

Contamination

SD-08 Manufacturer's Instructions

Masonry Cement

When masonry cement is used, submit the manufacturer's printed instructions on proportions of water and aggregates and on mixing to obtain the type of mortar required.

1.3 SAMPLE MASONRY PANELS

After material samples are approved and prior to starting masonry work, a portable panel of clay or shale brick and sample masonry panels shall be constructed for each type and color of masonry required. At least 48 hours prior to constructing the sample panel or panels, the Contractor shall submit written notification to the Contracting Officer's Representative. Sample panels shall not be built in, or as part of the structure, but shall be located where directed.

1.3.1 Configuration

Panels shall be L-shaped or otherwise configured to represent all of the wall elements. Panels shall be of the size necessary to demonstrate the acceptable level of workmanship for each type of masonry represented on the project. The minimum size of a straight panel or a leg of an L-shaped panel shall be 6 feet long by 4 feet high.

1.3.2 Composition

Panels shall show full color range, texture, and bond pattern of the masonry work. The Contractor's method for mortar joint tooling; grouting of reinforced vertical coresand cleaning of masonry work shall be demonstrated during the construction of the panels. Installation or application procedures for anchors, wall ties, CMU control joints, brick expansion joints, insulation, flashing, brick soldier, row lock courses and weep holes shall be shown in the sample panels.

1.3.3 Usage

The completed panels shall be used as the standard of workmanship for the type of masonry represented. Masonry work shall not commence until the sample panel for that type of masonry construction has been completed and approved. Panels shall be protected from the weather and construction operations until the masonry work has been completed and approved. After completion of the work, the sample panels, including all foundation concrete, shall become the property of the Contractor and shall be removed from the construction site.

1.4 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered, handled, stored, and protected to avoid chipping, breakage, and contact with soil or contaminating material. Store

and prepare materials in already disturbed areas to minimize project site disturbance and size of project site.

1.4.1 Masonry Units

Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C 90. Prefabricated lintels shall be marked on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.4.2 Reinforcement, Anchors, and Ties

Steel reinforcing bars, coated anchors, ties, and joint reinforcement shall be stored above the ground. Steel reinforcing bars and uncoated ties shall be free of loose mill scale and rust.

1.4.3 Cementitious Materials, Sand and Aggregates

Cementitious and other packaged materials shall be delivered in unopened containers, plainly marked and labeled with manufacturers' names and brands. Cementitious material shall be stored in dry, weathertight enclosures or be completely covered. Cement shall be handled in a manner that will prevent the inclusion of foreign materials and damage by water or dampness. Sand and aggregates shall be stored in a manner to prevent contamination or segregation.

1.5 STRUCTURAL MASONRY

1.5.1 Unit Strength Method

Compute compressive strength of masonry system "Unit Strength Method," ACI 530. Submit calculations and certifications of unit and mortar strength.

1.6 QUALITY ASSURANCE

1.6.1 Appearance

Bricks shall be manufactured at one time and from the same batch. Blend all brick to produce a uniform appearance when installed. An observable "banding" or "layering" of colors or textures caused by improperly mixed brick is unacceptable.

1.6.2 Contamination

When using bricks containing contaminated soil, supplier shall certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants will be released, or that the product is free from hazardous contaminants.

1.6.3 Testing

Masonry strength shall be determined in accordance with ACI 530; submit test reports on three prisms as specified in ACI 530.1. The cost of testing shall be paid by the Contractor.

1.6.4 Spare Vibrator

Maintain at least one spare vibrator on site at all times.

1.6.5 Bracing and Scaffolding

Provide bracing and scaffolding necessary for masonry work. Design bracing to resist wind pressure as required by local code.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

The source of materials which will affect the appearance of the finished work shall not be changed after the work has started except with Contracting Officer's approval.

2.2 CLAY OR SHALE BRICK

Color range and texture of clay or shale brick shall be as indicated and shall conform to the approved sample. Brick shall conform to ASTM C 62; Grade SW shall be used for brick in contact with earth or grade and for all exterior work and for all nonvertical surfaces. Grade SW or MW shall be used in other brickwork. Average dimensions of brick shall be 3-5/8 inches thick, 2-1/4 inches high, and 8 inches long (standard) , subject to the tolerances specified in ASTM C 62. Brick shall be tested for efflorescence. Clay or shale brick units shall be delivered factory-blended to provide a uniform appearance and color range in the completed wall.

2.2.1 Hollow Clay or Shale Brick

Hollow clay or shale brick shall conform to ASTM C 652, Type HBX . Brick size shall be modular and the nominal size of the brick used shall be 3 5/8 inches thick, 2 1/4 inches high, and 8 inches long. Where vertical reinforcement is shown in hollow brick, the minimum cell dimension shall be 2-1/2 inches and the units shall be designed to provide precise vertical alignment of the cells. Minimum compressive strength of the brick shall be 2500 psi.

2.3 CONCRETE MASONRY UNITS (CMU)

Cement shall have a low alkali content and be of one brand. Units shall be of modular dimensions and air, water, or steam cured. exposed surfaces of units shall be smooth and of uniform texture.

a. Hollow Load-Bearing Units: ASTM C 90, made with lightweight or normal weight aggregate. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.

b. Hollow Non-Load-Bearing Units: ASTM C 129, made with lightweight [or medium weight] [or normal weight] aggregate. Load-bearing units may be provided in lieu of non-load-bearing units.

c. Solid Load-Bearing Units: ASTM C 90, medium weightunits. Provide solid units [as indicated.

2.3.1 Aggregates

Lightweight aggregates and blends of lightweight and heavier aggregates in proportions used in producing the units, shall comply with the following requirements when tested for stain-producing iron compounds in accordance with ASTM C 641: by visual classification method, the iron stain deposited on the filter paper shall not exceed the "light stain" classification. Use industrial waste by-products (air-cooled slag, cinders, or bottom ash), ground waste glass and concrete, granulated slag, and expanded slag in aggregates. Slag shall comply with ASTM C 989; Grade [100.

2.3.2 Kinds and Shapes

Units shall be modular in size and shall include closer, jamb, header, lintel, and bond beam units and special shapes and sizes to complete the work as indicated. In exposed interior masonry surfaces, units having a bullnose shall be used for vertical external corners except at door, window, and louver jambs. Radius of the bullnose shall be 1 inch. Units used in exposed masonry surfaces in any one building shall have a uniform fine to medium texture and a uniform color.

2.4 STONE ITEMS

Stone for trim, sills, lintels, and copings shall be limestone, and shall be cut to the design shown. Limestone shall be standard buff limestone with a smooth machine finish free from tool marks (match exisitng color and texture). Lintels, except when supported by a steel member, shall be 4 inches or more thick from face to back edge and of the depth required to support the masonry over the opening. Stone shall have beds and joints at right angles to the face, with sharp, true arises. Copings and sills shall be provided with washes, and where overhanging the walls, shall have drips cut on the underside.

2.5 MORTAR FOR STRUCTURAL MASONRY

ASTM C 270, Type N. Strength (f'm) as indicated. Test in accordance with ASTM C 780. Use Type I or II portland cement. Do not use admixtures containing chlorides. When structural reinforcement is incorporated, maximum air-content shall be 12 percent in cement-lime mortar and 18 percent in masonry cement mortar. Use up to 40 percent Class F fly ash with type IP cement in cement-lime mortar. Fly ash shall comply with ASTM C 593.

2.6 MASONRY MORTAR

Type M mortar shall conform to ASTM C 270 and shall be used for foundation walls and piers. Mortar Type N shall conform to the proportion specification of ASTM C 270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate; Type N cement-lime mortar proportions shall be 1 part cement, 1 part lime and 6 parts aggregate. Type N or S mortar shall be used for non-load-bearing, non-shear-wall interior masonry; and Type S for remaining masonry work; except where higher compressive strength is indicated on structural drawings. When masonry cement ASTM C 91 is used the maximum air content shall be limited to 12 percent and performance equal to cement-lime mortar shall be verified. Verification of masonry cement performance shall be based on ASTM C 780 and ASTM C 1072. . Cement shall have a low alkali content and be of one brand. Aggregates shall be from one source.

2.6.1 Admixtures for Masonry Mortar

In cold weather, a non-chloride based accelerating admixture may be used subject to approval. Accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C.

2.6.2 Hydrated Lime and Alternates

Hydrated lime shall conform to ASTM C 207, Type [S][SA].

2.6.3 Cement

Portland cement shall conform to ASTM C 150, Type I, II, . Masonry cement shall conform to ASTM C 91, Type N. Containers shall bear complete instructions for proportioning and mixing to obtain the required types of mortar. Incorporate to the maximum extent, without conflicting with other requirements of this section, up to 40 percent fly ash, up to 70 percent slag, up to 10 percent cenospheres, and up to 10 percent silica fume. .

2.6.4 Pre-Mixed Mortar

Pre-mixed mortar shall conform to ASTM C 1142, Type RN .

2.6.5 Sand and Water

Sand shall conform to ASTM C 144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

2.7 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C 476, fine. Cement used in grout shall have a low alkali content. Grout slump shall be between 8 and 10 inches. Minimum grout strength shall be 2000 psi in 28 days, as tested by ASTM C 1019. Grout shall be used subject to the limitations of Table III. Proportions shall not be changed and materials with different physical or chemical characteristics shall not be used in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C 94/C 94M.

2.7.1 Admixtures for Grout

In cold weather, a non-chloride based accelerating admixture may be used subject to approval; accelerating admixture shall be non-corrosive, shall contain less than 0.2 percent chlorides, and shall conform to ASTM C 494/C 494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer.

2.7.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

2.8 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A 153/A 153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to

ASTM A 82/A 82M. Wire ties or anchors in exterior walls shall conform to ASTM A 641/A 641M. Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A 641/A 641M; coordinate with paragraph JOINT REINFORCEMENT below. Anchors and ties shall be sized to provide a minimum of 5/8 inch mortar cover from either face.

2.8.1 Wire Mesh Ties

Wire mesh for tying 4 inch thick concrete masonry unit partitions to other intersecting masonry partitions shall be 1/2 inch mesh of minimum 16 gauge steel wire. Minimum lengths shall be not less than 12 inches.

2.8.2 Wall Ties

Wall ties shall be rectangular-shaped or Z-shaped fabricated of 3/16 inch diameter zinc-coated steel wire. Rectangular wall ties shall be no less than 4 inches wide. Wall ties may also be of a continuous type conforming to paragraph JOINT REINFORCEMENT. Adjustable type wall ties, if approved for use, shall consist of two essentially U-shaped elements fabricated of 3/16 inch diameter zinc-coated steel wire. Adjustable ties shall be of the double pintle to eye type and shall allow a maximum of 1/2 inch eccentricity between each element of the tie. Play between pintle and eye opening shall be not more than 1/16 inch. The pintle and eye elements shall be formed so that both can be in the same plane.

2.8.3 Adjustable Anchors

Adjustable anchors shall be 3/16 inch diameter steel wire, triangular-shaped. Anchors attached to steel shall be 5/16 inch diameter steel bars placed to provide 1/16 inch play between flexible anchors and structural steel members. Spacers shall be welded to rods and columns. Equivalent welded-on steel anchor rods or shapes standard with the flexible-anchor manufacturer may be furnished when approved. Welds shall be cleaned and given one coat of zinc-rich touch up paint.

2.8.4 Bar Positioners

Bar positioners, used to prevent displacement of reinforcing bars during the course of construction, shall be factory fabricated from 9 gauge steel wire or equivalent, and coated with a hot-dip galvanized finish. Not more than one wire shall cross the cell.

2.9 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A 82/A 82M, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A 153/A 153M, Class B-2. All wires shall be a minimum of 9 gauge. Reinforcement shall be ladder type design, having one longitudinal wire in the mortar bed of each face shell for hollow units and one wire for solid units. Joint reinforcement shall be placed a minimum of 5/8 inch cover from either face. The distance between crosswires shall not exceed 16 inches. Joint reinforcement for straight runs shall be furnished in flat sections not less than 10 feet long. Joint reinforcement shall be provided with factory formed corners and intersections. If approved for use, joint reinforcement may be furnished with adjustable wall tie features.

2.10 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A 615/A 615M, Grade 60.

2.11 CONTROL JOINT KEYS

Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D 2000or polyvinyl chloride conforming to ASTM D 2287. The material shall be resistant to oils and solvents. The control joint key shall be provided with a solid shear section not less than 5/8 inch thick and 3/8 inch thick flanges, with a tolerance of plus or minus 1/16 inch. The control joint key shall fit neatly, but without forcing, in masonry unit jamb sash grooves. The control joint key shall be flexible at a temperature of minus 30 degrees F after five hours exposure, and shall have a durometer hardness of not less than 70 when tested in accordance with ASTM D 2240.

2.12 INSULATION

2.12.1 Rigid Board-Type Insulation

Rigid board-type insulation shall be extruded polystyrene. Polystyrene shall conform to ASTM C 578. Polyisocyanurate shall conform to ASTM C 1289, Type I, Class 1 or 2. The insulation shall be a standard product and shall be marked with not less than the manufacturer's trademark or name, the specification number, the permeance and R-values.

2.12.1.1 Insulation Thickness and Air Space

The cavity space shall allow for a maximum insulation thickness of 2 inches, and a minimum air space of 2 inch.

2.12.1.2 Aged R-Value

The insulation shall provide a minimum aged R-value of 10 for the overall thickness. The aged R-value shall be determined at 75 degrees F in accordance with the appropriate referenced specification. The stated R-value of the insulation shall be certified by an independent testing laboratory or certified by an independent Registered Professional Engineer if tests are conducted in the manufacturer's laboratory.

2.12.2 Insulation Adhesive

Insulation adhesive shall be specifically prepared to adhere the insulation to the masonry and, where applicable, to the thru-wall flashing. The adhesive shall not deleteriously affect the insulation, and shall have a record of satisfactory and proven performance for the conditions under which to be used.

2.13 EXPANSION-JOINT MATERIALS

Backer rod and sealant shall be adequate to accommodate joint compression equal to 50 percent of the width of the joint. The backer rod shall be compressible rod stock of polyethylene foam, polyurethane foam, butyl rubber foam, or other flexible, nonabsorptive material as recommended by the sealant manufacturer. Sealant shall conform to Section 07 92 00 JOINT SEALANTS, and shall be penetrating with a maximum volatile organic compound (VOC) content of 600 grams/liter.

2.14 FLASHING

Provide one of the following types except that flashing indicated to terminate in reglets shall be metal or coated-metal flashingand except that the material shall be one which is not adversely affected by dampproofing material.

a. Coated-Copper Flashing: 7 ounce, electrolytic copper sheet, uniformly coated on both sides with acidproof, alkaliproof, elastic bituminous compound. Factory apply coating to a weight of not less than 6 ounces/square foot (approximately 3 ounces/square foot on each side).

b. Copper or Stainless Steel Flashing: Copper, ASTM B 370, minimum 16 ounce weight; stainless steel, ASTM A 167, Type 301, 302, 304, or 316, 0.015 inch thick, No. 2D finish. Provide with factory-fabricated deformations that mechanically bond flashing against horizontal movement in all directions. Deformations shall consist of dimples, diagonal corrugations, or a combination of dimples and transverse corrugations.

c. Reinforced Membrane Flashing: Polyester film core with a reinforcing fiberglass scrim bonded to one side. The membrane shall be impervious to moisture, flexible, and not affected by caustic alkalis. The material, after being exposed for not less than 1/2 hour to a temperature of 32 degrees F, shall show no cracking when, at that temperature, it is bent 180 degrees over a 1/16 inch diameter mandrel and then bent at the same point over the same size mandrel in the opposite direction 360 degrees.

2.15 WEEP HOLE VENTILATORS

Weephole ventilators shall be prefabricated aluminum or plastic sized to form the proper size opening in head joints. Provide aluminum and plastic inserts with grill or screen-type openings designed to allow the passage of moisture from cavities and to prevent the entrance or insects. Ventilators shall be sized to match modular construction with a standard 1/4 inch mortar joint.

PART 3 EXECUTION

3.1 PREPARATION

Prior to start of work, masonry inspector shall verify the applicable conditions as set forth in ACI 530.1, inspection. The Contracting Officer will serve as inspector or will select a masonry inspector.

3.1.1 Hot Weather Installation

The following precautions shall be taken if masonry is erected when the ambient air temperature is more than 99 degrees F in the shade and the relative humidity is less than 50 percent or the ambient air temperature exceeds 90 degrees F and the wind velocity is more than 8 mph. All masonry materials shall be shaded from direct sunlight; mortar beds shall be spread no more than 4 feet ahead of masonry; masonry units shall be set within one minute of spreading mortar; and after erection, masonry shall be protected from direct exposure to wind and sun for 48 hours.

3.1.2 Cold Weather Installation

Before erecting masonry when ambient temperature or mean daily air temperature falls below 40 degrees F or temperature of masonry units is below 40 degrees F, a written statement of proposed cold weather construction procedures shall be submitted for approval. The following precautions shall be taken during all cold weather erection. Conform to ACI 530.1 for hot and cold weather masonry erection.

3.1.2.1 Protection

Ice or snow formed on the masonry bed shall be thawed by the application of heat. Heat shall be applied carefully until the top surface of the masonry is dry to the touch. Sections of masonry deemed frozen and damaged shall be removed before continuing construction of those sections.

a. Air Temperature 40 to 32 Degrees F. Sand or mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees F

b. Air Temperature 32 to 25 Degrees F. Sand and mixing water shall be heated to produce mortar temperatures between 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing.

c. Air Temperature 25 to 20 Degrees F. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Temperature of mortar on boards shall be maintained above freezing. Sources of heat shall be used on both sides of walls under construction. Windbreaks shall be employed when wind is in excess of 15 mph.

d. Air Temperature 20 Degrees F and below. Sand and mixing water shall be heated to provide mortar temperatures between 40 and 120 degrees F. Enclosure and auxiliary heat shall be provided to maintain air temperature above 32 degrees F. Temperature of units when laid shall not be less than 20 degrees F.

3.1.2.2 Completed Masonry and Masonry Not Being Worked On

a. Mean daily air temperature 40 to 32 degrees F. Masonry shall be protected from rain or snow for 24 hours by covering with weather-resistive membrane.

b. Mean daily air temperature 32 to 25 degrees F. Masonry shall be completely covered with weather-resistant membrane for 24 hours.

c. Mean Daily Air Temperature 25 to 20 degrees F. Masonry shall be completely covered with insulating blankets or equally protected for 24 hours.

d. Mean Daily Temperature 20 degrees F and Below. Masonry temperature shall be maintained above 32 degrees F for 24 hours by enclosure and supplementary heat, by electric heating blankets, infrared heat lamps, or other approved methods.

3.1.3 Stains

Potect exposed surfaces from mortar and other stains. When mortar joints are tooled, remove mortar from exposed surfaces with fiber brushes and wooden paddles. Protect base of walls from splash stains by covering

adjacent ground with sand, sawdust, or polyethylene.

3.1.4 Loads

Do not apply uniform loads for at least 12 hours or concentrated loads for at least 72 hours after masonry is constructed. Provide temporary bracing as required.

3.1.5 Surfaces

Surfaces on which masonry is to be placed shall be cleaned of laitance, dust, dirt, oil, organic matter, or other foreign materials and shall be slightly roughened to provide a surface texture with a depth of at least 1/8 inch. Sandblasting shall be used, if necessary, to remove laitance from pores and to expose the aggregate.

3.2 LAYING MASONRY UNITS

Coordinate masonry work with the work of other trades to accommodate built-in items and to avoid cutting and patching. Masonry units shall be laid in the indicated bond pattern to match the existing building. Facing courses shall be level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances shall be plus or minus 1/2 inch. Each unit shall be adjusted to its final position while mortar is still soft and plastic. Units that have been disturbed after the mortar has stiffened shall be removed, cleaned, and relaid with fresh mortar. Air spaces, cavities, chases, expansion joints, and spaces to be grouted shall be kept free from mortar and other debris. Units used in exposed masonry surfaces shall be selected from those having the least amount of chipped edges or other imperfections detracting from the appearance of the finished work. Vertical joints shall be kept plumb. Units being laid and surfaces to receive units shall be free of water film and frost. Solid units shall be laid in a nonfurrowed full bed of mortar. Mortar for veneer wythes shall be beveled and sloped toward the center of the wythe from the cavity side. Units shall be shoved into place so that the vertical joints are tight. Vertical joints of brick and the vertical face shells of concrete masonry units, except where indicated at control, expansion, and isolation joints, shall be completely filled with mortar. Mortar will be permitted to protrude up to 1/2 inch into the space or cells to be grouted. Means shall be provided to prevent mortar from dropping into the space below. In double wythe construction, the inner wythe may be brought up not more than 16 inches ahead of the outer wythe. Collar joints shall be filled with mortar or grout during the laying of the facing wythe, and filling shall not lag the laying of the facing wythe by more than 8 inches.

3.2.1 Forms and Shores

Provide bracing and scaffolding as required. Design bracing to resist wind pressure as required by local codes. Forms and shores shall be sufficiently rigid to prevent deflections which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout. Supporting forms and shores shall not be removed in less than 10 days.

3.2.2 Reinforced Concrete Masonry Units Walls

Where vertical reinforcement occurs, fill cores solid with grout. Lay units in such a manner as to preserve the unobstructed vertical continuity of cores to be filled. Embed the adjacent webs in mortar to prevent

leakage of grout. Remove mortar fins protruding from joints before placing grout. Minimum clear dimensions of vertical cores shall be 2 by 3 inches. Position reinforcing accurately as indicated before placing grout. As masonry work progresses, secure vertical reinforcing in place at vertical intervals not to exceed 160 bar diameters. Use puddling rod or vibrator to consolidate the grout. Minimum clear distance between masonry and vertical reinforcement shall be not less than 1/2 inch. Unless indicated or specified otherwise, form splices by lapping bars not less than 40 bar diameters and wire tying them together.

3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, lintels, and beams, and where cells are to be filled with grout shall be full bedded in mortar under both face shells and webs. Other units shall be full bedded under both face shells. Head joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell. Foundation walls below grade shall be grouted solid. Jamb units shall be of the shapes and sizes to conform with wall units. Solid units may be incorporated in the masonry work where necessary to fill out at corners, gable slopes, and elsewhere as approved. Double walls shall be stiffened at wall-mounted plumbing fixtures by use of strap anchors, two above each fixture and two below each fixture, located to avoid pipe runs, and extending from center to center of the double wall. Walls and partitions shall be adequately reinforced for support of wall-hung plumbing fixtures when chair carriers are not specified.

3.2.4 Clay or Shale Brick Units

Brick facing shall be laid with the better face exposed. Brick shall be laid in running bond with each course bonded at corners, unless otherwise indicated. Molded brick shall be laid with the frog side down. Brick that is cored, recessed, or has other deformations may be used in sills, treads, soldier courses, except where deformations will be exposed to view. Lay fire brick by dipping each brick in a soft mixture of fire clay and water and then rubbing the brick into place with joints as thin as practicable or provide refractory mortar with joints not more than 1/4 inch thick.

3.2.4.1 Wetting of Units

Wetting of clay, shale brick, or hollow brick units having an initial rate of absorption of more than 1 gram per minute per square inch of bed surface shall be in conformance with ASTM C 67. The method of wetting shall ensure that each unit is nearly saturated but surface dry when laid. Test clay or shale brick daily on the job, prior to laying, as follows: Using a wax pencil, draw a circle the size of a quarter on five randomly selected bricks. Apply 20 drops of water with a medicine dropper to the surface within the circle on each brick. If the average time that the water is completely absorbed in the five bricks is less than 1-1/2 minutes, wet bricks represented by the five bricks tested.

3.2.4.2 Solid Units

Bed, head, and collar joints shall be completely filled with mortar.

3.2.4.3 Hollow Units

Hollow units shall be laid as specified for concrete masonry units.

3.2.4.4 Brick-Faced Walls

For brick-faced walls [bond the two wythes in every sixth brick course with continuous horizontal joint reinforcement.] [bond brick in the pattern as indicated on the drawings.] Provide additional bonding ties spaced not more than 3 feet apart around the perimeter of and within 12 inches of all openings.

a. Collar Joints: Fill collar joints solid with mortar as each course of brick is laid. Do not disturb units in place.

b. Brick Sills: Lay brick on edge, slope, and project not less than 1/2 inch beyond the face of the wall to form a wash and drip. Fill all joints solidly with mortar and tool.

3.2.4.5 Cavity Walls

Provide a continuous cavity as indicated. Securely tie the two wythes together with horizontal joint reinforcement. Bevel mortar beds away from cavity to prevent projection into cavity when bricks are shoved in place. Keep cavities clear and clean of mortar droppings. At the bottom of cavity walls, in the course immediately above the through-wall flashing, temporarily omit one brick every 4 feet. With a hose and clean water, wash all mortar droppings and debris out of the cavity through the temporary openings at least twice each day masonry is laid, and more often when required to keep the cavities clean. Fill in the openings with bricks and mortar after the wall is complete and the cavity has been inspected and found clean. Provide weep holes of open head joints spaced 24 inches o.c. at base of wall and vertical obstructions (e.g. lintels).

3.2.4.6 Brick Veneer

Provide a continuous cavity as indicated. Install brick veneer after sheathing, masonry anchors, and flashing have been installed to the cold-formed steel framing system. Care shall be provided to avoid damaging the moisture barrier. Damaged moisture barrier and flashing shall be repaired or replaced before brick veneer is installed. Means shall be provided to keep cavities clean and clear of mortar droppings.

3.2.5 Tolerances

Masonry shall be laid plumb, true to line, with courses level. Bond pattern shall be kept plumb throughout. Corners shall be square unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, masonry shall be laid within the following tolerances (plus or minus unless otherwise noted):

TABLE II

TOLERANCES

Variation from the plumb in the lines and surfaces of columns, walls and arises	
In adjacent masonry units	1/8 inch
In 10 feet	1/4 inch
In 20 feet	3/8 inch

TOLERANCES

In 40 feet or more	1/2 inch
Variations from the plumb for external corners, expansion joints, and other conspicuous lines	
In 20 feet	1/4 inch
In 40 feet or more	1/2 inch
Variations from the level for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines	
In 20 feet	1/4 inch
In 40 feet or more	1/2 inch
Variation from level for bed joints and top surfaces of bearing walls	
In 10 feet	1/4 inch
In 40 feet or more	1/2 inch
Variations from horizontal lines	
In 10 feet	1/4 inch
In 20 feet	3/8 inch
In 40 feet or more	1/2 inch
Variations in cross sectional dimensions of columns and in thickness of walls	
Minus	1/4 inch
Plus	1/2 inch

3.2.6 Cutting and Fitting

Full units of the proper size shall be used wherever possible, in lieu of cut units. Cutting and fitting, including that required to accommodate the work of others, shall be done by masonry mechanics using power masonry saws. Concrete masonry units may be wet or dry cut. Wet cut units, before being placed in the work, shall be dried to the same surface-dry appearance as uncut units being laid in the wall. Cut edges shall be clean, true and sharp. Openings in the masonry shall be made carefully so that wall plates, cover plates or escutcheons required by the installation will completely conceal the openings and will have bottoms parallel with the masonry bed joints. Reinforced masonry lintels shall be provided above openings over 12 inches wide for pipes, ducts, cable trays, and other wall penetrations, unless steel sleeves are used.

3.2.7 Jointing

Joints shall be tooled when the mortar is thumbprint hard. Horizontal joints shall be tooled last. Joints shall be brushed to remove all loose

and excess mortar. Mortar joints shall be finished as follows:

3.2.7.1 Flush Joints

Joints in concealed masonry surfaces and joints at electrical outlet boxes in wet areas shall be flush cut. Flush cut joints shall be made by cutting off the mortar flush with the face of the wall. Joints in unparged masonry walls below grade shall be pointed tight. Flush joints for architectural units, such as fluted units, shall completely fill both the head and bed joints.

3.2.7.2 Tooled Joints

Joints in exposed exterior and interior masonry surfaces shall be tooled slightly concave. Joints shall be tooled with a jointer slightly larger than the joint width so that complete contact is made along the edges of the unit. Tooling shall be performed so that the mortar is compressed and the joint surface is sealed. Jointer of sufficient length shall be used to obtain a straight and true mortar joint.

3.2.7.3 Door and Window Frame Joints

On the exposed interior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch. On the exterior side of exterior frames, joints between frames and abutting masonry walls shall be raked to a depth of 3/8 inch.

3.2.8 Joint Widths

Joint widths shall be as follows:

3.2.8.1 Concrete Masonry Units

Concrete masonry units shall have 3/8 inch joints, except for prefaced concrete masonry units.

3.2.8.2 Brick

Brick joint widths shall be the difference between the actual and nominal dimensions of the brick in either height or length. Brick expansion joint widths shall be as shown. Brick joints to be 1/4" to match existing building.

3.2.9 Embedded Items

Spaces around built-in items shall be filled with mortar. Openings around flush-mount electrical outlet boxes in wet locations shall be pointed with mortar. Anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in shall be embedded as the masonry work progresses. Anchors, ties and joint reinforcement shall be fully embedded in the mortar. Cells receiving anchor bolts and cells of the first course below bearing plates shall be filled with grout.

3.2.10 Unfinished Work

Unfinished work shall be stepped back for joining with new work. Toothing may be resorted to only when specifically approved. Loose mortar shall be removed and the exposed joints shall be thoroughly cleaned before laying new work.

3.2.11 Masonry Wall Intersections

Each course shall be masonry bonded at corners and elsewhere as shown. Masonry walls shall be anchored or tied together at corners and intersections with bond beam reinforcement and prefabricated corner or tee pieces of joint reinforcement as shown.

3.3 ANCHORED VENEER CONSTRUCTION

The inner and outer wythes shall be completely separated by a continuous airspace as shown on the drawings. Both the inner and the outer wythes shall be laid up together except when adjustable joint reinforcement assemblies are approved for use. When both wythes are not brought up together, through-wall flashings shall be protected from damage until they are fully enclosed in the wall. The airspace between the wythes shall be kept clear and free of mortar droppings by temporary wood strips laid on the wall ties and carefully lifted out before placing the next row of ties. A coarse gravel or drainage material shall be placed behind the weep holes in the cavity to a minimum depth of 4 inches of coarse aggregate or 10 inches of drainage material to keep mortar droppings from plugging the weep holes.

3.4 WEEP HOLES

Wherever through-wall flashing occurs, provide weep holes to drain flashing to exterior at acceptable locations as indicated on drawings. at 24 inches o.c. Weep holes shall be provided not more than 24 inches on centers in mortar joints of the exterior wythe above wall flashing, over foundations, bond beams, and any other horizontal interruptions of the cavity. Weep holes shall be perfectly horizontal or slightly canted downward to encourage water drainage outward and not inward. Weep holes shall be constructed using weep hole ventilators. Weep holes shall be kept free of mortar and other obstructions.

3.5 MORTAR

Mortar shall be mixed in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measurement of ingredients for mortar shall be by volume. Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Mortar that has stiffened because of loss of water through evaporation shall be retempered by adding water to restore the proper consistency and workability. Mortar that has reached its initial set or that has not been used within 2.5 hours after mixing shall be discarded.

3.6 REINFORCING STEEL

Reinforcement shall be cleaned of loose, flaky rust, scale, grease, mortar, grout, or other coating which might destroy or reduce its bond prior to placing grout. Bars with kinks or bends not shown on the drawings shall not be used. Reinforcement shall be placed prior to grouting. Unless otherwise indicated, vertical wall reinforcement shall extend to within 2 inches of tops of walls.

3.6.1 Positioning Bars

Vertical bars shall be accurately placed within the cells at the positions indicated on the drawings. A minimum clearance of 1/2 inch shall be maintained between the bars and masonry units. Minimum clearance between parallel bars shall be one diameter of the reinforcement. Vertical reinforcing may be held in place using bar positioners located near the ends of each bar and at intermediate intervals of not more than 192 diameters of the reinforcement. Column and pilaster ties shall be wired in position around the vertical steel. Ties shall be in contact with the vertical reinforcement and shall not be placed in horizontal bed joints.

3.6.2 Splices

Bars shall be lapped a minimum of 48 diameters of the reinforcement. Welded or mechanical connections shall develop at least 125 percent of the specified yield strength of the reinforcement.

3.7 JOINT REINFORCEMENT INSTALLATION

Joint reinforcement shall be installed at 16 inches on center or as indicated. Reinforcement shall be lapped not less than 6 inches. Prefabricated sections shall be installed at corners and wall intersections. The longitudinal wires of joint reinforcement shall be placed to provide not less than 5/8 inch cover to either face of the unit.

3.8 PLACING GROUT

Cells containing reinforcing bars shall be filled with grout. Hollow masonry units in walls or partitions supporting plumbing, heating, or other mechanical fixtures, voids at door and window jambs, and other indicated spaces shall be filled solid with grout. Cells under lintel bearings on each side of openings shall be filled solid with grout for full height of openings. Walls below grade, lintels, and bond beams shall be filled solid with grout. Units other than open end units may require grouting each course to preclude voids in the units. Grout not in place within 1-1/2 hours after water is first added to the batch shall be discarded. Sufficient time shall be allowed between grout lifts to preclude displacement or cracking of face shells of masonry units. If blowouts, flowouts, misalignment, or cracking of face shells should occur during construction, the wall shall be torn down and rebuilt.

3.8.1 Vertical Grout Barriers for Fully Grouted Walls

Grout barriers shall be provided not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.8.2 Horizontal Grout Barriers

Grout barriers shall be embedded in mortar below cells of hollow units receiving grout.

3.8.3 Grout Holes and Cleanouts

3.8.3.1 Grout Holes

Grouting holes shall be provided in slabs, spandrel beams, and other in-place overhead construction. Holes shall be located over vertical reinforcing bars or as required to facilitate grout fill in bond beams.

Additional openings spaced not more than 16 inches on centers shall be provided where grouting of all hollow unit masonry is indicated. Openings shall not be less than 4 inches in diameter or 3 by 4 inches in horizontal dimensions. Upon completion of grouting operations, grouting holes shall be plugged and finished to match surrounding surfaces.

3.8.3.2 Cleanouts for Hollow Unit Masonry Construction

Cleanout holes shall be provided at the bottom of every pour in cores containing vertical reinforcement when the height of the grout pour exceeds 5 feet. Where all cells are to be grouted, cleanout courses shall be constructed using bond beam units in an inverted position to permit cleaning of all cells. Cleanout holes shall be provided at a maximum spacing of 32 inches where all cells are to be filled with grout. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanouts shall not be less than 3 by 4 inch openings cut from one face shell. Manufacturer's standard cutout units may be used at the Contractor's option. Cleanout holes shall not be closed until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.8.3.3 Cleanouts for Solid Unit Masonry Construction

Cleanouts for construction of walls consisting of a grout filled cavity between solid masonry wythes shall be provided at the bottom of every pour by omitting every other masonry unit from one wythe. A new series of cleanouts shall be established if grouting operations are stopped for more than 4 hours. Cleanout holes shall not be plugged until masonry work, reinforcement, and final cleaning of the grout spaces have been completed and inspected. For walls which will be exposed to view, cleanout holes shall be closed in an approved manner to match surrounding masonry.

3.8.4 Grouting Equipment

3.8.4.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Pumps shall be operated to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, waste materials and debris shall be removed from the equipment, and disposed of outside the masonry.

3.8.4.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. At least one spare vibrator shall be maintained at the site at all times. Vibrators shall be applied at uniformly spaced points not further apart than the visible effectiveness of the machine. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing segregation.

3.8.5 Grout Placement

Masonry shall be laid to the top of a pour before placing grout. Grout shall not be placed in two-wythe solid unit masonry cavity until mortar joints have set for at least 3 days during hot weather and 5 days during cold damp weather. Grout shall not be placed in hollow unit masonry until

mortar joints have set for at least 24 hours. Grout shall be placed using a hand bucket, concrete hopper, or grout pump to completely fill the grout spaces without segregation of the aggregates. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. The height of grout pours and type of grout used shall be limited by the dimensions of grout spaces as indicated in Table III. Low-lift grout methods may be used on pours up to and including 5 feet in height. High-lift grout methods shall be used on pours exceeding 5 feet in height.

3.8.5.1 Low-Lift Method

Grout shall be placed at a rate that will not cause displacement of the masonry due to hydrostatic pressure of the grout. Mortar protruding more than 1/2 inch into the grout space shall be removed before beginning the grouting operation. Grout pours 12 inches or less in height shall be consolidated by mechanical vibration or by puddling. Grout pours over 12 inches in height shall be consolidated by mechanical vibration and reconsolidated by mechanical vibration after initial water loss and settlement has occurred. Vibrators shall not be inserted into lower pours that are in a semi-solidified state. Low-lift grout shall be used subject to the limitations of Table III.

3.9 BOND BEAMS

Bond beams shall be filled with grout and reinforced as indicated on the drawings. Grout barriers shall be installed under bond beam units to retain the grout as required. Reinforcement shall be continuous, including around corners, except through control joints or expansion joints, unless otherwise indicated on the drawings. Where splices are required for continuity, reinforcement shall be lapped 48 bar diameters. A minimum clearance of 1/2 inch shall be maintained between reinforcement and interior faces of units.

3.10 CONTROL JOINTS

Control joints shall be provided as indicated and shall be constructed by using [mortar to fill the head joint] [special control-joint units] [sash jamb units with control joint key] [open end stretcher units] in accordance with the details shown on the drawings. Sash jamb units shall have a 3/4 by 3/4 inch groove near the center at end of each unit. The vertical mortar joint at control joint locations shall be continuous, including through all bond beams. This shall be accomplished by utilizing half blocks in alternating courses on each side of the joint. The control joint key shall be interrupted in courses containing continuous bond beam steel. In single wythe exterior masonry walls, the exterior control joints shall be raked to a depth of 3/4 inch; backer rod and sealant shall be installed in accordance with Section 07 92 00 JOINT SEALANTS. Exposed interior control joints shall be raked to a depth of 1/4 inch. Concealed control joints shall be flush cut.

3.11 BRICK EXPANSION JOINTS AND CONCRETE MASONRY VENEER JOINTS

Brick expansion joints and concrete masonry veneer joints shall be provided and constructed as shown on the drawings. Joints shall be kept free of mortar and other debris.

3.12 SHELF ANGLES

Shelf angles shall be adjusted as required to keep the masonry level and at

the proper elevation. Shelf angles shall be galvanized. Shelf angles shall be provided in sections not longer than 10 feet and installed with a 1/4 inch gap between sections. Shelf angles shall be mitered and welded at building corners with each angle not shorter than 4 feet, unless limited by wall configuration.

3.13 LINTELS

3.13.1 Masonry Lintels

3.13.2 Steel Lintels

Lintels shall be set in a full bed of mortar with faces plumb and true. Steel and precast lintels shall have a minimum bearing length of 8 inches unless otherwise indicated on the drawings.

3.14 SILLS AND COPINGS

Sills and copings shall be set in a full bed of mortar with faces plumb and true.

3.15 ANCHORAGE STRUCTURAL STEEL

3.15.1 Anchorage to Structural Steel

Masonry shall be anchored to vertical structural steel framing with adjustable steel wire anchors spaced not over 16 inches on centers vertically, and if applicable, not over 24 inches on centers horizontally.

3.16 INSULATION

Anchored veneer walls shall be insulated, where shown, by installing board-type insulation on the cavity side of the inner wythe. Board type insulation shall be applied directly to the masonry or thru-wall flashing with adhesive. Insulation shall be neatly fitted between obstructions without impaling of insulation on ties or anchors. The insulation shall be applied in parallel courses with vertical joints breaking midway over the course below and shall be applied in moderate contact with adjoining units without forcing, and shall be cut to fit neatly against adjoining surfaces.

3.17 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, mortar and grout daubs or splashings shall be completely removed from masonry-unit surfaces that will be exposed or painted. Before completion of the work, defects in joints of masonry to be exposed or painted shall be raked out as necessary, filled with mortar, and tooled to match existing joints. Immediately after grout work is completed, scum and stains which have percolated through the masonry work shall be removed using a high pressure stream of water and a stiff bristled brush. Masonry surfaces shall not be cleaned, other than removing excess surface mortar, until mortar in joints has hardened. Masonry surfaces shall be left clean, free of mortar daubs, dirt, stain, and discoloration, including scum from cleaning operations, and with tight mortar joints throughout. Metal tools and metal brushes shall not be used for cleaning.

3.17.1 Concrete Masonry Unit and Concrete Brick Surfaces

Exposed concrete masonry unit and concrete brick surfaces shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.17.2 Clay or Shale Brick Surfaces

Exposed clay or shale brick masonry surfaces shall be cleaned as necessary to obtain surfaces free of stain, dirt, mortar and grout daubs, efflorescence, and discoloration or scum from cleaning operations. After cleaning, the sample panel of similar material shall be examined for discoloration or stain as a result of cleaning. If the sample panel is discolored or stained, the method of cleaning shall be changed to assure that the masonry surfaces in the structure will not be adversely affected. The exposed masonry surfaces shall be water-soaked and then cleaned with a solution proportioned 1/2 cup trisodium phosphate and 1/2 cup laundry detergent to one gallon of water or cleaned with a proprietary masonry cleaning agent specifically recommended for the color and texture by the clay products manufacturer. The solution shall be applied with stiff fiber brushes, followed immediately by thorough rinsing with clean water. Proprietary cleaning agents shall be used in conformance with the cleaning product manufacturer's printed recommendations. Efflorescence shall be removed in conformance with the brick manufacturer's recommendations.

3.18 BEARING PLATES

Bearing plates for beams, joists, joist girders and similar structural members shall be set to the proper line and elevation with damp-pack bedding mortar, except where non-shrink grout is indicated.

3.19 PROTECTION

Facing materials shall be protected against staining. Top of walls shall be covered with nonstaining waterproof covering or membrane when work is not in progress. Covering of the top of the unfinished walls shall continue until the wall is waterproofed with a complete roof or parapet system. Covering shall extend a minimum of 2 feet down on each side of the wall and shall be held securely in place. Before starting or resuming, top surface of masonry in place shall be cleaned of loose mortar and foreign material.

3.20 WASTE MANAGEMENT

Manage waste according to the Waste Management Plan and as follows. Minimize water used to wash mixing equipment. Use trigger operated spray nozzles for water hoses.

3.20.1 Separate and Recycle Waste

Place materials defined as hazardous or toxic waste in designated containers. Fold up metal banding, flatten, and place in designated area for recycling. Collect wood packing shims and pallets and place in designated area. Separate masonry waste and place in designated area for use as structural fill. Separate selected masonry waste and excess for landscape uses, either whole or crushed as ground cover.

3.21 TEST REPORTS

3.21.1 Field Testing of Mortar

At least three specimens of mortar shall be taken each day. A layer of mortar 1/2 to 5/8 inch thick shall be spread on the masonry units and allowed to stand for one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM C 780.

3.21.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C 1019. A minimum of three specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2000 psi at 28 days.

3.21.3 Efflorescence Test

Brick which will be exposed to weathering shall be tested for efflorescence. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of "effloresced" will be subject to rejection.

-- End of Section --

SECTION 05 12 00

STRUCTURAL STEEL
10/07

PART 1 GENERAL

1.1 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 INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 303	(2005) Code of Standard Practice for Steel Buildings and Bridges
AISC 317	(1992; Reprint 1999) ASD Manual of Steel Construction, Vol II: Connections
AISC 325	(2005) Manual of Steel Construction
AISC 326	(2002) Detailing for Steel Construction
AISC 341	(2005; Supp 2001) Seismic Provisions for Structural Steel Buildings
AISC 348	(2000) Structural Joints Using ASTM A325 or A490 Bolts
AISC 360	(2005) Specification for Structural Steel Buildings, with Commentary
AISC 810	(1997) Erection Bracing of Low-Rise Structural Steel Frames/Fisher and West
AISC FCD	(1995a) Quality Certification Program Description

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2007) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B46.1	(2002) Surface Texture (Surface Roughness, Waviness and Lay)

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 143/A 143M	(2007) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 242/A 242M	(2004e1) Standard Specification for High-Strength Low-Alloy Structural Steel
ASTM A 276	(2006) Standard Specification for Stainless Steel Bars and Shapes
ASTM A 307	(2007b) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 325	(2007a) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 36/A 36M	(2005) Standard Specification for Carbon Structural Steel
ASTM A 500/A 500M	(2007) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 588/A 588M	(2005) Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance
ASTM A 6/A 6M	(2007) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 992/A 992M	(2006a) Standard Specification for Structural Steel Shapes
ASTM C 1107/C 1107M	(2007a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 827	(2001a; R 2005) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

ASTM F 436	(2007a) Hardened Steel Washers
ASTM F 844	(2007a) Washers, Steel, Plain (Flat), Unhardened for General Use

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2000; E 2004) Shop, Field, and Maintenance Painting
SSPC PS 13.01	(1982; E 2004) Epoxy-Polyamide Painting System
SSPC Paint 25	(1997; E 2004) Paint Specification No. 25Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel Type I and Type II
SSPC SP 3	(2004; E 2004) Power Tool Cleaning
SSPC SP 6	(2000; E 2004) Commercial Blast Cleaning

1.2 SYSTEM DESCRIPTION

Provide the structural steel system, including shop primer galvanizing, complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing shall be provided in accordance with AISC 325 and AISC 317 except as modified in this contract.

1.3 MODIFICATIONS TO REFERENCES

Conform to AISC 325, AISC 317, AISC 360, AISC 303, AISC 348, and AISC 325, except as modified in this section.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication drawings including description of connections; G

SD-03 Product Data

Shop primer

Welding electrodes and rods

Non-Shrink Grout

Include test report for Class B primer.

SD-06 Test Reports

Class B coating

Bolts, nuts, and washers

Supply the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

SD-07 Certificates

Steel

Bolts, nuts, and washers

Galvanizing

AISC Quality Certification

Welding procedures and qualifications

1.5 AISC QUALITY CERTIFICATION

Work shall be fabricated in an AISC certified fabrication plant.

1.6 SEISMIC PROVISIONS

The structural steel system shall be provided in accordance with AISC 341.

1.7 QUALITY ASSURANCE

1.7.1 Drawing Requirements

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 326, AISC 325 and AISC 317. Fabrication drawings shall not be reproductions of contract drawings. Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols. Member substitutions of details shown on the contract drawings shall be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

1.7.2 Certifications

1.7.2.1 Erection Plan

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing, and a detailed sequence of welding, including each welding procedure required.

1.7.2.2 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welding operator is more than one-year old, the welding operator's qualification certificate shall be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.

Conform to all requirements specified in AWS D1.1/D1.1M.

PART 2 PRODUCTS

2.1 STEEL

2.1.1 Structural Steel

ASTM A 36/A 36M.

2.1.2 High-Strength Structural Steel

2.1.2.1 Low-Alloy Steel

ASTM A 992/A 992M Grade _50____

2.1.3 Weathering Structural Steel

ASTM A 242/A 242M, Type 1; ASTM A 588/A 588M.

2.1.4 Structural Shapes for Use in Building Framing

Wide flange shapes, ASTM A 992/A 992M.

2.1.5 Structural Steel Tubing

ASTM A 500/A 500M, Grade B

2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.2.1 Structural Steel

2.2.1.1 Bolts

ASTM A 307, Grade A; ASTM A 325, Type 1. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.2.1.2 Nuts

ASTM A 563, Grade and Style for applicable ASTM bolt standard recommended.

2.2.1.3 Washers

ASTM F 844 washers for ASTM A 307 bolts, and ASTM F 436 washers for ASTM A 325.

2.2.2 High-Strength Structural Steel and Structural Steel Tubing

2.2.2.1 Bolts

ASTM A 325, Type 1 .

2.2.2.2 Nuts

ASTM A 563, Grade and Style as specified in the applicable ASTM bolt standard.

2.2.2.3 Washers

ASTM F 436, plain carbon steel.

2.2.3 Weathering Structural Steel

2.2.3.1 Bolts

ASTM A 325, Type 3; .

2.2.3.2 Nuts

ASTM A 563, heavy hex style, Grade DH3, except Grade C3 may be furnished for ASTM A 325 bolts.

2.2.3.3 Washers

ASTM F 436, weathering steel.

2.2.4 Foundation Anchorage

2.2.4.1 Anchor Bolts

ASTM A 307. conforming to ASTM A 276.

2.2.4.2 Anchor Nuts

ASTM A 563, Grade A, hex style. conforming to ASTM A 276.

2.2.4.3 Anchor Washers

ASTM F 844. conforming to ASTM A 276.

2.3 STRUCTURAL STEEL ACCESSORIES

2.3.1 Welding Electrodes and Rods

AWS D1.1/D1.1M.

2.3.2 Non-Shrink Grout

ASTM C 1107/C 1107M, with no ASTM C 827 shrinkage. Grout shall be nonmetallic.

2.3.3 Welded Shear Stud Connectors

AWS D1.1/D1.1M.

2.4 SHOP PRIMER

SSPC Paint 25, (alkyd primer) or SSPC PS 13.01 epoxy-polyamide, green primer (Form 150) type 1, except provide a Class B coating in accordance with AISC 325 and AISC 317 for slip critical joints. Primer shall conform to Federal, State, and local VOC regulations. If flash rusting occurs,

re-clean the surface prior to application of primer.

2.5 GALVANIZING

ASTM A 123/A 123M or ASTM A 153/A 153M, as applicable, unless specified otherwise galvanize after fabrication where practicable.

2.6 FABRICATION

2.6.1 Markings

Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded or on surfaces of weathering steels that will be exposed in the completed structure. Do not locate match markings in areas that will decrease member strength or cause stress concentrations.

2.6.2 Shop Primer

Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, galvanized surfaces, or surfaces within 0.5 inch of the toe of the welds prior to welding (except surfaces on which metal decking is to be welded). Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 40 degrees F within 48 hours after application, unless approved otherwise by the Contracting Officer.

2.6.2.1 Cleaning

SSPC SP 6, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

2.6.2.2 Primer

Apply primer to a minimum dry film thickness of 2.0 mil Repair damaged primed surfaces with an additional coat of primer.

2.6.3 Surface Finishes

ASME B46.1 maximum surface roughness of 125 for pin, pinholes, and sliding bearings, unless indicated otherwise.

2.7 DRAINAGE HOLES

Adequate drainage holes shall be drilled to eliminate water traps. Hole diameter shall be 1/2 inch and location shall be indicated on the detail drawings. Hole size and location shall not affect the structural integrity.

PART 3 EXECUTION

3.1 FABRICATION

Fabrication shall be in accordance with the applicable provisions of AISC 325. Fabrication and assembly shall be done in the shop to the greatest extent possible. The fabricating plant shall be certified under the AISC FCD for Category structural steelwork.

Compression joints depending on contact bearing shall have a surface roughness not in excess of 500 micro inch as determined by ASME B46.1, and ends shall be square within the tolerances for milled ends specified in ASTM A 6/A 6M.

Structural steelwork, except surfaces of steel to be encased in concrete, surfaces to be field welded, surfaces to be fireproofed, and contact surfaces of friction-type high-strength bolted connections shall be prepared for painting in accordance with endorsement "P" of AISC FCD and primed with the specified paint.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

3.2 ERECTION

a. Erection of structural steel, except as indicated in item b. below, shall be in accordance with the applicable provisions of AISC 325AISC 325endorsement F of AISC FCD. Erection plan shall be reviewed, stamped and sealed by a licensed structural engineer.

b. For low-rise structural steel buildings (60 feet tall or less and a maximum of 2 stories), the erection plan shall conform to AISC 303 and the structure shall be erected in accordance with AISC 810.

Provide for drainage in structural steel. After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

3.2.1 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

3.3 CONNECTIONS

Except as modified in this section, connections not detailed shall be designed in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Punch, subpunch and ream, or drill bolt holes perpendicular to the surface of the member. Holes shall not be cut or enlarged by burning. Bolts, nuts, and washers shall be clean of dirt and rust, and lubricated immediately prior to installation.

3.3.1 Common Grade Bolts

ASTM A 307 bolts shall be tightened to a "snug tight" fit. "Snug tight" is

the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.3.2 High-Strength Bolts

ASTM A 325 bolts shall be fully tensioned to 70 percent of their minimum tensile strength. Bolts shall be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, bolts shall then be fully tensioned, progressing from the most rigid part of a connection to the free edges.

3.4 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officers.

3.5 WELDING

AWS D1.1/D1.1M. Grind exposed welds smooth as indicated. Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

The Contractor shall develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified shall be submitted for approval.

3.5.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

Removal is not required.

3.6 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

3.6.1 Field Priming

Field priming of steel exposed to the weather, or located in building areas without HVAC for control of relative humidity. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat shall be cleaned and primed with paint of the same quality as that used for the shop coat.

3.7 GALVANIZING REPAIR

Provide as indicated or specified. Galvanize after fabrication where practicable. Repair damage to galvanized coatings using ASTM A 780 zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

3.8 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing, except that electric power for field tests will be furnished as set forth in Division 1. The Contracting Officer shall be notified in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of weld inspection.

3.8.1 Welds

3.8.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. Welding inspectors shall visually inspect and mark welds, including fillet weld end returns.

3.8.1.2 Nondestructive Testing

AWS D1.1/D1.1M. Test locations shall be selected by the Contracting Officer. If more than 20 percent of welds made by a welder contain defects identified by testing, then all welds made by that welder shall be tested by radiographic or ultrasonic testing, as approved by the Contracting Officer. When all welds made by an individual welder are required to be tested, magnetic particle testing shall be used only in areas inaccessible to either radiographic or ultrasonic testing. Retest defective areas after repair.

3.8.2 High-Strength Bolts

3.8.2.1 Testing Bolt, Nut, and Washer Assemblies

Test a minimum of 3bolt, nut, and washer assemblies from each mill certificate batch in a tension measuring device at the job site prior to the beginning of bolting start-up. Demonstrate that the bolts and nuts, when used together, can develop tension not less than the provisions specified in AISC 348, Table 4, depending on bolt size and grade. The bolt tension shall be developed by tightening the nut. A representative of the manufacturer or supplier shall be present to ensure that the fasteners are properly used, and to demonstrate that the fastener assemblies supplied satisfy the specified requirements.

3.8.2.2 Inspection

Inspection procedures shall be in accordance with AISC 348, Section 9. Confirm and report to the Contracting Officer that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

Inspection by the Government will include proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of torque wrenches for high-strength bolts.

The Contractor shall inspect proper preparation, size, gaging location, and

acceptability of welds; identification marking; operation and current characteristics of welding sets in use; and calibration of torque wrenches for high-strength bolts.

Inspection of high-strength bolted connections by the Government will be performed in accordance with AISC 317.

The Contractor shall inspect high-strength bolted connections in accordance with AISC 317.

3.8.2.3 Testing

The Government has the option to perform nondestructive tests on 5percent of the installed bolts to verify compliance with pre-load bolt tension requirements. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations shall be selected by the Contracting Officer. If more than 10percent of the bolts tested contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, shall be tested. Retest new bolts after installation.

3.8.3 Testing for Embrittlement

ASTM A 143/A 143M for steel products hot-dip galvanized after fabrication.

3.9 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

Special inspections and testing for seismic-resisting systems and components shall be done in accordance with SPECIAL INSPECTION FOR SEISMIC-RESISTING SYSTEMS.

-- End of Section --

SECTION 05 21 19

OPEN WEB STEEL JOIST FRAMING
07/07

PART 1 GENERAL

1.1 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 WELDING SOCIETY (AWS)

AWS B2.1	(2005; Errata 2006; Errata 2006) Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel

STEEL JOIST INSTITUTE (SJI)

SJI 279167 SPECS/LOADS	(2006) 42nd Edition Standard Specifications and Load Tables for Steel Joists and Joist Girders
SJI MANUAL	(2003) 75 Year Manual, 1928-2003
SJI TD 10	(2003) Technical Digest for the Design of Fire Resistive Assemblies with Steel Joists
SJI TD 8	(1983) Technical Digest for the Welding of Open Web Steel Joists
SJI TD 9	(2006) Technical Digest for the Handling and Erection of Steel Joists and Joist Girders

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PS 14.01	(1982; E 2004) Steel Joist Shop Painting System
SSPC Paint 15	(1999; E 2004) Steel Joist Shop Primer/Metal Building Primer

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.1200	Hazard Communication
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.757	Steel Erection; Open Web Steel Joists

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Welder qualification

Material Safety Data Sheet (MSDS) per OSHA 1910.1200

SD-02 Shop Drawings

Steel joist framing; G

SD-06 Test Reports

Erection inspection

Welding inspections

SD-07 Certificates

Accessories

Certification of Compliance

1.3 REGULATORY REQUIREMENT

All joist girder framing must conform to 29 CFR 1926.757. Secure all joist bridging and anchoring in place prior to the application of any construction loads. Distribute temporary loads so that joist capacity is not exceeded. Do not apply loads to bridging.

1.4 DELIVERY AND STORAGE

Handle, transport, and store joists in a manner to prevent damage affecting their structural integrity. Store all items off the ground in a well drained location protected from the weather and easily accessible for inspection and handling.

1.5 QUALITY ASSURANCE

All work must comply with the requirements set forth in 29 CFR 1926.

1.5.1 Drawing Requirements

Submit steel joist framing drawings. Show joist type and size, layout in plan, and erection details including methods of anchoring, framing at openings, type and spacing of bridging, requirements for field welding, and details of accessories as applicable.

1.5.2 Certification of Compliance

Prior to construction commencement, submit Material Safety Data Sheetper 29 CFR 1910.1200 for steel joists , and certification for welder qualification, compliance with AWS B2.1, welding operation, and tacker, stating the type of welding and positions qualified for, the code and

procedure qualified under, date qualified, and the firm and individual certifying the qualification tests.

Submit certification of compliance for the following:
SJI MANUAL
SJI TD 8
SJI TD 9
SJI TD 10
29 CFR 1926
29 CFR 1926.757

PART 2 PRODUCTS

2.1 JOISTS AND ACCESSORIES

Provide design data from SJI 279167 SPECS/LOADS for the joist series indicated.

2.2 PAINTING

2.2.1 Shop Painting

Clean and prime joists in accordance with SSPC Paint 15 and SSPC PS 14.01, Steel Joist Shop Painting System, using only Type I, "Red Oxide Paint." Finish coat of paint is specified in Section 09 90 00 PAINTING AND COATING.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Handling and Erection

Conform to SJI 279167 SPECS/LOADS for the joist series indicated.

3.1.2 Welding

All welding must conform to AWS B2.1 and AWS D1.1/D1.1M.

3.2 BEARING PLATES

Provide bearing plates to accept full bearing after the supporting members have been plumbed and properly positioned, but prior to placing superimposed loads. The area under the plate must be damp-packed solidly with bedding mortar, except where nonshrink grout is indicated on the drawings. Bedding mortar and grout must be as specified in Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.3 PAINTING

3.3.1 Touch-Up Painting

After erection of joists, touch-up connections and areas of abraded shop coat with paint of the same type used for the shop coat.

3.3.2 Field Painting

Paint joists requiring a finish coat in conformance with the requirements of Section 09 90 00 PAINTING AND COATING.

3.4 VISUAL INSPECTIONS

3.4.1 Erection Inspection

AWS D1.1/D1.1M, Section 6. Perform erection inspection and field welding inspections with AWS certified welding inspectors. Welding inspectors must visually inspect and mark welds.

-- End of Section --

SECTION 05 30 00

STEEL DECKS
07/06

PART 1 GENERAL

1.1 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 INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2005) Specification for Structural Steel Buildings, with Commentary

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI SG-913	(1991) LRFD Cold-formed Steel Design Manual
AISI SG03-3	(2002) Cold-Formed Steel Design Manual Set

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2008) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 1008/A 1008M	(2007a) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened
ASTM A 108	(2007) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 36/A 36M	(2005) Standard Specification for Carbon Structural Steel
ASTM A 570/A 570M	(1998) Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled
ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D 1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1149	(2007) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber
ASTM D 746	(2007) Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM E 84	(2008a) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM P7825	(2005) Approval Guide

STEEL DECK INSTITUTE (SDI)

SDI 30	(2001) Design Manual for Composite Decks, Form Decks, and Roof Decks
SDI DDMO3	(3rd Edition) Diaphragm Design Manual
SDI DDP	(1987; R 2000) Deck Damage and Penetrations
SDI MOC2	(2006) Manual of Construction with Steel Deck

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 20	(2002; E 2004) Paint Specification No. 20 Zinc-Rich Coating Type I Inorganic and Type II Organic

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-310-01	Load Assumptions for Buildings

UNDERWRITERS LABORATORIES (UL)

UL 209	(2005; Rev thru May 2007) Cellular Metal Floor Raceways and Fittings
UL 580	(2006) Tests for Uplift Resistance of Roof Assemblies
UL Bld Mat Dir	(2008) Building Materials Directory

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation;

submittals not having a "G" designation are for Contractor Quality Control approval.or for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings

Metal Floor Deck Units

Cant Strips

Ridge and Valley Plates

Metal Closure Strips

SD-03 Product Data

Accessories

Deck Units

Galvanizing Repair Paint

Joint Sealant Material

Mechanical Fasteners

Metal Floor Deck Units

Piston Tool Operator

Repair Paint

Sound Absorbing Material

SD-04 Samples

Metal Roof Deck Units

Flexible Closure Strips

Accessories

SD-05 Design Data

Deck Units

Submit manufacturer's design calculations, or applicable published literature for the structural properties of the proposed deck units.

SD-07 Certificates

. Welding Procedures

Fire Safety

Wind Storm Resistance

1.3 QUALITY ASSURANCE

1.3.1 Deck Units

Furnish deck units and accessory products from a manufacturer regularly engaged in manufacture of steel decking. Provide a 2 sq ft. sample of decking material and each accessory to be used. Provide a sample of acoustical material to be used. Provide manufacturer's certificates attesting that the decking material meets the specified requirements.

1.3.2 Certification of Piston Tool Operator

Manufacturer's certificate attesting that the operators are authorized to use the low velocity piston tool.

1.3.3 Qualifications for Welding Work

Follows Welding Procedures in accordance with AWS D1.1/D1.1M. Test specimens shall be made in the presence of Contracting Officer and shall be tested by an approved testing laboratory at the Contractor's expense.

Submit qualified Welder Qualifications in accordance with AWS D1.1/D1.1M, or under an equivalent approved qualification test. Perform tests on test pieces in positions and with clearances equivalent to those actually encountered. If a test weld fails to meet requirements, perform an immediate retest of two test welds until each test weld passes. Failure in the immediate retest will require the welder be retested after further practice or training, performing a complete set of test welds.

Submit manufacturer's catalog data for Welding Equipment and Welding Rods and Accessories.

1.3.4 Regulatory Requirements

1.3.4.1 Fire Safety

Test roof deck as a part of a roof deck construction assembly of the type used for this project, listing as fire classified in the UL Bld Mat Dir, or listing as Class I construction in the FM P7825, and so labeled.

1.3.4.2 Wind Storm Resistance

Provide roof construction assembly capable of withstanding an uplift pressure of 90 pounds per square foot when tested in accordance with the uplift pressure test described in the in UL 580 and in general compliance with UFC 3-310-01.

1.3.5 Fabrication Drawings

Show type and location of units, location and sequence of connections, bearing on supports, methods of anchoring, attachment of accessories, adjusting plate details, size and location of holes to be cut and reinforcement to be provided, the manufacturer's erection instructions and other pertinent details.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver deck units to the site in a dry and undamaged condition. Store and handle steel deck in a manner to protect it from corrosion, deformation, and other types of damage. Do not use decking for storage or as working platform until units have been fastened into position. Exercise care not to damage material or overload decking during construction. Must not exceed the design live load. The maximum uniform distributed storage load. Stack decking on platforms or pallets and cover with weathertight ventilated covering. Elevate one end during storage to provide drainage. Maintain deck finish at all times to prevent formation of rust. Repair deck finish using touch-up paint. Replace damaged material.

1.5 DESIGN REQUIREMENTS FOR ROOF DECKS

1.5.1 Properties of Sections

Properties of metal roof deck sections must comply with engineering design width as limited by the provisions of AISI SG-913.

1.5.2 Allowable Loads

Indicate total uniform dead and live load for detailing purposes.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Steel Sheet

Flat rolled carbon steel sheets of structural quality, thickness not less than indicated 0.028 inch before coating, meeting the requirements of AISI SG03-3, except as modified herein.

2.1.2 Steel Coating

ASTM A 653/A 653M designation G90 galvanized, Apply coating to both sides of sheet. Conform to UL 209 for coating on decking provided as wire raceways.

2.1.3 Mixes

2.1.4 Galvanized Steel Angles for Roof Decks

Provide hot-rolled carbon steel angles conforming to ASTM A 36/A 36M, merchant quality, Grade Designation SAE/AISI 1023 or SAE/AISI 1025, and hot-dip galvanized in accordance with ASTM A 123/A 123M.

2.1.5 Joint Sealant Material for Roof Decks

Provide a nonskinning, gun-grade, bulk compound material as recommended by the manufacturer.

2.1.6 Galvanizing Repair Paint for Roof Decks

Provide a high zinc-dust content paint for regalvanizing welds in galvanized steel and shall conform to ASTM A 780.

2.1.7 Flexible Closure Strips for Roof Decks

Provide strips made of elastomeric material specified and premolded to the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

Provide a vulcanized, closed-cell, expanded chloroprene elastomer having approximately 3.5 psi compressive-deflection at 25 percent deflection (limits), conforming to ASTM D 1056, Grade No. SCE 41, with the following additional properties:

Brittleness temperature of minus 40 degrees F when tested in accordance with ASTM D 746.

Flammability resistance with a flame spread rating of less than 25 when tested in accordance with ASTM E 84.

Resistance to ozone must be "no cracks" after exposure of a sample kept under a surface tensile strain of 25 percent to an ozone concentration of 100 parts per million of air by volume in air for 100 hours at 104 degrees F and tested in accordance with ASTM D 1149.

Provide a elastomeric type adhesive with a chloroprene base as recommended by the manufacturer of the flexible closure strips.

2.2 ACCESSORIES

Provide accessories of same material as deck, unless specified otherwise. Provide manufacturer's standard type accessories, as specified.

2.2.1 Adjusting Plates

Provide adjusting plates, or segments of deck units, of same thickness and configuration as deck units in locations too narrow to accommodate full size units. Provide factory cut plates of predetermined size where possible.

2.2.2 End Closures

Fabricated of sheet metal by the deck manufacturer. Provide end closures minimum 0.028 inch thick to close open ends at parapets, end walls, openings through deck.

2.2.3 Partition Closures

Provide closures for closing voids above interior walls and partitions that are perpendicular to the direction of the configurations. Provide rubber, plastic, or sheet steel closures above typical partitions.Provide minimum one inch thick soft composition rubber closures above walls and partitions contiguous to acoustical steel deck.Provide sheet steel closures above fire-resistant interior walls and partitions located on both sides of wall or partition. Provide glass fiber blanket insulation in the space between pairs of closures at acoustical partitions.

2.2.4 Closure Plates for Composite Deck

Support and retain concrete at each floor level. Provide edge closures at all edges of the slab of sufficient strength and stiffness to support the wet concrete. Provide metal closures for all openings in composite steel

deck 1/4 inch and over.

2.2.5 Sheet Metal Collar

Where deck is cut for passage of pipes, ducts, columns, etc., and deck is to remain exposed, provide a neatly cut sheet metal collar to cover edges of deck. Do not cut deck until after installation of supplemental supports.

2.2.6 Cover Plates

Sheet metal to close panel edge and end conditions, and where panels change direction or butt. Polyethylene-coated, self-adhesive, 2 inch wide joint tape may be provided in lieu of cover plates on flat-surfaced decking butt joints.

Fabricate cover plates for abutting floor deck units from the specified structural-quality steel sheets not less than nominalthick before galvanizing. Provide 6 inch wide cover plates and form to match the contour of the floor deck units.

2.2.7 Roof Sump Pans

Sump pans must be provided for roof drains and must be minimum 0.075 inch thick steel, flatrecessed] type. Shape sump pans to meet roof slope by the supplier or by a sheet metal specialist. Provide bearing flanges of sump pans to overlap steel deck a minimum of 3 inch. Shape, size, and reinforce the opening in bottom of the sump pan to receive roof drain.

2.2.8 Column Closures

Sheet metal, minimum 0.0358 inch thick or metal rib lath.

2.2.9 Access Hole Covers

Sheet metal, minimum 0.0474 inch thick.

2.2.10 Hanger

Provide clips or loops for utility systems of one or more of the following types:

a. Lip tabs or integral tabs where noncellular decking or flat plate of cellular section is 0.0474 inch thick or more, and a structural concrete fill is used over deck.

b. Slots or holes punched in decking for installation of pigtails.

c. Tabs driven from top side of decking and arranged so as not to pierce electrical cells.

d. Decking manufacturer's standard as approved by the Contracting Officer.

2.2.11 Shear Connectors

Provide shear connectors as headed stud type, ASTM A 108, Grade 1015 or 1020, cold finished carbon steel with dimensions complying with AISC 360 and orstrap type, ASTM A 570/A 570M, Grade D, hot-rolled carbon steel.

2.2.12 Mechanical Fasteners

Provide mechanical fasteners, such as powder actuated or pneumatically driven fasteners, for anchoring the deck to structural supports and adjoining units that are designed to meet the loads indicated. Provide positive locking-type fasteners standard with the Steel Deck Institute and the steel deck manufacturer, as approved by the Contracting Officer.

2.2.13 Miscellaneous Accessories

Furnish the manufacturer's standard accessories to complete the deck installation. Furnish metal accessories of the same material as the deck and with the minimum design thickness as follows: saddles, 0.0474 inch; welding washers, 0.0598 inch cant strip, 0.0295 inch other metal accessories, 0.0358 inch unless otherwise indicated. Accessories must include but not be limited to saddles, welding washers, fasteners, cant strips, butt cover plates, underlapping sleeves, and ridge and valley plates.

2.3 FABRICATION

Furnish one sample of each type of Metal Floor Deck Units used to illustrate the actual cross section dimensions and configuration.

Furnish sample of Metal Roof Deck Units used to illustrate actual cross section dimensions and configurations.

Furnish one sample of each type Flexible Closure Strips, 12 inch long.

2.3.1 Deck Units

2.3.2 Roof Deck

Conform to ASTM A 1008/A 1008M for deck used in conjunction with insulation and built-up roofing. Fabricate roof deck units of the steel design thickness required by the design drawing and galvanized

2.3.2.1 Cant Strips for Roof Decks

Fabricate cant strips from the specified commercial-quality steel sheets not less than nominal 0.0359 inch thick before galvanizing. Bend strips to form a 45-degree cant not less than 5 inch wide, with top and bottom flanges a minimum 3 inch wide. Length of strips 10 feet.

2.3.2.2 Ridge and Valley Plates for Roof Decks

Fabricate plates from the specified structural-quality steel sheets, not less than nominal 0.0359 inch thick before galvanizing. Provide plates of minimum 4-1/2 inch wide and bent to provide tight fitting closures at ridges and valleys. Provide a minimum length of ridge and valley plates of 10 feet.

2.3.2.3 Metal Closure Strips for Roof Decks

Fabricate strips from the specified commercial-quality steel sheets not less than nominal 0.0359 inch thick before galvanizing. Provide strips from the configuration required to provide tight-fitting closures at open ends and sides of steel roof decking.

2.3.3 Shop Priming

Shop prime accessories and underside of deck at the factory after coating. Clean surfaces in accordance with the manufacturer's standard procedure followed by a spray, dip or roller coat of rust-inhibitive primer, oven cured.

2.3.4 Touch-Up Paint

Provide touch-up paint for shop-painted units of the same type used for the shop painting and touch-up paint for zinc-coated units of an approved galvanizing repair paint with a high-zinc dust content. Touch-up welds with paint conforming to SSPC Paint 20 in accordance with ASTM A 780. Maintain finish of deck units and accessories by using touch-up paint whenever necessary to prevent the formation of rust.

After roof decking installation, wire brush, clean, and touchup paint the scarred areas on top and bottom surfaces of metal roof decking. The scarred areas include welds, weld scars, bruises, and rust spots. Touchup galvanized surfaces with galvanizing repair paint. Touchup painted surfaces with repair paint of painted surfaces.

PART 3 EXECUTION

3.1 EXAMINATION

Prior to installation of decking units and accessories, examine worksite to verify that as-built structure will permit installation of decking system without modification.

3.2 INSTALLATION

Install steel deck units in accordance with SDI 30 approved shop drawings. Place units on structural supports, properly adjusted, leveled, and aligned at right angles to supports before permanently securing in place. Damaged deck and accessories including material which is permanently stained or contaminated, deformed, or with burned holes shall not be installed. Extend deck units over three or more supports unless absolutely impractical. Report inaccuracies in alignment or leveling to the Contracting Officer and make necessary corrections before permanently anchoring deck units. Locate deck ends over supports only. Do not use unanchored deck units as a work or storage platform. Permanently anchor units placed by the end of each working day. Do not support suspended ceilings, light fixtures, ducts, utilities, or other loads by steel deck unless indicated. Distribute loads by appropriate means to prevent damage. Prepare Neatly fit

3.2.1 Attachment

Immediately after placement and alignment, and after correcting inaccuracies, permanently fasten steel deck units to structural supports and to adjacent deck units by welding with normal5/8 inch diameter puddle welds as indicated on the design drawings and in accordance with manufacturer's recommended procedure and SDI 30. Clamp or weight deck units to provide firm contact between deck units and structural supports while performing welding or fastening.

3.2.1.1 Welding

Perform welding in accordance with AWS D1.3/D1.3M using methods and electrodes recommended by the manufacturers of the base metal alloys being used. Ensure only operators previously qualified by tests prescribed in AWS D1.1/D1.1M and AWS D1.3/D1.3M make welds. Immediately recertify, or replace qualified welders, that are producing unsatisfactory welding. Indicate Conform to the recommendations of the Steel Deck Institute and the steel deck manufacturerfor location, size, and spacing of fastening. Do Do not use welding washers at the connections of the deck to supports. Do not use welding washers at sidelaps. Holes and similar defects will not be acceptable. 2 inch deck ends. Attach all partial or segments of deck units to structural supports in accordance with Section 2.5 of SDI DDMO3. Attach shear connectors as shown and welded as per AWS D1.1/D1.1M through the steel deck to the steel member. Immediately clean welds by chipping and wire brushing. Heavily coat welds, cut edges and damaged portions of shop primed painted] finish with the manufacturer's standard touch-up paint.

3.2.1.2 Fastening

Anchor deck to structural supports and adjoining units with mechanical deck fasteners as recommended by the Steel Deck Institute and the steel deck manufacturer, as approved by the Contracting Officer. Drive the . Drive pneumatically fasteners with a low-velocity fastening tool and comply with the manufacturer's recommendations.

3.2.2 Openings

Cut or drill all holes and openings required and be coordinated with the drawings, specifications, and other trades. Frame and reinforce openings through the deck in conformance with SDI DDP. Reinforce holes and openings 6 to 12 inch across by 0.0474 inch thick steel sheet at least 12 inch wider and longer than the opening and be fastened to the steel deck at each corner of the sheet and at a maximum of 6 inch on center. Reinforce holes and openings larger than 12 inch by steel channels or angles installed perpendicular to the steel joists and supported by the adjacent steel joists. Install steel channels or angles perpendicular to the deck ribs and fasten to the channels or angles perpendicular to the steel joists. Deck manufacturer shall approve holes or openings larger than 6 inch in diameter prior to drilling or cutting.Openings must not interfere with seismic members such as chords

3.2.3 Deck Damage

SDI MOC2, for repair of deck damage.

3.2.4 Accessory Installation

3.2.4.1 Adjusting Plates

Install as shown on shop drawings.

3.2.4.2 End Closures

Provide end closure to close open ends of cells at columns, walls, and openings in deck.

3.2.4.3 Closures Above Partitions

Provide for closing voids between cells over partitions that are perpendicular to direction of cells. Provide a one-piece closure strip for partitions 4 inch nominal or less in thickness and two-piece closure strips for wider partitions.

3.2.4.4 Cover Plates

3.2.4.5 Column Closures

Provide for spaces between floor decking and columns which penetrate the deck. Field cut closure plate to fit column in the field and tack weld to decking and columns.

3.2.4.6 Access Hole Covers

Provide to seal holes cut in decking to facilitate welding of decking to structural supports.

3.2.4.7 Hangers

Provide as indicated to support utility system. Space devices as indicated.

3.2.5 Preparation of Fire-Proofed Surfaces

Provide deck surfaces, both composite and noncomposite, which are to receive sprayed-on fireproofing, galvanized and free of all grease, mill oil, paraffin, dirt, salt, and other contaminants which impair adhesion of the fireproofing. Complete any required cleaning prior to steel deck installation using a cleaning method that is compatible with the sprayed-on fireproofing.

3.3 JOINT SEALING FOR ROOF DECKS

Seal sidelaps and endlaps with manufacturer's recommended joint sealing material. Shop or field apply the material. Before applying the sealing material, completely remove dust, dirt, moisture, and other foreign material from the surfaces to which the sealing material is to be applied. Apply sealing material in strict accordance with the sealing material manufacturer's printed instructions.

3.4 ROOF SUMP PANS

Place sump pans over openings in roof decking and fusion welded to top surface of roof decking. Do not exceed spacing of welds of 12 inch with not less than one weld at each corner. Field cut opening in the bottom of each roof sump pan to receive the roof drain as part of the work of this section.

3.5 CANT STRIPS FOR ROOF DECKS

Provide strips to be fusion welded to surface of roof decking, secured to wood nailers by galvanized screws or to steel framing by galvanized self-tapping screws or welds. Do not exceed spacing of welds and fasteners of 12 inch. Lap end joints a minimum 3 inch and secure with galvanized sheet metal screws spaced a maximum 4 inch on center.

3.6 RIDGE AND VALLEY PLATES FOR ROOF DECKS

Provide plates to be fusion welded to top surface of roof decking. Lap end joints a minimum 3 inch. For valley plates, provide endlaps to be in the direction of water flow.

3.7 CLOSURE STRIPS FOR ROOF DECKS

Provide closure strips at open, uncovered ends and edges of the roof decking and in voids between roof decking and top of walls and partitions where indicated. Install closure strips in position in a manner to provide a weathertight installation.

3.8 ROOF INSULATION SUPPORT FOR ROOF DECKS

Provide metal closure strips for support of roof insulation where rib openings in top surface of metal roof decking occur adjacent to edges and openings. Weld metal closure strips in position.

3.9 CLEANING AND PROTECTION FOR ROOF DECKS

Upon completion of the deck, sweep surfaces clean and prepare for installation of the roofing.

3.10 FIELD QUALITY CONTROL

3.10.1 Decks Not Receiving Concrete

Inspect the decking top surface for distortion after installation. For roof decks not receiving concrete, verify distortion by placing a straight edge across three adjacent top flanges. The maximum allowable gap between the straight edge and the top flanges is 1/16 inch; when gap is more than 1/16 inch, provide corrective measures or replacement. Reinspect decking after performing corrective measures or replacement.

-- End of Section --

SECTION 06 10 00

ROUGH CARPENTRY
07/06

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM A 307	(2004) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS FF-B-588	(Rev E) Bolt, Toggle: and Expansion Sleeve, Screw

1.2 DELIVERY, HANDLING, AND STORAGE

Wood materials shall be securely bundled and shipped with adequate moisture-resistant covers to preclude damage by weather or handling during delivery, when stored, and during construction.

Wood materials that must be stored outdoors before immediate use shall be placed in orderly piles and stored on blocks above ground. Lumber shall be stored in stacks with provision for air circulation within stacks. Material shall be protected from the elements with moisture-resistant covers.

PART 2 PRODUCTS

2.1 WOOD MATERIALS

2.1.1 General Requirements

Each piece of framing lumber, board lumber, and plywood shall bear the trademark and grade identification of the manufacturer's association or the authorized inspection bureau under rules of which the lumber is manufactured and graded.

Softwood lumber shall be seasoned S4S and kiln-dried or air-dried to the specified moisture content. Dressed sizes shall conform to NIST PS 20.

Moisture content shall conform to the rules of the lumber association or the inspection bureau under which the lumber is graded but shall not exceed 15 percent for boards and dimensional lumber 2 inches or less in thickness.

2.2 ANCHORAGE AND FASTENER MATERIALS

2.2.1 Nails and Staples

Nails, staples, and tacks shall conform to FS FF-N-105.

Nails for roof blocking, cants, and nailers shall be galvanized.

2.2.2 Bolts, Nuts and Screws

Bolts and nuts shall be carbon steel, galvanized, conforming to ASTM A 307, Grade A.

Wood screws shall be carbon steel, galvanized, conforming to ASME B18.6.1.

Lag screws or lag bolts shall be commercial steel, galvanized, conforming to ASME B18.2.1.

Expansion shields, expansion nails, and drive screw devices shall conform to FS FF-S-325.

Toggle bolts shall conform to FS FF-B-588.

Washers shall be carbon steel, galvanized, general assembly purpose type, conforming to ANSI B18.22.1.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

Washers shall be provided under bolt heads or nuts in contact with wood. Lumber shall be bored to receive bolts.

Nailers, blocking, and furring shall be furnished in lengths that minimize joints.

3.1.2 Blocking and Nailers

Nailing strips, blocking and sub fascia wood members shall be continuous, cut with square ends and in maximum practical lengths.

For bolted connections, sub fascia members shall be fastened to structural steel members or concrete with 1/2-inch bolts at a maximum spacing of 4 feet on center, one bolt near each end of the member. Bolt heads shall be countersunk flush with the surface of the wood. Sub fascia members shall be held to a tolerance of 1/8 inch in 10 feet.

Perimeter roof blocking and nailers shall be groove-cut to provide ventilation for insulation. Groove cuts shall be matched for continuity or new vent grooves cut when wide vents are built of more than one width of wood.

-- End of Section --

SECTION 06 61 16

SOLID POLYMER (SOLID SURFACING) FABRICATIONS
04/06

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM D 2583	(2007) Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D 570	(1998; R 2005) Standard Test Method for Water Absorption of Plastics
ASTM D 638	(2003) Standard Test Method for Tensile Properties of Plastics
ASTM D 696	(2003) Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 degrees C and 30 degrees C With a Vitreous Silica Dilatometer
ASTM E 84	(2008a) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM G 21	(1996; R 2002) Determining Resistance of Synthetic Polymeric Materials to Fungi

INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS (IAPMO)

IAPMO Z124.3	(1995) Plastic Lavatories
IAPMO Z124.6	(1997) Plastic Sinks

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA LD 3	(2005) Standard for High-Pressure Decorative Laminates

NSF INTERNATIONAL (NSF)

NSF 51	(2007) Food Equipment Materials

TILE COUNCIL OF AMERICA (TCA)

TCA Hdbk	(2007) Handbook for Ceramic Tile Installation

1.2 GENERAL DESCRIPTION

Work in this section includes other items utilizing solid polymer (solid surfacing) fabrication as shown on the drawings and as described in this specification. Do not change source of supply for materials after work has started, if the appearance of finished work would be affected. Variation in component size and location of openings to be plus or minus 1/8 inch.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G
Installation; G

Detail Drawings indicating locations, dimensions, component sizes, fabrication and joint details, attachment provisions, installation details, and coordination requirements with adjacent work.

SD-03 Product Data

Solid polymer material
Qualifications
Fabrications

Product data indicating product description, fabrication information, and compliance with specified performance requirements for solid polymer, joint adhesive, sealants, and heat reflective tape. Both the manufacturer of materials and the fabricator shall submit a detailed description of operations and processes in place that support efficient use of natural resources, energy efficiency, emissions of ozone depleting chemicals, management of water and operational waste, indoor environmental quality, and other production techniques supporting sustainable design and products.

SD-04 Samples

Material; G

A minimum 4 by 4 inch sample of each color and pattern for approval. Samples shall indicate full range of color and pattern variation. Approved samples shall be retained as a standard for this work.

SD-06 Test Reports

Solid polymer material

Test report results from an independent testing laboratory attesting that the submitted solid polymer material meets or exceeds each of the specified performance requirements.

SD-07 Certificates

Fabrications
Qualifications

Solid polymer manufacturer's certification attesting to fabricator qualification approval.

SD-10 Operation and Maintenance Data

Clean-up

A minimum of six copies of maintenance data indicating manufacturer's care, repair and cleaning instructions. Maintenance video shall be provided,if available. Maintenance kit for matte finishes shall be submitted.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall not be delivered to project site until areas are ready for installation. Components and materials shall be delivered to the site undamaged, in containers clearly marked and labeled with manufacturer's name. Materials shall be stored indoors and adequate precautions taken to prevent damage to finished surfaces. Protective coverings shall be provided to prevent physical damage or staining following installation, for duration of project.

1.5 WARRANTY

Manufacturer's warranty of ten years against defects in materials, excluding damages caused by physical or chemical abuse or excessive heat, shall be provided. Warranty shall provide for material and labor for replacement or repair of defective material for a period of ten years after component installation.

1.6 QUALIFICATIONS

To insure warranty coverage, solid polymer fabricators shall be certified to fabricate by the solid polymer material manufacturer being utilized. All fabrications shall be marked with the fabricator's certification label affixed in an inconspicuous location. Fabricators shall have a minimum of 5 years of experience working with solid polymer materials.

PART 2 PRODUCTS

2.1 MATERIAL

Solid polymer material shall be a homogeneous filled solid polymer; not coated, laminated or of a composite construction; meeting IAPMO Z124.3 and IAPMO Z124.6 requirements. Material shall have minimum physical and performance properties specified. Superficial damage to a depth of 0.01 inch shall be repairable by sanding or polishing. Material thickness shall be as indicated on the drawings. In no case shall material be less than 1/4 inch in thickness.

2.1.1 Cast,100 Percent Acrylic Polymer Solid Surfacing Material

Cast, 100 percent acrylic solid polymer material shall be composed of

acrylic polymer, mineral fillers, and pigments and shall meet the following minimum performance requirements:

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Tensile Strength	5800 psi (min.)	ASTM D 638
Hardness	55-Barcol Impressor (min.)	ASTM D 2583
Thermal Expansion	.000023 in/in/F (max.)	ASTM D 696
Boiling water Surface Resistance	No Change	NEMA LD 3-3.05
High Temperature Resistance	No Change	NEMA LD 3-3.06
Impact Resistance (Ball drop)		NEMA LD 3-303
1/4" sheet	36", 1/2 lb ball, no failure	
1/2" sheet	140", 1/2 lb ball, no failure	
3/4" sheet	200", 1/2 lb ball, no failure	
Mold & Mildew Growth	No growth	ASTM G 21
Bacteria Growth	No Growth	ASTM G 21
Liquid Absorption (Weight in 24 hrs.)	0.1% max.	ASTM D 570
Flammability		ASTM E 84
Flame Spread	25 max.	
Smoke Developed	30 max	
Sanitation	"Food Contact" approval	NSF 51

2.1.2 Acrylic-modified Polymer Solid Surfacing Material

Cast, solid polymer material shall be composed of a formulation containing acrylic and polyester polymers, mineral fillers, and pigments. Acrylic polymer content shall be not less than 5 percent and not more than 10 percent in order to meet the following minimum performance requirements:

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Tensile Strength	4100 psi (min.)	ASTM D 638

PROPERTY	REQUIREMENT (min. or max.)	TEST PROCEDURE
Hardness	50-Barcol Impressor (min.)	ASTM D 2583
Thermal Expansion	.000023 in/in/F (max.)	ASTM D 696
Boiling water Surface Resistance	No Change	NEMA LD 3-3.05
High Temperature Resistance	No Change	NEMA LD 3-3.06
Impact Resistance (Ball drop)		NEMA LD 3-303
1/4" sheet	36", 1/2 lb ball, no failure	
1/2" sheet	140", 1/2 lb ball, no failure	
3/4" sheet	200", 1/2 lb ball, no failure	
Mold & Mildew Growth	No growth	ASTM G 21
Bacteria Growth	No Growth	ASTM G 21
Liquid Absorption (Weight in 24 hrs.)	0.6% max.	ASTM D 570
Flammability		ASTM E 84
Flame Spread	25 max.	
Smoke Developed	100 max	
Sanitation	"Food Contact" approval	NSF 51

2.1.3 Material Patterns and Colors

Patterns and colors for all solid polymer components and fabrications shall be as selected by the government from manufacturer's standard colors. Pattern and color shall occur, and shall be consistent in appearance, throughout the entire depth (thickness) of the solid polymer material.

2.1.4 Surface Finish

Exposed finished surfaces and edges shall receive a uniform appearance. Exposed surface finish shall be semigloss; gloss rating of 25-50.

2.2 ACCESSORY PRODUCTS

Accessory products, as specified below, shall be manufactured by the solid polymer manufacturer or shall be products approved by the solid polymer manufacturer for use with the solid polymer materials being specified.

2.2.1 Seam Adhesive

Seam adhesive shall be a two-part adhesive kit to create permanent, inconspicuous, non-porous, hard seams and joints by chemical bond between solid polymer materials and components to create a monolithic appearance of the fabrication. Adhesive shall be approved by the solid polymer manufacturer. Adhesive shall be color-matched to the surfaces being bonded where solid-colored, solid polymer materials are being bonded together. The seam adhesive shall be clear or color matched where particulate patterned, solid polymer materials are being bonded together.

2.2.2 Panel Adhesive

Panel adhesive shall be neoprene based panel adhesive meeting TCA Hdbk, Underwriter's Laboratories (UL) listed. This adhesive shall be used to bond solid polymer components to adjacent and underlying substrates.

2.2.3 Silicone Sealant

Sealant shall be a mildew-resistant, FDA and OSHA Nationally Recognized Testing Laboratory (NRTL) listed silicone sealant or caulk in a clear formulation. The silicone sealant shall be approved for use by the solid polymer manufacturer. Sealant shall be used to seal all expansion joints between solid polymer components and all joints between solid polymer components and other adjacent surfaces such as walls, floors, ceiling, and plumbing fixtures.

2.3 FABRICATIONS

Components shall be factory or shop fabricated to sizes and shapes indicated, to the greatest extent practical, in accordance with approved Shop Drawings and manufacturer's requirements. Factory cutouts shall be provided for sinks, lavatories, and plumbing fixtures where indicated on the drawings. Contours and radii shall be routed to template, with edges smooth. Defective and inaccurate work will be rejected.

2.3.1 Joints and Seams

Joints and seams shall be formed between solid polymer components using manufacturer's approved seam adhesive. Joints shall be inconspicuous in appearance and without voids to create a monolithic appearance.

2.3.2 Edge Finishing

Rout and finish component edges to a smooth, uniform appearance and finish. Edge shapes and treatments, including any inserts, shall be as detailed on the drawings. Rout all cutouts, then sand all edges smooth. Repair or reject defective or inaccurate work.

2.3.3 Window Stools

Window stools shall be fabricated from 1/2 inch thick solid surfacing, solid polymer material. Dimensions, edge shape, and other details shall be as indicated on the drawings.

PART 3 EXECUTION

3.1 COORDINATION

In most instances, installation of solid polymer fabricated components and assemblies will require strong, correctly located structural support provided by other trades. To provide a stable, sound, secure installation, close coordination is required between the solid polymer fabricator/installer and other trades to insure that necessary structural wall support, cabinet counter top structural support, proper clearances, and other supporting components are provided for the installation of wall panels, countertops, shelving, and all other solid polymer fabrications to the degree and extent recommended by the solid polymer manufacturer. Contractor shall appropriate staging areas for solid polymer fabrications.

3.2 INSTALLATION

3.2.1 Components

All components and fabricated units shall be installed plumb, level, and rigid. Field joints between solid polymer components to provide a monolithic appearance shall be made using solid polymer manufacturer's approved seam adhesives, with joints inconspicuous in the finished work.

3.2.2 Silicone Sealant

A clear, silicone sealant or caulk shall be used to seal all expansion joints between solid polymer components and all joints between solid polymer components and other adjacent surfaces such as walls, floors, ceiling, and plumbing fixtures. Sealant bead shall be smooth and uniform in appearance and shall be the minimum size necessary to bridge any gaps between the solid surfacing material and the adjacent surface. Bead shall be continuous and run the entire length of the joint being sealed.

3.3 CLEAN-UP

Components shall be cleaned after installation and covered to protect against damage during completion of the remaining project items. Components damaged after installation by other trades will be repaired or replaced at the General Contractor's cost. Component supplier will provide a repair/replace cost estimate to the General Contractor who shall approve estimate before repairs are made. The Contractor shall submit maintenance data as specified in the Submittals paragraph, under SD-10.

-- End of Section --

SECTION 07 11 13

BITUMINOUS DAMPPROOFING
04/06

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM D 1187	(1997; R 2002e1) Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM D 1227	(1995; R 2007) Emulsified Asphalt Used as a Protective Coating for Roofing
ASTM D 226	(2006) Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 227	(2003) Coal-Tar-Saturated Organic Felt Used in Roofing and Waterproofing
ASTM D 41	(2005) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 4263	(1983; R 2005) Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D 449	(2003; R 2008) Asphalt Used in Dampproofing and Waterproofing

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-07 Certificates

Materials

1.3 DELIVERY AND STORAGE

Deliver materials in sealed containers bearing manufacturer's original labels. Labels shall include date of manufacture, contents of each container, performance standards that apply to the contents and recommended shelf life.

PART 2 PRODUCTS

2.1 ASPHALT

ASTM D 449, Type I or Type II.

2.2 ASPHALT PRIMER

ASTM D 41.

2.3 EMULSION-BASED ASPHALT DAMPPROOFING

2.3.1 Non-Fibrated Emulsion-Based Asphalt

Non-fibrated emulsion-based asphalt dampproofing shall be cold-applied type conforming to ASTM D 1187 Type II or ASTM D 1227 Type III, manufactured of refined asphalt, emulsifiers and selected clay. Asphalt shall contain a minimum 58 percent solids by weight, 55 percent solids by volume.

2.4 SURFACE PROTECTION

2.4.1 Saturated Felt

ASTM D 226, Asphalt Saturated, Type I, 15 pound; ASTM D 227, Coal-Tar Saturated.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Remove or cut form ties and repair all surface defects as required in Section 03 30 00 CAST-IN-PLACE CONCRETE. Clean concrete and masonry surfaces to receive dampproofing of foreign matter and loose particles. Apply dampproofing to clean dry surfaces. Moisture test in accordance with ASTM D 4263. If test indicates moisture, allow a minimum of 7 additional days after test completion for curing. If moisture still exists, redo test until substrate is dry.

3.1.1 Metal Surfaces

Metal surfaces shall be dry and be free of rust, scale, loose paint, oil, grease, dirt, frost and debris.

3.2 Protection of Surrounding Areas

Before starting the dampproofing work, the surrounding areas and surfaces shall be protected from spillage and migration of dampproofing material onto other work. Drains and conductors shall be protected from clogging with dampproofing material.

3.3 APPLICATION

Apply dampproofing after priming coat is dry, but prior to any deterioration of primed surface, and when ambient temperature is above 40 degrees F.

3.3.1 Surface Priming

Prime surfaces to receive asphalt or dampproofing with asphalt primer.

Apply primer when ambient temperature is above 40 degrees F and at rate of approximately one gallon per 100 square feet, fully covering entire surface to be dampproofed.

3.3.2 Cold-Application Method

3.3.2.1 Emulsion-Based Asphalt

Emulsion-based asphalt dampproofing work shall not be performed in temperatures below 40 degrees F. Emulsions shall have a smooth and uniform consistency at time of application. Dampproofing materials shall be applied in accordance with manufacturer's published instructions to produce a smooth uniform dry film of not less than 12 mils thick without voids or defects. Dull or porous spots shall be recoated. Dampproofing materials shall seal tightly around pipes and other items projecting through dampproofing. Rates of application shall be as follows:

a. Primer: 1/2 gallon per 100 square feet, cold-applied.

c. Non-fibrated Dampproofing: 2 gallons per 100 square feet, cold-applied with spray, brush or trowel.

3.4 PROTECTIVE COVERING

Protect dampproofed surfaces against which backfill will be placed with one layer of 15 pound saturated felt conforming to the requirements specified herein. Use asphalt-saturated felt where the dampproofing material is asphalt. Embed felts in the second coating of bitumen and lap edges and ends not less than one inch.

-- End of Section --

SECTION 07 21 13

BOARD AND BLOCK INSULATION
04/06

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM C 591	(2007) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 930	(2005) Potential Health and Safety Concerns Associated with Thermal Insulation Materials and Accessories
ASTM D 3833/D 3833M	(1996; R 2006) Water Vapor Transmission of Pressure-Sensitive Tapes
ASTM E 154	(1999; R 2005) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM E 96/E 96M	(2005) Standard Test Methods for Water Vapor Transmission of Materials

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.134	Respiratory Protection

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Block or board insulation; G

Vapor retarder

Pressure sensitive tape

Protection board or coating

Accessories

SD-08 Manufacturer's Instructions

Block or Board Insulation

Adhesive

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery

Deliver materials to the site in original sealed wrapping bearing manufacturer's name and brand designation, specification number, type, grade, R-value, and class. Store and handle to protect from damage. Do not allow insulation materials to become wet, soiled, crushed, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storing, and protecting of materials before and during installation.

1.3.2 Storage

Inspect materials delivered to the site for damage; unload and store out of weather in manufacturer's original packaging. Store only in dry locations, not subject to open flames or sparks, and easily accessible for inspection and handling.

1.4 SAFETY PRECAUTIONS

1.4.1 Respirators

Provide installers with dust/mist respirators, training in their use, and protective clothing, all approved by National Institute for Occupational Safety and Health (NIOSH)/Mine Safety and Health Administration (MSHA) in accordance with 29 CFR 1910.134.

1.4.2 Other Safety Considerations

Consider safety concerns and measures as outlined in ASTM C 930.

PART 2 PRODUCTS

2.1 BLOCK OR BOARD INSULATION

Provide only thermal insulating materials recommended by manufacturer for type of application indicated. Provide board or block thermal insulation conforming to the following standards and the physical properties listed below:

a. Unfaced Preformed Rigid Polyurethane and Polyisocyanurate Board: ASTM C 591

2.1.1 Thermal Resistance

As indicated.

2.1.2 Recycled Materials

Provide thermal insulation containing recycled materials to the extent practicable, provided that the material meets all other requirements of this section. The minimum required recycled material contents (by weight, not volume) are:

Polyisocyanurate/Polyurethane: 9 percent

2.1.3 Prohibited Materials

Do not provide materials containing more than one percent of asbestos.

2.2 VAPOR RETARDER AND DAMPPROOFING

2.2.1 Dampproofing for Masonry Cavity Walls

Bituminous material is specified in Section 07 11 13 BITUMINOUS DAMPPROOFING.

2.2.2 Vapor Retarder under Floor Slab

a. Water vapor permeance: 0.2 Perm or less when tested in accordance with ASTM E 96/E 96M.

b. Puncture resistance: Maximum load no less than 40 pounds when tested according to ASTM E 154.

2.3 PRESSURE SENSITIVE TAPE

As recommended by manufacturer of vapor retarder and having a water vapor permeance rating of one perm or less when tested in accordance with ASTM D 3833/D 3833M.

2.4 PROTECTION BOARD OR COATING

As recommended by insulation manufacturer.

2.5 ACCESSORIES

2.5.1 Adhesive

As recommended by insulation manufacturer.

2.5.2 Mechanical Fasteners

Corrosion resistant fasteners as recommended by the insulation manufacturer.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

Before installing insulation, ensure that all areas that will be in contact with the insulation are dry and free of projections which could cause voids, compressed insulation, or punctured vapor retarders. If installing perimeter or under slab insulation, check that the fill is flat, smooth, dry, and well tamped. If moisture or other conditions are found that do not allow the proper installation of the insulation, do not proceed but notify the Contracting Officer of such conditions.

3.2 PREPARATION

3.3 INSTALLATION

3.3.1 Insulation Board

Install and handle insulation in accordance with the manufacturer's installation instructions. Keep material dry and free of extraneous materials. Observe safe work practices.

3.3.2 Electrical Wiring

Surface mount all wiring per electrical specifications herein.

3.3.3 Continuity of Insulation

Butt tightly against adjoining boards, sill plates, headers and obstructions. Provide continuity and integrity of insulation at corners, wall to ceiling joint, roof, and floor. Avoid creating any thermal bridges or voids.

3.4 INSTALLATION ON WALLS

3.4.1 Installation on Masonry Walls

Apply board directly to masonry with adhesive or fasteners as recommended by the insulation manufacturer. Fit between obstructions without impaling board on ties or anchors. Apply in parallel courses with joints breaking midway over course below. Put ends in moderate contact with adjoining insulation without forcing. Cut and shape as required to fit around wall penetrations, projections or openings to accommodate conduit or other services. Seal around cut-outs with sealant. Install board in wall cavities so that it leaves at least a nominal one inch free air space outside of the insulation to allow for cavity drainage.

3.4.2 Adhesive Attachment to Concrete and Masonry Walls

Apply adhesive to wall and completely cover wall with insulation.

a. As recommended by the insulation manufacturer.

b. Use only full back method for pieces of one square foot or less.

c. Butt all edges of insulation and seal edges with tape.

3.5 PERIMETER AND UNDER SLAB INSULATION

Install perimeter thermal insulation where heated spaces are adjacent to exterior walls or slab edges in slab-on-grade or floating-slab construction.

3.5.1 Manufacturer's Instructions

Install, attach, tape edges, provide vapor retarder and other requirements such as protection against vermin, insects, damage during construction as recommended in manufacturer's instructions.

3.5.2 Insulation on Vertical Surfaces

Install thermal insulation as indicated on interior of foundation walls

below grade. Fasten insulation with adhesive.

3.5.3 Insulation Under Slab

Provide insulation horizontally under slab on grade Turn insulation up at slab edge, and extend full height of slab. Install insulation on top of vapor retarder and turn retarder up over the outside edge of insulation to top of slab.

3.5.4 Protection of Insulation

Protect insulation on vertical surfaces from damage during construction and back filling by application of protection board or coating. Do not leave installed vertical insulation unprotected overnight. Install protection over entire exposed exterior insulation board.

3.6 VAPOR RETARDER

Apply a continuous vapor retarder as indicated. Overlap all joints at least 6 inches and seal with pressure sensitive tape. Seal at sill, header, windows, doors and utility penetrations. Repair punctures or tears with pressure sensitive tape.

-- End of Section --

SECTION 07 22 00.00 40

ROOF AND DECK INSULATION
06/06

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM C 1289	(2005) Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
ASTM C 208	(1995; R 2001) Standard Specification for Cellulosic Fiber Insulating Board
ASTM D 312	(2000) Standard Specification for Asphaltr Used in Roofing
ASTM D 41	(2005) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's data shall be submitted indicating percentage of recycle material in roof and deck insulation to verify affirmative procurement compliance.

Total weight and volume quantities of roof and deck insulation with recycle material shall be submitted.

Manufacturer's catalog data shall be submitted for the following items:

Thermal Insulation Materials; G
Fastening Materials; G
Bituminous Plastic Cement; G
Asphalt-Base Emulsion; G

SD-04 Samples

Contractor shall submit the following samples:

Three of each type of Fasteners

Three 1-quart containers of Adhesives.

Three pieces, full thickness by 12 inches by the width of Insulation (or underlayment).

After approval, full-sized samples may be used in the construction, provided each sample is clearly identified and its location recorded.

SD-07 Certificates

Certificates for the following items shall exactly identify each item by the designation that will appear on the packaging for that item. Certificates shall be submitted for all materials that are identified by a referenced specification.

Polyisocyanurate Roof Insulation
Asphalt Primer
Steep Asphalt
Bituminous Plastic Cement

SD-08 Manufacturer's Instructions

Manufacturer's instructions for the following items shall indicate fastener and adhesive instructions for each type of installation.

Roof Insulation

SD-11 Closeout Submittals

Warranty

1.3 QUALIFICATIONS FOR ROOF AND DECK INSULATION WORK

Roof and deck insulation shall be performed by Contractor personnel certified by the insulation manufacturer to install their products.

1.4 DELIVERY AND STORAGE OF MATERIALS

Materials shall be delivered to the project site in their original, unopened packages or containers bearing labels identifying the manufacturer's name, brand name, material, and other information.

Materials shall be stored in their original, unbroken packages or containers in a weathertight and dry area and protected from damage until needed for use.

PART 2 PRODUCTS

2.1 THERMAL INSULATION AND UNDERLAYMENT MATERIALS

2.1.1 Rigid Board

Underlayment (cover board) shall be 1/2" thick high density wood fiberboard complying with ASTM C 208, Grade 1, with a maximum thermal conductance value of 4.35 W/m2 x degree C). Provide black organic-glass mat facer of all six sides. An acceptable product is Fesco Board as manufactured by Johns Manville, Inc. or equal.

Polyisocyanurate roof insulation shall conform to ASTM C 1289, Type II, with a maximum thermal conductance value of .57 (W/m2 x degree C). Minimum compressive strength shall be 135 Kpa when tested according to ASTM D 1621. Thickness for flat boards shall be minimum of 1-1/2". Two layers of board are required, except at drains, for a total minimum thickness of 3". Top and bottom surfaces shall be covered with non-asphalt fiberglass mat facers. An acceptable product is Hy-Therm roof insulation as manufactured by Celotex Inc. or equal.

Provide tapered polyisocyanurate roof insulation boards where indicated for sloping to drain. Fabricate with minimum taper of 1/4 inch per foot.

Provide tapered crickets formed from either polyisocyanurate or wood fiberboard for positive drainage to roof drains. Fabricate with minimum taper of 1/4" per foot.

2.2 FASTENING MATERIALS

2.2.1 Insulation Adhesives

Insulation adhesive for adhering cover board over rigid insulation shall be asphalt conforming to ASTM D 312, Type III.

2.2.2 Insulation Joint Tape

A strong mat of continuous glass fibers, bonded together with a resinous binder to provide maximum strength. Joint tape shall be FM approved. Tape specifically designed to reinforce roofing membrane at insulation joint.

2.3 ASPHALT PRIMER

Asphalt-primer shall be asbestos free, quick-drying water based, polymer modified asphalt emulsion. Primer shall conform to ASTM D 41.

2.4 ASPHALT

Asphalt shall conform to ASTM D 312, Type III.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Roof insulation shall be installed in accordance with approved manufacturer's descriptive data and installation instructions.

Contractor shall examine deck surfaces for inadequate anchorage, foreign material, moisture, and unevenness, any condition which would prevent the execution and quality of application of roof insulation system as specified.

The Contractor shall not proceed with insulation application until existing roof deck defects as corrected.

Starting work designates acceptance of the surfaces by the Contractor.

Insulation material shall be cut and fit as necessary to fully insulate small areas and to accommodate piping, scuttles, vents, and other construction penetrating the insulation material.

3.2 PREPARATION

3.2.1 Protection of Property

Before starting work, paving and faces of building walls, adjacent to hoist areas, shall be protected. Protection shall be maintained for the duration of work.

HVAC units on the roofs shall be protected from damage. Coordinate with COR the use of HVAC units, during the installation of roofing materials, to avoid intake of unacceptable fumes.

3.2.2 Preparation of Surfaces

Surfaces on which thermal insulation materials are to be applied shall be clean, smooth, dry, and free from projections. Condition of surfaces shall be inspected and approved by the Contracting Officer prior to the start of roof insulation work.

3.3 APPLICATION

3.3.1 General Procedures

Insulation installation shall be continuous, with all operations proceeding together.

Before cessation of work on each working day or when work is interrupted due to rainfall or other causes, the roof shall be sealed against intrusion of water. Insulation or underlayment shall not be left exposed during rainfall or overnight.

Traffic over partially or completely finished underlayment or insulation shall be only on planks, or on plywood not less than 5/8-inch thick and 2-feet wide.

Materials temporarily stored on the roof shall be distributed to stay within the live-load limits of the roof, which is 15 Kg per square meter. Ample bases shall be provided under equipment to distribute the weight to conform to the live-load limits.

3.3.2 Insulation Application

Insulation shall be installed in accordance with the manufacturer's requirements and as specified below.

Install insulation according to the following table.

Surface	First/Second Layers	Cover Layer
Fluted metal deck	3" Rigid Board	1/2" Fiber Board

Provide minimum of 1 inch thick insulation at all roof drain collars or as indicated on the contract drawings. Thickness shall include 1/2 inch of rigid insulation and 1/2 inch of fiber cover board. If any drain cannot accept specified thickness of insulation, then hold back insulation 16 inches and add tapered insulation to drain.

Total nominal thickness shall be 3-1/2" when installed in 2 layers of insulation with cover layer. No more insulation shall be installed at one

time than can be protected from wetting or other damage by installation of roofing membranes on the same day or prior to rain or dew.

Layer to receive the roofing membrane shall be installed with longitudinal joints parallel to the short dimension of the roof. Joints shall be staggered in each layer. First layer and between layers shall be installed with solid-contact. Insulation shall be laid with edges in moderate contact, but not forced into place. End joints shall be staggered.

Mechanically fasten insulation to metal roof deck with screws and plates.

Joints of insulation board shall be taped.

Temporary water cutoffs shall be installed at the completion of each day's work and removed upon resumption of work.

Attach flashing membranes to wood nailers at 8 inches on center, or as directed by the manufacturer's recommendations or instructions.

Install second insulation board and cover layer of insulation to rigid insulation in solid mopping of hot asphalt (Type III) applied at nominal rate of 25lbs/square. Immediately after placement, walk insulation boards into adhesive to achieve solid contacts.

Adhere tapered insulation system and crickets in pattern prescribed by approved shop drawings.

-- End of Section --

SECTION 07 51 13

ASPHALT BUILT-UP ROOFING
04/06

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 532	(1988) Structural Insulating Formboard (Cellulosic Fiber)
ASTM D 1863	(1993) Mineral Aggregate Used on Built-Up Roofs
ASTM D 2178	(1989) Asphalt Glass (Felt) Used in Roofing and Waterproofing
ASTM D 2277	(1987) Fiberboard Nail-Base Sheathing
ASTM D 312	(1995) Asphalt Used in Roofing
ASTM D 4586	(1993) Standard Specification for Asphalt Roof Cement, Asbestos Free

ASTM INTERNATIONAL (ASTM)

ASTM D 4601	(2004) Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing

1.2 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-03 Product Data

Manufacturer's Catalog Data shall be submitted for the following items:

Roofing Felts
Bituminous Plastic Cement
Cants
Aggregate Surfacing
Adhesives
Flashing Sheet

SD-04 Samples

Three pieces of base, ply sheet and flashing backer sheet 300 by 300 millimeters square.

Three pieces of flashing membrane 300 by 300 millimeter square.

Three pieces of roof walkway pad 300 by 300 millimeters square.

SD-07 Certificates

Signed certificate by roofing manufacturer certifying that roofing systems meet performance requirements.

Manufacturer's Roofing System Warranty shall be submitted for material and labor for a period of 20 years.

Bidders shall submit and identify the system used in their bid with published values.

1.3 QUALITY ASSURANCE

The roofing system shall be composed of materials and products approved by the manufacturer which provides the ten year warranty.

Applicator of roofing system shall be certified and approved by the roofing system manufacturer.

Provide full-time field technical services representative for monitoring project work on a full-time basis, and available for final roof inspection.

Roofing system manufacturer shall provide field representative to make periodic site visits, report work quality and job progress.

The presence and activity of the manufacturer's representative shall not relieve the Contractor of contractual responsibilities or duties.

1.4 PERFORMANCE REQUIREMENTS

Provide installed roofing membrane and base flashing that remain watertight, do not permit the passage of water, that resists specified uplift pressures and thermally induced movement and exposure to weather without failure.

Provide roofing materials that are compatible with one another under conditions of service and application requirements, as demonstrated by the roofing manufacturer based on previous testing and field experience.

1.5 DELIVERY, STORAGE AND HANDLING

Deliver roofing material to project site in original containers with seals unbroken and labeled with manufacturer's name, product name and type, date of manufacture and direction for storage.

Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling and other sources. Store in a dry location. Comply with insulation manufacturer's written instruction for handling, storing and protecting during installation.

Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.6 PROJECT CONDITIONS

Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instruction and warranty requirements.

1.7 WARRANTY

Provide manufacturer's standard form, without monetary limitation, which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within the specified warrant period. Failure includes roof leaks.

Warranty includes roofing membrane, base flashings, roofing membrane accessories, roof insulation, fasteners, substrate board, base sheets, walkway products and other components of roofing system.

Warranty shall be in force for a period of 20 years from the date of final completion.

PART 2 PRODUCTS

2.1 ROOF SYSTEM

The roof system described in this section is based on the salient features of a hot process asphalt built-up roof application. The system consists of multi layers of asbestos free, porous fiberglass asphalt sheets that are adhered with hot asphalt that is specifically designed in a built-up application.

Manufacturers meeting the Government's specified minimum requirements for hot process roofing systems are listed below.

Tremco, Incorporated

Johns Manville

Firestone Building Products Company

2.2 BASE, AND INTERPLY SHEET ROOFING MEMBRANE

Roofing felts for the main field roofing shall be porous, smooth surface, fiberglass reinforced asphalt coating, with a fine mineral parting agent. Roofing felts that make up the Hot Process system shall incorporate asphalt felt membranes. Base sheet asphalt roofing felt shall meet or exceed the requirements for ASTM D 4601, Type II roofing sheets. Interply sheet a sphalt roofing felts shall meet or exceed the requirements for ASTM D 2178, Type IV roofing sheets. Thickness of felts shall range from a minimum of 1.0 millimeter to a maximum of 2.2 millimeters.

Roofing membranes shall be compatible with manufacturer's specified hot process adhesive, and when combined shall produce a homogeneous water proof roof system.

Manufacturers meeting the Government's specified minimum requirements for

roofing felts as listed below.

Tremco, Incorporated 4-ply Built-up (burmastic base sheet & 3 plys of Thermglass)with aggregate flood coat surfacing

Johns Manville equal

Firestone Building Products Company equal

Base Sheet Properties

Property	Minimum Value	Test Method
Weight	1.5kg/m2	
Breaking Strength	135lbf/in	
Pliability, 13mm radius	No failures	
Mass of desaturated glass Mat, minimum	107g/m2	
Surfacing & stabilizer	65%	
Asphalt, minimum	485 g/m2	
Resistance to puncture	120lbf	

Interply Sheet Properties

Property	Minimum Value	Test Method
Weight,roll	1.8kg	ASTM D 2178
Breaking Strength	7.7 kN/m	
Pliability, 13mm radius	No failures	
Mass of desaturated glass Mat, minimum	83.0 g/m2	
Surfacing & stabilizer	156 g/m2	
Asphalt, minimum	146.0 g/m2	
Width of roll	1000 millimeter	

2.3 BASE FLASHING

Base flashing felts for walls and equipment curb flashing shall be non-porous, smooth surface, polyester/glass reinforced asphalt coating, with a fine mineral parting agent. Flashing felts may be similar to main roofing membranes and may incorporate asphalt felts or SBS modified asphalt membranes. Asphalt roofing felts shall meet or exceed the requirements for ASTM D 4601, Type II roofing sheets. SBS modified asphalt membranes shall meet or exceed the requirements of ASTM D 6164, Type I, Grade S. Thickness of felts shall range from a minimum of 1.2 millimeter to a maximum of 4.0 millimeters.

Flashing membranes shall be compatible with manufacturer's specified hot process flashing adhesive, and when combined shall produce a homogeneous water proof roof system.

Manufacturers meeting the Government's specified minimum requirements for base flashing felts are listed below.

Tremco, Incorporated Burmastic Composite Flashing
Johns Manville equal
Firestone Building Products equal

Property	Minimum Value	Test Method
Weight	1.5kg/m^2 (3lb/100ft^2)	ASTM D 228
Breaking Strength	600N MD (135lbf/in) 575N XD (130lbf/in)	ASTM D 146
Pliability, 12.7 mm (1/2") radius bend	No failures	ASTM D 146
Mass of desaturated Polyester/glass mat	107g/m^2 (2.2lb/100ft^2)min	ASTM D 146
Surfacing & stabilizer	65% max	ASTM D 4601
Asphalt	485 g/m^2 (10.0lb/100ft^2)	ASTM D 228
Puncture resistant	5340 N (120lbf)	ASTM D 154

2.4 FLASHING MEMBRANE

Cap flashing membrane shall be non-porous, smooth surface or granular, polyester/glass reinforced asphalt coating, with a fine mineral parting agent on one or both sides. Cap flashing membranes that make up the Cold Process system shall incorporate asphalt felt membrane. Asphalt roofing felts shall meet or exceed the requirements for ASTM D 4601, Type II roofing sheets. Thickness of felts shall range from a minimum of 1.2 millimeter to a maximum of 4.0 millimeters.

Cap flashing membranes may be granular coated on exposed side, or a smooth surface that may be coated with the manufacturer's recommended coating system for UV protection.

Manufacturers meeting the Government's minimum requirements for flashing felts are listed below.

Tremco, Incorporated
Johns Manville
Firestone Building Products Company

2.5 MESH STRIPPING

Mesh stripping shall be a non-shrinking, non-rotting, vinyl coated, woven glass mesh used for stripping in roof membrane, flashing and for reinforcing roof curb corners. An acceptable product is Burmesh reinforcing mesh as manufactured by Tremco Incorporated, or an approved industry standard mesh product.

2.6 ROOFING MEMBRANE ADHESIVE

Roofing membrane adhesive shall be hot mopped asphalt roofing system. The adhesive shall be Types III and IV asphalts used in hot asphalt specifications, possessing waterproofing properties and is compatible with both SBS modified bitumen products and with conventional asphaltic materials. Asphalt shall comply with ASTM D 312 testing requirements.

Manufacturers meeting the Government's minimum requirements for membrane adhesives are listed below.

Tremco, Incorporated Type III or IV asphalt or equal
Johns Manville equal
Firestone Building Products Company equal

2.7 FLASHING ADHESIVE

Flashing adhesive shall be hot asphalt, heat welding of specially treated asphalt sheets and one or two-part, asbestos-free interplay and surfacing adhesive to be used in a multi-ply cold process built-up roofing system. Hot asphalt, heat welding and cold applied adhesive shall be compatible with both SBS modified bitumen products, elastomeric sheets and with conventional asphaltic materials.

Manufacturers meeting the Government's minimum requirements for flashing adhesives are listed below.

Tremco, Incorporated Sheeting Bond Adhesive
Johns Manville equal
Firestone Building Products Company equal

2.8 MASTIC

Mastic shall be an asphalt-based, heavily fibrated mastic, with penetrating oils and plasticizing agents, used to seal wall and curb flashing edges. An acceptable product is ELS mastic as manufactured by Tremco Incorporated. The salient features of the ELS mastic are as follows:

Property	Minimum Value	Test Method
Asbestos content	None	ASTM 276
Viscosity @ 25 deg C	600-2000 Pa (600,000-2,000,000cP)	ASTM D 2196
Density @ 25 deg C	979 kg/m^3 (8.1lb/gal)	ASTM D 1475
Nonvolatile matter	70%	ASTM D 4586
Behavior at 140 deg F (Sag resistant)	3.18mm (1/8 in)	ASTM D 4586
Moisture vapor Transmission rate	1.55-6.2 g/m^2/24 hrs @ 0.51 mm (.42g/100in^2/24 hrs)	ASTM E 398

2.9 CANTS

Cants shall be made from treated fiberboard and shall reduce the angle covered into two equal angles. Fiberboard shall conform to ASTM C 532 and ASTM D 2277, treated for moisture resistance by an integral treatment of wax or bituminous impregnation.

2.10 AGGREGATE SURFACING

Gravel shall conform to ASTM D 1863, size No. 7.

PART 3 EXECUTION

3.1 ROOFING SYSTEM

Contractor shall provide a hot-applied roofing system with asphalt adhesive and weathering membrane over existing concreteor metal deck with insulation.

The hot process roofing system shall be installed according to the manufacturer's recommendations and instructions. Roofing installation shall be continuous, with all operations proceeding together. Phasing of roofing system installation may be permitted due inclement weather or as approved by the Government.

Adhesive and roofing materials shall be kept in a heated enclosed space at least 24 hours prior to installation when temperatures are below 10 degrees C. Avoid overheating asphalt. Insulated asphalt lines and insulated roof-top equipment shall be used.

3.2 PREPARATION

Contractor shall verify that work of other trades that penetrates the roof deck or requires men and equipment to traverse the roof deck is complete.

Contractor shall examine deck surfaces for inadequate anchorage, foreign material, moisture, and unevenness which would prevent the execution and quality of application.

Contractor shall proceed with the roofing application only after defects have been corrected.

Starting work designates acceptance of the surfaces by the Contractor.

3.3 APPLICATION

3.3.1 General

Roofing installation shall be continuous, with all operations proceeding together. Specified plies of felt shall follow shingle-fashion as a single composite operation.

Interval between the base sheet application and succeeding plies shall not exceed 48 hours.

Before cessation of work on each working day or when work is interrupted due to rainfall or other causes, the roof shall be sealed against intrusion of water. Base sheet shall be brought to the edge of the insulation, dams shall be installed and exposed felts shall be effectively glazed. Insulation or unglazed felts shall not be left exposed during rainfall or overnight.

Debris shall be removed from the roof at the end of each work day.

3.3.2 Hot Process Built-Up Roofing Application

3.3.2.1 Roof Membrane

Install one base sheet and three (3) plies of roofing felts in hot-process adhesive, shingle fashion as required by manufacturer's installation instructions. Interply application rate shall be at 1/4 lbs/ft^2. Overlap starter strips 24 inches with first ply. Overlap each succeeding ply 24 inches. Place ply sheet to ensure water will flow over or parallel to, but never against exposed edges. Use 12",24" and 36" wide plies to start and finish roof membrane along roof edges and terminations or as required by manufacturer. Broom and/or roll ply sheet immediately after installation. Overlap previous day's work 24 inches. Lap ply membrane ends 6 inches. Stagger end laps 12 inches minimum.

Brush apply hot-process asphalt adhesive as required by manufacturer's installation instructions. Lap selvage 4 inches and end laps 6 inches with a stagger of 36 inches. Overlap each succeeding ply 24 inches. Place ply sheet to ensure water will flow over or parallel to, but never against exposed edges. Immediately broadcast minimum of 4 lbs/ft^2 of new, clean

roofing gravel, conforming to ASTM D 1863. Cover flood coat material completely with gravel.

All roofing felts shall be broomed in place.

3.3.3 Flashing Applications

3.3.3.1 Edge Flashing

Secure continuous cleat to outside roof edge. Fabricate and install new stainless steel metal edge as shown on drawings. Stripe in edge with base flashing ply and heavily fibrated mastic as base flashing. Cover with flashing sheet and flashing adhesive. Over lap flashing 4 inches and secure edges with flashing lap mastic. Extend flashing 4 inches beyond base flashing.

3.3.3.2 Wall and Roof Curb Flashing

Adhere one ply of base flashing ply in a continuous application of heavily fibrated mastic or asphalt. Extend base flashing ply 4 inches beyond toe of cant.

Cut flashing in lengths not to exceed ten feet in length. Apply asphalt or flashing adhesive to base flashing ply in a continuous 1.6 millimeter thick application. Adhere flashing sheet to asphalt or mastic. Lap flashing sheet ends 4 inches. Extend membrane 6 inches beyond toe of cant. Adhere laps with flashing lap mastic or asphalt. Seal vertical and horizontal laps of flashing membrane with reinforcing mesh embedded between alternate continuous courses of elastomer sealant, heavily fibrated mastic or asphalt. Mechanically attach flashing along top edge 8 inches on center.

Double coat all flashing materials with a reflective coating if non-granular cap sheet is not used.

3.3.3.3 Expansion Joints

Construct a wood roof expansion joint assembly, complete with fiber cants, flashing and stainless steel cover.

3.3.3.4 Drains

Apply flashing ply sheet and lead sheet around roof drains over newly installed plies in accordance with NRCA published flashing details. Cover flashing with two ply of roofing felts and strip-in edges with mesh and mastic. Provide new metal strainers for all drains that are missing a strainer.

3.3.4 Cant Strip Application

Cant strips shall be installed in the angles formed at wall and other vertical surfaces as backing for base flashings. Cant strips shall be laid in a solid coat of insulation adhesive just prior to laying the roofing plies. Cants shall have a face dimension, shall be continuous, and shall be installed in as long lengths as practical.

-- End of Section --

SECTION 07 60 00

FLASHING AND SHEET METAL
01/07

PART 1 GENERAL

1.1 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/SPRI RD-1	(20035) Standard for Retrofit Roof Drains

AMERICAN WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2003; Errata 2004) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 308/A 308M	(2003) Standard Specification for Steel Sheet, Terne (Lead-Tin Alloy) Coated by the Hot Dip Process
ASTM A 653/A 653M	(2006a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 209	(2006) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	(2006) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B 32	(2004) Standard Specification for Solder Metal
ASTM B 69	(2001a; R 2005) Standard Specification for Rolled Zinc
ASTM D 1784	(2006a) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 226	(2006) Standard Specification for Asphalt-Saturated Organic Felt Used in

	Roofing and Waterproofing
ASTM D 41	(2005) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 4586	(2000; R 2006) Asphalt Roof Cement, Asbestos-Free

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA Arch. Manual	(2003, 6th Ed) Architectural Sheet Metal Manual

1.2 General Requirements

Finished sheet metalwork will form a weathertight construction without waves, warps, buckles, fastening stresses or distortion, which allows for expansion and contraction. Sheet metal mechanic is repsonsible for cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades. Coordinate installation of sheet metal items used in conjunction with roofing with roofing work to permit continuous roofing operations.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Covering on flat, sloped, or curved surfaces; G

Counterflashing; G

Flashing at roof penetrations; G

Reglets; G

Indicate thicknesses, dimensions, fastenings and anchoring methods, expansion joints, and other provisions necessary for thermal expansion and contraction. Scaled manufacturer's catalog data may be submitted for factory fabricated items.

SD-11 Closeout Submittals

Quality Control Plan

Submit for sheet metal work in accordance with paragraph entitled "Field Quality Control."

1.4 DELIVERY, HANDLING, AND STORAGE

Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the job site. Remove from the site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until immediately before installation.

PART 2 PRODUCTS

2.1 MATERIALS

Do not use lead, lead-coated metal, or galvanized steel. Use any metal listed by SMACNA Arch. Manual for a particular item, unless otherwise specified or indicated. Conform to the requirements specified and to the thicknesses and configurations established in SMACNA Arch. Manual for the materials. Different items need not be of the same metal, except that if copper is selected for any exposed item, all exposed items must be copper.

Furnish sheet metal items in 8 to 10 foot lengths. Single pieces less than 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 12 inch legs. Provide accessories and other items essential to complete the sheet metal installation. Provide accessories made of the same or compatible materials as the items to which they are applied. Fabricate sheet metal items of the materials specified below and to the gage, thickness, or weight shown in Table I at the end of this section. Provide sheet metal items with mill finish unless specified otherwise. Where more than one material is listed for a particular item in Table I, each is acceptable and may be used except as follows:

2.1.1 Exposed Sheet Metal Items

Must be of the same material.

2.1.2 Steel Sheet, Zinc-Coated (Galvanized)

ASTM A 653/A 653M.

2.1.2.1 Finish

Exposed exterior items of zinc-coated steel sheet must have a baked-on, factory-applied color coating of polyvinylidene fluoride or other equivalent fluorocarbon coating applied after metal substrates have been cleaned and pretreated. Provide finish coating dry-film thickness of 0.8 to 1.3 mils and color of selected bu the Government.

2.1.3 Zinc Sheet and Strip

ASTM B 69, Type I, a minimum of 0.024 inch thick.

2.1.4 Stainless Steel

ASTM A 167, Type 302 or 304, 2D Finish, fully annealed, dead-soft temper.

2.1.5 Terne-Coated Steel

Minimum of 14 by 20 inch with minimum of 40 pound coating per double base box. ASTM A 308/A 308M.

2.1.6 Aluminum Alloy Sheet and Plate

ASTM B 209, anodized clear form alloy, and temper appropriate for use.

2.1.7 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B 221.

2.1.8 Solder

ASTM B 32, 95-5 tin-antimony.

2.1.9 Polyvinyl Chloride Reglet

ASTM D 1784, Type II, Grade 1, Class 14333-D, 0.075 inch minimum thickness.

2.1.10 Bituminous Plastic Cement

ASTM D 4586, Type I.

2.1.11 Roofing Felt

ASTM D 226 Type II.

2.1.12 Asphalt Primer

ASTM D 41.

2.1.13 Fasteners

Use the same metal or a metal compatible with the item fastened. Use stainless steel fasteners to fasten dissimilar materials.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Workmanship

Make lines and angles sharp and true. Free exposed surfaces from visible wave, warp, buckle, and tool marks. Fold back exposed edges neatly to form a 1/2 inch hem on the concealed side. Make sheet metal exposed to the weather watertight with provisions for expansion and contraction.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA Arch. Manual, Architectural Sheet Metal Manual. Provide sheet metal flashing in the angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.2 Nailing

Confine nailing of sheet metal generally to sheet metal having a maximum width of 18 inch. Confine nailing of flashing to one edge only. Space nails evenly not over 3 inch on center and approximately 1/2 inch from edge unless otherwise specified or indicated. Face nailing will not be permitted. Where sheet metal is applied to other than wood surfaces, include in shop drawings, the locations for sleepers and nailing strips required to secure the work.

3.1.3 Cleats

Provide cleats for sheet metal 18 inch and over in width. Space cleats evenly not over 12 inch on center unless otherwise specified or indicated. Unless otherwise specified, provide cleats of 2 inch wide by 3 inch long and of the same material and thickness as the sheet metal being installed. Secure one end of the cleat with two nails and the cleat folded back over the nailheads. Lock the other end into the seam. Where the fastening is to be made to concrete or masonry, use screws and drive in expansion shields set in concrete or masonry. Pretin cleats for soldered seams.

3.1.4 Bolts, Rivets, and Screws

Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection. Provide mechanically formed joints in aluminum sheets 0.040 inch or less in thickness.

3.1.5 Seams

Straight and uniform in width and height with no solder showing on the face.

3.1.5.1 Flat-lock Seams

Finish not less than 3/4 inch wide.

3.1.5.2 Lap Seams

Finish soldered seams not less than one inch wide. Overlap seams not

soldered, not less than 3 inch.

3.1.5.3 Loose-Lock Expansion Seams

Not less than 3 inch wide; provide minimum one inch movement within the joint. Completely fill the joints with the specified sealant, applied at not less than 1/8 inch thick bed.

3.1.5.4 Flat Seams

Make seams in the direction of the flow.

3.1.6 Soldering

Where soldering is specified, apply to copper, terne-coated stainless steel, zinc-coated steel, and stainless steel items. Pretin edges of sheet metal before soldering is begun. Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

3.1.6.1 Edges

Scrape or wire-brush the edges of lead-coated material to be soldered to produce a bright surface. Flux brush the seams in before soldering. Treat with soldering acid flux the edges of stainless steel to be pretinned. Seal the joints in aluminum sheets of 0.040 inch or less in thickness with specified sealants. Do not solder aluminum.

3.1.7 Welding and Mechanical Fastening

Use welding for aluminum of thickness greater than 0.040 inch. Aluminum 0.040 inch or less in thickness must be butted and the space backed with formed flashing plate; or lock joined, mechanically fastened, and filled with sealant as recommended by the aluminum manufacturer.

3.1.7.1 Welding of Aluminum

Use welding of the inert gas, shield-arc type. For procedures, appearance and quality of welds, and the methods used in correcting welding work, conform to AWS D1.2/D1.2M.

3.1.7.2 Mechanical Fastening of Aluminum

Use No. 12, aluminum alloy, sheet metal screws or other suitable aluminum alloy or stainless steel fasteners. Drive fasteners in holes made with a No. 26 drill in securing side laps, end laps, and flashings. Space fasteners 12 inch maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 2 inch from the end of the overlapping sheet.

3.1.8 Protection from Contact with Dissimilar Materials

3.1.8.1 Copper or Copper-bearing Alloys

Paint with heavy-bodied bituminous paint surfaces in contact with dissimilar metal, or separate the surfaces by means of moistureproof building felts.

3.1.8.2 Aluminum

Do not allow aluminum surfaces in direct contact with other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, paint the dissimilar metal with a primer followed by two coats of aluminum paint. Where drainage from a dissimilar metal passes over aluminum, paint the dissimilar metal with a non-lead pigmented paint.

3.1.8.3 Metal Surfaces

Paint surfaces in contact with mortar, concrete, or other masonry materials with alkali-resistant coatings such as heavy-bodied bituminous paint.

3.1.8.4 Wood or Other Absorptive Materials

Paint surfaces that may become repeatedly wet and in contact with metal with two coats of aluminum paint or a coat of heavy-bodied bituminous paint.

3.1.9 Expansion and Contraction

Provide expansion and contraction joints at not more than 32 foot intervals for aluminum and at not more than 40 foot intervals for other metals. Provide an additional joint where the distance between the last expansion joint and the end of the continuous run is more than half the required interval. Space joints evenly. Join extruded aluminum gravel stops and fascias by expansion and contraction joints spaced not more than 12 feet apart.

3.1.10 Counterflashing

Except where indicated or specified otherwise, insert counterflashing in reglets located from 9 to 10 inch above roof decks, extend down vertical surfaces over upturned vertical leg of base flashings not less than 3 inch. Fold the exposed edges of counterflashings 1/2 inch. Where stepped counterflashings are required, they may be installed in short lengths a minimum 8 inch by 10 inch or may be of the preformed one-piece type. Provide end laps in counterflashings not less than 3 inch and make it weathertight with plastic cement. Do not make lengths of metal counterflashings exceed 10 feet. Form the flashings to the required shapes before installation. Factory-form the corners not less than 12 inch from the angle. Secure the flashings in the reglets with lead wedges and space not more than 18 inch apart; on short runs, place wedges closer together. Fill caulked-type reglets or raked joints which receive counterflashing with caulking compound. Turn up the concealed edge of counterflashings built into masonry or concrete walls not less than 1/4 inch and extend not less than 2 inch into the walls. Install counterflashing to provide a spring action against base flashing. Where bituminous base flashings are provided, extend down the counter flashing as close as practicable to the top of the cant strip. Factory form counter flashing to provide spring action against the base flashing.

3.1.11 Metal Reglets

Provide factory fabricated caulked type or friction type reglets with a minimum opening of 1/4 inch and a depth of 1 1/4 inch, as approved.

3.1.11.1 Caulked Reglets

Provide with rounded edges and metal strap brackets or other anchors for

securing to the concrete forms. Provide reglets with a core to protect them from injury during the installation. Provide built-up mitered corner pieces for internal and external angles. Wedge the flashing in the reglets with lead wedges every 18 inch, caulked full and solid with an approved compound.

3.1.11.2 Friction Reglets

Provide with flashing receiving slots not less than 5/8 inch deep, one inch jointing tongues, and upper and lower anchoring flanges installed at 24 inch maximum snaplock receiver. Insert the flashing the full depth of the slot and lock by indentations made with a dull-pointed tool, wedges, and filled with a sealant. For friction reglets, install flashing snaplock receivers at 24 inch on center maximum. When the flashing has been inserted the full depth, caulk the slot and lock with wedges and fill with sealant.

3.1.12 Polyvinyl Chloride Reglets (Temporary Construction Installation)

Rigid polyvinyl chloride reglets ASTM D 1784, Type II, Grade 1, Class 14333-D, 0.075 inch minimum thickness may be provided in lieu of metal reglets for temporary construction.

3.1.13 Flashing for Roof Drains

Provide a 30 inch square sheet indicated. Taper insulation to drain from 24 inch out. Set flashing on finished felts in a full bed of asphalt roof cement, ASTM D 4586. Heavily coat the drain flashing ring with asphalt roof cement. Clamp the roof membrane, flashing sheet, and stripping felt in the drain clamping ring. Secure clamps so that felts and drain flashing are free of wrinkles and folds. Retrofit roof drains must conform to ANSI/SPRI RD-1.3.1.14 Sheet Metal Covering on Flat, Sloped, or Curved Surfaces

Except as specified or indicated otherwise, cover and flash all minor flat, sloped, or curved surfaces such as crickets, bulkheads, dormers and small decks with metal sheets of the material used for flashing; maximum size of sheets, 16 by 18 inch. Fasten sheets to sheathing with metal cleats. Lock seams and solder. Lock aluminum seams as recommended by aluminum manufacturer. Provide an underlayment of roofing felt for all sheet metal covering.

3.1.15 Flashing at Roof Penetrations and Equipment Supports

Provide metal flashing for all pipes, ducts, and conduits projecting through the roof surface and for equipment supports, guy wire anchors, and similar items supported by or attached to the roof deck.

3.1.16 Single Pipe Vents

Set flange of sleeve in bituminous plastic cement and nail 3 inch on center. Bend the top of sleeve over and extend down into the vent pipe a minimum of 2 inch. For long runs or long rises above the deck, where it is impractical to cover the vent pipe with lead, use a two-piece formed metal housing. Set metal housing with a metal sleeve having a 4 inch roof flange in bituminous plastic cement and nailed 3 inch on center. Extend sleeve a minimum of8 inch above the roof deck and lapped a minimum of 3 inch by a metal hood secured to the vent pipe by a draw band. Seal the area of hood in contact with vent pipe with an approved sealant.

3.2 PAINTING

Field-paint sheet metal for separation of dissimilar materials.

3.2.1 Aluminum Surfaces

Shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint.

3.3 CLEANING

Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub-clean. Free the exposed metal surfaces of dents, creases, waves, scratch marks, and solder or weld marks.

3.4 REPAIRS TO FINISH

Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items which cannot be repaired.

3.5 FIELD QUALITY CONTROL

Establish and maintain a Quality Control Plan for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Remove work that is not in compliance with the contract and replace or correct.

-- End of Section --

SECTION 07 84 00

FIRESTOPPING
04/06

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM E 814	(2002) Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM E 84	(2007) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM AS 4991	(2001) Approval of Firestop Contractors
FM P7825a	(2005) Approval Guide Fire Protection

UNDERWRITERS LABORATORIES (UL)

UL 1479	(2003) Fire Tests of Through-Penetration Firestops
UL 723	(2003; Rev thru May 2005) Standard for Test for Surface Burning Characteristics of Building Materials
UL Fire Resistance	(2007) Fire Resistance Directory Set

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping Materials.

Detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resistance or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgement, derived from

similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal shall indicate the firestopping material to be provided for each type of application. When more than a total of 5 penetrations and/or construction joints are to receive firestopping, provide drawings that indicate location, "F" and "T" ratings, and type of application.

SD-07 Certificates

Firestopping Materials.

Certificates attesting that firestopping material complies with the specified requirements. In lieu of certificates, drawings showing UL classified materials as part of a tested assembly may be provided. Drawings showing evidence of testing by an alternate nationally recognized independent laboratory may be substituted.

Installer Qualifications.

Documentation of training and experience.

Inspection.

Manufacturer's representative certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

1.3 GENERAL REQUIREMENTS

Firestopping shall consist of furnishing and installing tested and listed firestop systems, combination of materials, or devices to form an effective barrier against the spread of flame, smoke and gases, and maintain the integrity of fire resistance rated walls, partitions, floors, and ceiling-floor assemblies, including through-penetrations and construction joints and gaps. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint. Gaps requiring firestopping include gaps between the curtain wall and the floor slab and between the top of the fire-rated walls and the roof or floor deck above.

1.4 DELIVERY AND STORAGE

Materials shall be delivered in the original unopened packages or containers showing name of the manufacturer and the brand name. Materials shall be stored off the ground and shall be protected from damage and exposure to elements. Damaged or deteriorated materials shall be removed from the site.

1.5 INSTALLER QUALIFICATIONS

The Contractor shall engage an experienced Installer who is:

a. FM Research approved in accordance with FM AS 4991, or

b. Certified, licensed, or otherwise qualified by the firestopping

manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer qualification on the buyer. The Installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures.

1.6 COORDINATION

The specified work shall be coordinated with other trades. Firestopping materials, at penetrations of pipes and ducts, shall be applied prior to insulating, unless insulation meets requirements specified for firestopping. Firestopping materials at building joints and construction gaps shall be applied prior to completion of enclosing walls or assemblies. Cast-in-place firestop devices shall be located and installed in place before concrete placement. Pipe, conduit or cable bundles shall be installed through cast-in-place device after concrete placement but before area is concealed or made inaccessible.

PART 2 PRODUCTS

2.1 FIRESTOPPING MATERIALS

Firestopping materials shall consist of commercially manufactured, asbestos-free, noncombustible products FM P7825a approved, or UL listed, for use with applicable construction and penetrating items, complying with the following minimum requirements:

2.1.1 Fire Hazard Classification

Material shall have a flame spread of 25 or less, and a smoke developed rating of 50 or less, when tested in accordance with ASTM E 84 or UL 723. Material shall be an approved firestopping material as listed in UL Fire Resistance or by a nationally recognized testing laboratory.

2.1.2 Toxicity

Material shall be nontoxic to humans at all stages of application or during fire conditions.

2.1.3 Fire Resistance Rating

Firestop systems shall be UL Fire Resistance listed or FM P7825a approved with "F" rating at least equal to fire-rating of fire wall or floor in which penetraded openings are to be protected, except that "F" rating may be 3 hours in through-penetrations of 4 hour fire rated wall or floor. Firestop systems shall also have "T" rating where required.

2.1.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph GENERAL REQUIREMENTS, shall provide "F" and "T" fire resistance ratings in accordance with ASTM E 814 or UL 1479. Fire resistance ratings shall be as follows:

a. Penetrations of Fire Resistance Rated Walls and Partitions: F Rating = Rating of wall or partition being penetrated.

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement shall be sound and capable of supporting device. Surfaces shall be prepared as recommended by the manufacturer.

3.2 INSTALLATION

Firestopping material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 4 inches or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Firestopping shall be installed in accordance with manufacturer's written instructions. Tested and listed firestop systems shall be provided in the following locations, except in floor slabs on grade:

a. Penetrations of duct, conduit, tubing, cable and pipe through floors and through fire-resistance rated walls, partitions, and ceiling-floor assemblies.

b. Penetrations of vertical shafts such as pipe chases, elevator shafts, and utility chutes.

c. Gaps at the intersection of floor slabs and curtain walls, including inside of hollow curtain walls at the floor slab.

d. Gaps at perimeter of fire-resistance rated walls and partitions, such as between the top of the walls and the bottom of roof decks.

e. Construction joints in floors and fire rated walls and partitions.

f. Other locations where required to maintain fire resistance rating of the construction.

3.2.1 Insulated Pipes and Ducts

Thermal insulation shall be cut and removed where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Thermal insulation shall be replaced with a material having equal thermal insulating and firestopping characteristics.

3.2.2 Fire Dampers

Fire dampers shall be installed and firestopped per drawings.

3.2.3 Data and Communication Cabling

Cabling for data and communication applications shall be sealed with re-enterable firestopping products that do not cure over time. Firestopping shall be modular devices, containing built-in self-sealing intumescent inserts. Firestopping devices shall allow for cable moves,

adds or changes without the need to remove or replace any firestop materials.

-- End of Section --

SECTION 07 92 00

JOINT SEALANTS
01/07

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM C 834	(2005) Latex Sealants
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants

Primers

Bond breakers

Backstops

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). Provide a copy of the Material Safety Data Sheet for each solvent, primer or sealant material.

SD-07 Certificates

Sealant

Certificates of compliance stating that the materials conform to the specified requirements.

1.3 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 40 and 90 degrees F.

1.4 DELIVERY AND STORAGE

Deliver materials to the job site in unopened manufacturers' external shipping containers, with brand names, date of manufacture, color, and

material designation clearly marked thereon. Lable elastomeric sealant containers to identify type, class, grade, and use. Carefully handle and store materials to prevent inclusion of foreign materials or subjection to sustained temperatures exceeding 90 degrees F or less than 0 degrees F.

1.5 QUALITY ASSURANCE

1.5.1 Compatibility with Substrate

Verify that each of the sealants are compatible for use with joint substrates.

1.5.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.5.3 Mock-Up

Project personnel is responsible for installing sealants in mock-up prepared by other trades, using materials and techniques approved for use on the project.

1.6 SPECIAL WARRANTY

Guarantee sealant joint against failure of sealant and against water penetration through each sealed joint for five years.

PART 2 PRODUCTS

2.1 SEALANTS

Provide sealant that has been tested and found suitable for the substrates to which it will be applied.

2.1.1 Interior Sealant

Provide ASTM C 834, ASTM C 920, Type S or M, Grade NS, Class 12.5, Use NT. Location(s) and color(s) of sealant for the following:

	LOCATION	COLOR
a.	Small voids between walls or partitions and adjacent lockers, casework, shelving, door frames, built-in or surface-mounted equipment and fixtures, and similar items.	As selected
b.	Perimeter of frames at doors, windows, and access panels which adjoin exposed interior concrete and masonry surfaces.	As selected
c.	Joints of interior masonry walls and partitions which adjoin columns, pilasters, concrete walls, and exterior walls unless otherwise detailed.	As selected
e.	Interior locations, not otherwise indicated	As selected

LOCATION	COLOR
or specified, where small voids exist between materials specified to be painted.	
h. Behind escutcheon plates at valve pipe penetrations and showerheads in showers.	As selected

2.1.2 Exterior Sealant

For joints in vertical surfaces, provide ASTM C 920, Type S or M, Grade NS, Class 25, Use NT. For joints in horizontal surfaces, provide ASTM C 920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

LOCATION	COLOR
a. Joints and recesses formed where frames and subsills of windows, doors, louvers, and vents adjoin masonry, concrete, or metal frames. Use sealant at both exterior and interior surfaces of exterior wall penetrations.	Match adjacent surface color
b. Joints between new and existing exterior masonry walls.	"
c. Masonry joints where shelf angles occur.	"
d. Joints in wash surfaces of stonework.	"
e. Expansion and control joints.	"
f. Interior face of expansion joints in exterior concrete or masonry walls where metal expansion joint covers are not required.	"
g. Voids where items pass through exterior walls.	"
h. Metal reglets, where flashing is inserted into masonry joints, and where flashing is penetrated by coping dowels.	"
i. Metal-to-metal joints where sealant is indicated or specified.	"
j. Joints between ends of gravel stops, fascias, copings, and adjacent walls.	"

2.2 PRIMERS

Provide a nonstaining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application.

2.3 BOND BREAKERS

Provide the type and consistency recommended by the sealant manufacturer to prevent adhesion of the sealant to backing or to bottom of the joint.

2.4 BACKSTOPS

Provide glass fiber roving or neoprene, butyl, polyurethane, or polyethylene foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell and 40 to 50 percent oversized backing for open cell material, unless otherwise indicated. Make backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

2.5 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer except for aluminum and bronze surfaces that will be in contact with sealant.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Clean surfaces from dirt frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would tend to destroy or impair adhesion. Remove oil and grease with solvent. Surfaces must be wiped dry with clean cloths. When resealing an existing joint, remove existing calk or sealant prior to applying new sealant. For surface types not listed below, contact sealant manufacturer for specific recommendations.

3.1.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finish work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue-free solvent.

3.1.2 Aluminum or Bronze Surfaces

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and any residual adhesive just prior to sealant application. For removing protective coatings and final cleaning, use nonstaining solvents recommended by the manufacturer of the item(s) containing aluminum or bronze surfaces.

3.1.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Laitance, remove efflorescence and loose mortar from the joint cavity.

3.2 SEALANT PREPARATION

Do not add liquids, solvents, or powders to the sealant. Mix multicomponent elastomeric sealants in accordance with manufacturer's instructions.

3.3 APPLICATION

3.3.1 Joint Width-To-Depth Ratios

a. Acceptable Ratios:

JOINT WIDTH	JOINT DEPTH Minimum	JOINT DEPTH Maximum
For metal, glass, or other nonporous surfaces:		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch	1/2 of width	Equal to width
For wood, concrete, masonry,		
1/4 inch (minimum)	1/4 inch	1/4 inch
Over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
Over 1/2 inch to 2 inch	1/2 inch	5/8 inch
Over 2 inch.	(As recommended by sealant manufacturer)	

:

b. Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is not required on metal surfaces.

3.3.2 Masking Tape

Place masking tape on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Remove masking tape within 10 minutes after joint has been filled and tooled.

3.3.3 Backstops

Install backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide a joint of the depth specified. Install backstops in the following locations:

a. Where indicated.

b. Where backstop is not indicated but joint cavities exceed the acceptable maximum depths specified in paragraph entitled, "Joint Width-to-Depth Ratios".

3.3.4 Primer

Immediately prior to application of the sealant, clean out loose particles from joints. Where recommended by sealant manufacturer, apply primer to joints in concrete masonry units, wood, and other porous surfaces in accordance with sealant manufacturer's instructions. Do not apply primer to exposed finish surfaces.

3.3.5 Bond Breaker

Provide bond breakers to the back or bottom of joint cavities, as recommended by the sealant manufacturer for each type of joint and sealant used, to prevent sealant from adhering to these surfaces. Carefully apply the bond breaker to avoid contamination of adjoining surfaces or breaking bond with surfaces other than those covered by the bond breaker.

3.3.6 Sealants

Provide a sealant compatible with the material(s) to which it is applied. Do not use a sealant that has exceeded shelf life or has jelled and can not be discharged in a continuous flow from the gun. Apply the sealant in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Force sealant into joints to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Make sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled joints, apply sealant, and tool smooth as specified. Apply sealer over the sealant when and as specified by the sealant manufacturer.

3.4 PROTECTION AND CLEANING

3.4.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled.

3.4.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

a. Masonry and Other Porous Surfaces: Immediately scrape off fresh sealant that has been smeared on masonry and rub clean with a solvent as recommended by the sealant manufacturer. Allow excess sealant to cure for 24 hour then remove by wire brushing or sanding.

b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent-moistened cloth.

-- End of Section --

SECTION 08 11 13

STEEL DOORS AND FRAMES

07/06

PART 1 GENERAL

1.1 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.

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A 653/A 653M	(2006a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 879/A 879M	(2006) Standard Specification for Steel Sheet, zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
ASTM A 924/A 924M	(2006) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM C 578	(2006) Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 591	(2005) Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C 612	(2004) Mineral Fiber Block and Board Thermal Insulation
ASTM D 2863	(2006a) Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A115	(2006) (Complete Set - Spec dates Vary) Specifications for Door and Frame Preparation for Hardware (Incl A115.1 (1990), A115.2 (1987), A115.4 (1994), A115.5 (1992), A115.6 (1993), A115.12

(1994), A115.13 (1991), A115.14 (1994), A115.15 (1994), A115.16 (1990), A115.17 (1994), A115.18 (1994)

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR 111	(2000) Recommended Selection and Usage Guide for Standard Steel Doors, Frames and Accessories
SDI/DOOR 113	(2001) Determining the Steady State Thermal Transmittance of Steel Door and Frame Assemblies
SDI/DOOR A250.11	(2001) Recommended Erection Instructions for Steel Frames
SDI/DOOR A250.6	(2003) Hardware on Steel Doors (Reinforcement - Application)
SDI/DOOR A250.8	(2003) Recommended Specification for Standard Steel Doors and Frames

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

Doors; G

Frames; G

Accessories

Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

Schedule of doors; G

Schedule of frames; G

Submit door and frame locations.

SD-03 Product Data

Doors; G

Frames; G

Accessories

Submit manufacturer's descriptive literature for doors, frames, and accessories. Include data and details on door construction,

panel (internal) reinforcement, insulation, and door edge construction. When "custom hollow metal doors" are provided in lieu of "standard steel doors," provide additional details and data sufficient for comparison to SDI/DOOR A250.8 requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Strap knock-down frames in bundles. Provide temporary steel spreaders securely fastened to the bottom of each welded frame. Store doors and frames on platforms under cover in clean, dry, ventilated, and accessible locations, with 1/4 inch airspace between doors. Remove damp or wet packaging immediately and wipe affected surfaces dry. Replace damaged materials with new.

PART 2 PRODUCTS

2.1 STANDARD STEEL DOORS

SDI/DOOR A250.8, except as specified otherwise. Prepare doors to receive door hardware. Doors shall be 1-3/4 inch thick, unless otherwise indicated.2.1.1 Classification - Level, Performance, Model2.1.1.1 Maximum Duty Doors

SDI/DOOR A250.8, Level 4, physical performance Level A, Model 1 with core construction as required by the manufacturer for indicated exterior doors, of size(s) and design(s) indicated. Where vertical stiffener cores are required, the space between the stiffeners shall be filled with mineral board insulation. Provide Level 4 at exterior door locations.2.2 ACCESSORIES

2.2.1 Moldings

Provide moldings around glass of interior and exterior doors and louvers of interior doors. Provide nonremovable moldings on outside of exterior doors and on corridor side of interior doors. Other moldings may be stationary or removable. Secure inside moldings to stationary moldings, or provide snap-on moldings. Muntins shall interlock at intersections and shall be fitted and welded to stationary moldings.

2.3 INSULATION CORES

Insulated cores shall be of type specified, and provide an apparent U-factor of .48 in accordance with SDI/DOOR 113 and shall conform to:

a. Rigid Polyurethane Modified Polyisocyanurate Foam: ASTM C 591, Type I or II, foamed-in-place or in board form, with oxygen index of not less than 22 percent when tested in accordance with ASTM D 2863; or

b. Rigid Polystyrene Foam Board: ASTM C 578, Type I or II; or

c. Mineral board: ASTM C 612, Type I.2.4 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level 1, except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners . Provide steel frames for doors, unless otherwise indicated.

2.4.1 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded.

2.4.2 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated or painted with rust-inhibitive paint, not lighter than 18 gage.

2.4.2.1 Wall Anchors

Provide at least three anchors for each jamb. For frames which are more than 7.5 feet in height, provide one additional anchor for each jamb for each additional 2.5 feet or fraction thereof.

a. Masonry: Provide anchors of corrugated or perforated steel straps or 3/16 inch diameter steel wire, adjustable or T-shaped;

c. Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111; and

2.4.2.2 Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member. Where floor fill occurs, terminate bottom of frames at the indicated finished floor levels and support by adjustable extension clips resting on and anchored to the structural slabs.

2.5 HARDWARE PREPARATION

Provide minimum hardware reinforcing gages as specified in SDI/DOOR A250.6. Drill and tap doors and frames to receive finish hardware. Prepare doors and frames for hardware in accordance with the applicable requirements of SDI/DOOR A250.8 and SDI/DOOR A250.6. For additional requirements refer to BHMA A115. Drill and tap for surface-applied hardware at the project site. Build additional reinforcing for surface-applied hardware into the door at the factory. Locate hardware in accordance with the requirements of SDI/DOOR A250.8, as applicable. Punch door frames , with the exception of frames that will have weatherstripping to receive a minimum of two rubber or vinyl door silencers on lock side of single doors and one silencer for each leaf at heads of double doors. Set lock strikes out to provide clearance for silencers.

2.6 FINISHES

2.6.1 Factory-Primed Finish

All surfaces of doors and frames shall be thoroughly cleaned, chemically

treated and factory primed with a rust inhibiting coating as specified in SDI/DOOR A250.8. , or paintable A25 galvannealed steel without primer. Where coating is removed by welding, apply touchup of factory primer.

2.6.2 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate exteriordoors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A 924/A 924Mand ASTM A 653/A 653M. The coating weight shall meet or exceed the minimum requirements for coatings having 0.4 ounces per square foot, total both sides, i.e., A40. Repair damaged zinc-coated surfaces by the application of zinc dust paint. Thoroughly clean and chemically treat to insure maximum paint adhesion. Factory prime as specified in SDI/DOOR A250.8. Provide for exterior doors.

2.6.3 Electrolytic Zinc-Coated Anchors and Accessories

Provide electrolytically deposited zinc-coated steel in accordance with ASTM A 879/A 879M, Commercial Quality, Coating Class A. Phosphate treat and factory prime zinc-coated surfaces as specified in SDI/DOOR A250.8.

2.7 FABRICATION AND WORKMANSHIP

Finished doors and frames shall be strong and rigid, neat in appearance, and free from defects, waves, scratches, cuts, dents, ridges, holes, warp, and buckle. Molded members shall be clean cut, straight, and true, with joints coped or mitered, well formed, and in true alignment. Dress exposed welded and soldered joints smooth. Design door frame sections for use with the wall construction indicated. Corner joints shall be well formed and in true alignment. Conceal fastenings where practicable. Design frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive calking compound.

2.7.1 Grouted Frames

For frames to be installed in exterior walls and to be filled with mortar or grout, fill the stops with strips of rigid insulation to keep the grout out of the stops and to facilitate installation of stop-applied head and jamb seals.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Frames

Set frames in accordance with SDI/DOOR A250.11. Plumb, align, and brace securely until permanent anchors are set. Anchor bottoms of frames with expansion bolts or powder-actuated fasteners. Build in or secure wall anchors to adjoining construction. Backfill frames with mortar. Coat inside of frames with corrosion-inhibiting bituminous material.

3.1.2 Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.3.2 PROTECTION

Protect doors and frames from damage. Repair damaged doors and frames prior to completion and acceptance of the project or replace with new, as directed. Wire brush rusted frames until rust is removed. Clean thoroughly. Apply an all-over coat of rust-inhibitive paint of the same

type used for shop coat.

3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

-- End of Section --

SECTION 08 33 23

OVERHEAD COILING DOORS
07/07

PART 1 GENERAL

1.1 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 SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2005; Supp 1) Minimum Design Loads for Buildings and Other Structures

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

ASHRAE FUN IP	(2005) Fundamentals Handbook, I-P Edition

ASME INTERNATIONAL (ASME)

ASME B29.400	(2001) Combination, "H" Type Mill Chains, and Sprockets

ASTM INTERNATIONAL (ASTM)

ASTM A 153/A 153M	(2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 27/A 27M	(2005) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A 307	(2007a) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 36/A 36M	(2005) Standard Specification for Carbon Structural Steel
ASTM A 48/A 48M	(2003) Standard Specification for Gray Iron Castings
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 653/A 653M	(2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 780	(2001; R 2006) Standard Practice for Repair of Damaged and Uncoated Areas of

	Hot-Dip Galvanized Coatings
ASTM A 924/A 924M	(2007) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM D 2000	(2006ae1) Standard Classification System for Rubber Products in Automotive Applications
ASTM E 330	(2002) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 84	(2007) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F 568M	(2004) Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; Errata 2002; R 2005; Errata 2006) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 6	(1993; R 2006) Standard for Industrial Controls and Systems Enclosures
NEMA MG 1	(2006; Errata 2007) Standard for Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2007) National Electrical Code

1.2 DESCRIPTION

Overhead coiling doors to be counterbalanced doors by methods of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members. Doors to be coiling type, with interlocking slats, complete with anchoring and door hardware, guides, hood, and operating mechanisms, and designed for use on openings as indicated.

1.3 PERFORMANCE REQUIREMENTS

1.3.1 Wind Loading

Design and fabricate door assembly to withstand the wind loading pressure of at least 20 pounds per square foot with a maximum deflection of 1/120 of the opening width. Provide test data showing compliance with ASTM E 330. Sound engineering principles may be used to interpolate or extrapolate test results to door sizes not specifically tested Complete assembly must meet or exceed the requirements of ASCE 7.

1.3.2 Operational Cycle Life

All portions of the door, hardware and operating mechanism that are subject to movement, wear, or stress fatigue must be designed to operate through a minimum number of 10 cycles per day. One complete cycle of door operation is defined as when the door is in the closed position, moves to the fully open position, and returns to the closed position.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Provide fabrication drawings that show complete assembly with hardware and framing details for the following items:

Overhead Coiling Doors
Counterbalancing Mechanism
Manual Door Operators
Electric Door Operators
Bottom Bar
Guides
Mounting Brackets
Overhead Drum
Hood
Painting

Submit Installation Drawings in accordance with paragraph entitled, "Overhead Coiling Door Assemblies," of this section.

SD-03 Product Data

Submit manufacturer's catalog data for the following items listing all accessories including supports, locks and latches, and weather stripping.

Overhead Coiling Doors
Hardware
Counterbalancing Mechanism
Manual Door Operators
Electric Door Operators

SD-05 Design Data

Submit equipment and performance data for the following items in accordance with the paragraph entitled, "Performance Requirements," of this section.

Overhead Coiling Doors
Hardware
Counterbalancing Mechanism
Manual Door Operators
Electric Door Operators

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies , including the following items:

Materials
Devices
Procedures
Manufacture's Brochures
Parts Lists
Cleaning

1.5 OVERHEAD COILING DOOR DETAIL SHOP DRAWINGS

Provide installation drawings for overhead coiling door assemblies which show elevations of each door type, shape and thickness of materials, finishes, details of joints and connections, and details of guides and fittings, rough opening dimensions, location and description of hardware, anchorage locations, and counterbalancing mechanism and door operator details. Show locations of replaceable fusible links wiring diagrams for power, signal and controls. Include a schedule showing the location of each door with the drawings.

Contractor must submit 6 copies of the Operation and Maintenance Manuals 30 calendar days prior to testing the Overhead Coiling Door Assemblies. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

Provide operation and maintenance manuals which are consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Provide test data that is legible and of good quality.

1.6 WARRANTY, OPERATION AND MAINTENANCE DATA

Submit Operation and Maintenance Manuals for Overhead Coiling Door Assemblies, including the following items:

Materials
Devices
Manual Door Operators
Electric Door Operators
Hood
Counterbalancing Mechanism
Painting
Procedures
Manufacture's Brochures

Parts Lists

Contractor must furnish a written guarantee that the helical spring and counterbalance mechanism are free from defects in material and workmanship and that they will remain so for not less than two years after completion and acceptance of the project.

Contractor must warrant that upon notification by the Government, he will immediately make good any defects in material, workmanship, and door operation within the same time period covered by the guarantee, at no cost to the Government.

1.7 DELIVERY AND STORAGE

Delivered doors to the jobsite wrapped in a protective covering with the brands and names clearly marked thereon. Store doors in a dry location that is adequately ventilated and free from dirt and dust, water, and other contaminants, and in a manner that permits easy access for inspection and handling.

PART 2 PRODUCTS

2.1 OVERHEAD COILING DOORS

2.1.1 Curtain Materials and Construction

Fabricate doors from interlocking cold-rolled slats, with section profiles as specified, designed to withstand the specified wind loading. Provide slats which are continuous without splices for the width of the door.

Provide slats filled with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within slat faces on interior surface of slats.

2.1.2 Insulated Curtains

Form Curtains from manufacturer's standard shapes of interlocking slats. Supply slat system with a minimum R-value of 4 when calculated in accordance with ASHRAE FUN IP. Slats to consist of a polystyrene core not less than 11/16 inch thick, completely enclosed within metal facings. Exterior face of slats must be the same gauge as specified for curtains. Interior face must be not lighter than 0.0219 inches. The insulated slat assembly is to have a flame spread rating of not more than 25 and a smoke development factor of not more than 50 when tested in accordance with ASTM E 84.

2.1.3 Curtain Bottom Bar

Curtain bottom bars must be pairs of angles from the manufacturer's standard steel, stainless and aluminum extrusions not less than 2.0 by 2.0 inches by 0.188 inch. Steel extrusions must conform to ASTM A 36/A 36M. Stainless steel extrusions conforming to ASTM A 666, Type 304. Aluminum extrusions conforming to ASTM B 221 or(ASTM B 221M). Galvanize angles and fasteners in accordance with ASTM A 653/A 653M and ASTM A 924/A 924M. Coat welds and abrasions with paint conforming to ASTM A 780.

2.1.4 Locks

Provide end and/or wind locks of cast steel conforming to ASTM A 27/A 27M, Grade B; galvanized in accordance with ASTM A 653/A 653M, ASTM A 153/A 153M and ASTM A 924/A 924M and secured at every other curtain slat.

2.1.5 Weather Stripping

Weather-stripping at the door-head and jamb must be 3.2 millimeter 1/8-inch thick sheet of natural or neoprene rubber with air baffles, secured to the insides of hoods with galvanized-steel fasteners through continuous galvanized-steel pressure bars at least 15.9 millimeter 5/8-inch wide and 3.2 millimeter 1/8-inch thick.

Threshold weather-stripping must be 3.2 millimeter 1/8-inch thick sheet natural or neoprene rubber secured to the bottom bars.

Provide weather-stripping of natural or neoprene rubber conforming to ASTM D 2000.

2.1.6 Locking Devices

Slide Bolt to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

Locking Device Assembly which includes cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

2.1.7 Safety Interlock

Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.1.8 Overhead Drum

Fabricate drums from nominal 0.028-inch- (0.71-mm-) thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.

2.2 HARDWARE

All hardware must conform to ASTM A 153/A 153M, ASTM A 307, ASTM F 568M, and ASTM A 27/A 27M.

2.2.1 Guides

Fabricate curtain jamb guides from the manufacturer's standard angles or channels of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for track adjustment.

2.2.2 Equipment Supports

Fabricate door-operating equipment supports from the manufacturer's standard steel shapes and plates conforming to ASTM A 36/A 36M, galvanized in accordance with ASTM A 653/A 653M and ASTM A 924/A 924M. Size the

shapes and plates in accordance with the industry standards for the size, weight, and type of door installation..

2.3 COUNTERBALANCING MECHANISM

Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed or self-lubricating bearings for rotating members.

2.3.1 Brackets

Provide the manufacturer's standard mounting brackets of either cast iron or cold-rolled steel with one located at each end of the counterbalance barrel conforming to ASTM A 48/A 48M.

2.3.2 Counterbalance Barrels

Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, conforming to ASTM A 53/A 53M, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 2.5 mm per meter 0.03 inch per foot of span under full load.

2.3.3 Spring Balance

One or more oil-tempered, heat-treated steel helical torsion springs installed within the barrel capable of producing sufficient torque to assure easy operation of the door curtain. Provide and size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

2.3.4 Torsion Rod for Counter Balance

Fabricate rod from the manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

2.4 ELECTRIC DOOR OPERATORS

Provide electrical wiring and door operating controls conforming to the applicable requirements of NFPA 70.

Electric door-operator assemblies must be the sizes and capacities recommended and provided by the door manufacturer for specified doors. Assemblies must be complete with electric motors and factory-prewired motor controls, starter, gear reduction units, solenoid-operated brakes, clutch, remote-control stations, manual or automatic control devices, and accessories as required for proper operation of the doors.

Design the operators so that motors may be removed without disturbing the limit-switch adjustment and affecting the emergency auxiliary operators.

Provide a manual operator of crank-gear or chain-gear mechanisms with a release clutch to permit manual operation of doors in case of power failure. Arrange the emergency manual operator so that it may be put into

and out of operation from floor level, and its use will not affect the adjustment of the limit switches. Provide an electrical or mechanical device which will automatically disconnect the motor from the operating mechanism when the emergency manual operating mechanism is engaged.

2.4.1 Door-Operator Types

Provide an operator which is mounted to the right or left door head plate with the operator on top of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Headroom is required for this type of mounting.

2.4.2 Electric Motors

Provide motors which are the high-starting-torque, reversible, constant-duty electrical type with overload protection of sufficient torque and horsepower to move the door in either direction from any position and produce a door-travel speed of not less than 8 nor more than 12 inches per second without exceeding the horsepower rating.

Provide motors which conform to NEMA MG 1 designation, temperature rating, service factor, enclosure type, and efficiency to the requirements specified.

2.4.3 Motor Bearings

Bearings must be bronze-sleeve or heavy-duty ball or roller antifriction type with full provisions for the type of thrust imposed by the specific duty load.

Pre-lubricate and factory seal bearings in motors less than 1/2 horsepower.

Equip motors coupled to worm-gear reduction units with either ball or roller bearings.

Equip bearings in motors 1/2 horsepower or larger with lubrication service fittings. Fit lubrication fittings with color-coded plastic or metal dust caps.

In any motor, bearings that are lubricated at the factory for extended duty periods do not need to be lubricated for a given number of operating hours. Display this information on an appropriate tag or label on the motor with instructions for lubrication cycle maintenance.

2.4.4 Motor Starters, Controls, and Enclosures

Each door motor must have a factory-wired, unfused, disconnect switch; a reversing, across-the-line magnetic starter with thermal overload protection; 120-volt operating coils with a control transformer limit switch; and a safety interlock assembled in a NEMA ICS 6 type enclosure as specified herein. Control equipment must conform to NEMA ICS 2.

Provide adjustable switches, electrically interlocked with the motor controls and set to stop the door automatically at the fully open and fully closed position.

2.4.5 Control Enclosures

Provide control enclosures that conform to NEMA ICS 6 for general purpose

NEMA Type 1.

2.4.6 Safety-Edge Device

Provide each door with a pneumatic safety device extending the full width of the door and located within a U-section neoprene or rubber astragal mounted on the bottom rail of the bottom door section. Device must immediately stop and reverse the door upon contact with an obstruction in the door opening during downward travel and cause the door to return to full-open position. Safety device is not a substitute for a limit switch.

Connect safety device to the control circuit through a retracting safety cord and reel.

2.4.7 Remote-Control Stations

Provide interior remote control stations which are full-guarded, momentary-contact three-button, heavy-duty, surface-mounted NEMA ICS 6 type enclosures as specified. Mark buttons "OPEN," "CLOSE," and "STOP." The "CLOSE" button must be the type requiring a constant pressure to maintain the closing motion of the door. When the door is in motion and the "STOP" button is pressed, the door must stop instantly and remain in the stopped position; from the stopped position, the door may then be operated in either direction.

2.4.8 Speed-Reduction Units

Provide speed-reduction units consisting of hardened-steel worm and bronze worm gear assemblies running in oil or grease and encased in a sealed casing, coupled to the motor through a flexible coupling. Drive shafts must rotate on ball- or roller-bearing assemblies that are integral with the unit.

Provide minimum ratings of speed reduction units which are in accordance with AGMA provisions for class of service.

Ground worm gears to provide accurate thread form; machine teeth for all other types of gearing. Surface harden all gears.

Provide bearings which are the antifriction type equipped with oil seals.

2.4.9 Chain Drives

Provide roller chains that are power-transmission series steel roller type conforming to ASME B29.400, with a minimum safety factor of 10 times the design load.

Roller-chain side bars, rollers, pins, and bushings must be heat-treated or otherwise hardened.

Provide chain sprockets that are high-carbon steel with machine-cut hardened teeth, finished bore and keyseat, and hollow-head setscrews.

2.4.10 Brakes

Provide brakes which are 360-degree shoe brakes or shoe and drum brakes, solenoid-operated and electrically interlocked to the control circuit to set automatically when power is interrupted.

2.4.11 Clutches

Clutches must be the 4-inch diameter, multiple face, externally adjustable friction type or adjustable centrifugal type.

2.5 SURFACE FINISHING

Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Noticeable variations in the same metal component are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

PART 3 EXECUTION

3.1 GENERAL

Install overhead coiling door assembly, anchors and inserts for guides, brackets, motors, switches, hardware, and other accessories in accordance with approved detail drawings and manufacturer's written instructions. Upon completion of installation, doors must be free from all distortion.

Install overhead coiling doors, motors, hoods, and operators at the mounting locations as indicated for each door in the contract documents and as required by the manufacturer.

Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility and as required by the manufacturer.

3.2 FACTORY FINISH

Coling doors and frames which are to be factory finshed with a powder coat paint. Color to be selected from available standard colors. Protect weather stripping from paint. Finishes must be free of scratches or other blemishes.

3.3 ACCEPTANCE PROVISIONS

After installation, adjust hardware and moving parts. Lubricate bearings and sliding parts as recommended by manufacturer to provide smooth operating functions for ease movement, free of warping, twisting, or distortion of the door assembly.

Adjust seals to provide weather-tight fit around entire perimeter.

Engage a factory-authorized service representative to perform startup service and checks according to manufacturer's written instructions.

Test the door opening and closing operation when activated by controls or alarm-connected fire-release system. Adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Reset door-closing mechanism after successful test.

Test and make final adjustment of new doors at no additional cost to the Government.

3.3.1 Maintenance and Adjustment

Not more than 90 calendar days after completion and acceptance of the project, the Contractor must examine, lubricate, test, and re-adjust doors as required for proper operation.

3.3.2 CLEANING

Clean doors in accordance with manufacturer's approved instructions.

-- End of Section --

SECTION 08 51 13

ALUMINUM WINDOWS
01/08

PART 1 GENERAL

1.1 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.

ALUMINUM ASSOCIATION (AA)

AA DAF-45	(2003) Designation System for Aluminum Finishes

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 101	(2005) Standard Specification for Windows, Doors, and Unit Skylights
AAMA 1503	(1998) Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
AAMA 611	(1998) Voluntary Specification for Anodized Architectural Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM B 117	(2007a) Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM B 244	(1997; R 2002) Standard Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments
ASTM E 283	(2004) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E 330	(2002) Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 331	(2000) Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

GREEN SEAL (GS)

GS-36	(2000) Commercial Adhesives

NATIONAL FENESTRATION RATING COUNCIL (NFRC)

NFRC 100	(2004) Procedure for Determining Fenestration Product U-Factors

NATIONAL WOOD WINDOW AND DOOR ASSOCIATION (NWWDA)

AAMA/NWWDA 101/I.S.2	(1997) Voluntary Guide Specifications for Aluminum, Poly(Vinyl Chloride)(PVC) and Wood Windows and Glass Doors

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 101	(1982) Paint Specification No. 101 Aluminum Alkyd Paint Leafing (Type I) and Non-Leafing (Type II)
SSPC Paint 12	(1982; E 2000) Paint Specification No. 12 Cold-Applied Asphalt Mastic (Extra Thick Film)

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.2 CERTIFICATION

Each prime window unit must bear the AAMA Label warranting that the product complies with AAMA 101. Certified test reports attesting that the prime window units meet the requirements of AAMA 101, including test size, will be acceptable in lieu of product labeling.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Windows; G

SD-03 Product Data

Windows; G

Fasteners; G; (LEED)

Aluminum Windows; G

Frames; G

Aluminum Sills; G

THERMAL-BARRIER WINDOWS; G

MULLIONS; G

Weatherstripping; G

Windows

Submit documentation for Energy Star qualifications.

SD-04 Samples

Finish Sample

Window Sample

SD-05 Design Data

Structural calculations for deflection; G

Design Analysis; G

SD-06 Test Reports

Minimum condensation resistance factor

SD-10 Operation and Maintenance Data

Windows, Data Package 1; G

1.4 QUALITY ASSURANCE

1.4.1 Shop Drawing Requirements

Provide drawings that indicate elevations of windows, full-size sections, thickness and gages of metal, fastenings, proposed method of anchoring, size and spacing of anchors, details of construction, method of glazing, , mullion details, material and method of attaching subframes, trim, installation details, and other related items.

1.4.2 Sample Requirements

1.4.2.1 Finish Sample Requirements

Submit color chart of standard factory color coatings when factory-finish color coating is to be provided.

1.4.3 Test Report Requirements

Submit test reports for each type of window attesting that identical windows have been tested and meet the requirements specified herein for conformance to AAMA 101 including test size, and minimum condensation resistance factor (CRF), and resistance to forced entry.

1.5 DELIVERY AND STORAGE

Deliver windows to project site in an undamaged condition. Use care in handling and hoisting windows during transportation and at the jobsite. Store windows and components out of contact with the ground, under a weathertight covering, so as to prevent bending, warping, or otherwise damaging the windows. Repair damaged windows to an "as new" condition as approved. If windows can not be repaired, provide a new unit.

1.6 PROTECTION

Protect finished surfaces during shipping and handling using the manufacturer's standard method. Do not apply coatings or lacquers to surfaces to which calking and glazing compounds must adhere.

1.7 FIELD MEASUREMENTS

Take field measurements prior to preparation of the drawings and fabrication.

1.8 PERFORMANCE REQUIREMENTS

1.8.1 Wind Loading Design Pressure

Design window components, including mullions, hardware, and anchors, to withstand a wind-loading design pressure of at least 20 pounds per square foot (psf).

1.8.2 Tests

Test windows proposed for use in accordance with AAMA/NWWDA 101/I.S.2 for the particular type and quality window specified.

Perform tests by a nationally recognized independent testing laboratory equipped and capable of performing the required tests. Submit the results of the tests as certified laboratory reports required herein.

Minimum design load for a uniform-load structural test must be 50 psf.

1.9 WINDOW PERFORMANCE

Aluminum windows must meet the following performance requirements. Perform testing requirements by an independent testing laboratory or agency.

1.9.1 Structural Performance

Structural test pressures on window units must be for positive load (inward) and negative load (outward) in accordance with ASTM E 330. After testing, there will be no glass breakage, permanent damage to fasteners, hardware parts, support arms or actuating mechanisms or any other damage which could cause window to be inoperable. There must be no permanent deformation of any main frame, sash or ventilator member in excess of the requirements established by AAMA 101 for the window types and classification specified in this section.

1.9.2 Air Infiltration

Air infiltration must not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 283.

1.9.3 Water Penetration

Water penetration must not exceed the amount established by AAMA 101 for each window type when tested in accordance with ASTM E 331.

1.9.4 Thermal Performance

Thermal transmittance for thermally broken aluminum windows with insulating glass must not exceed a U-factor of 0.35 Btu/hr-ft^2-F determined according to NFRC 100. Provide window units that comply with the U.S. Department of Energy, Energy Star Window Program for the Northern Climate Zone.

1.9.5 Condensation Index Rating

The condensation index rating must be 85as determined using NFRC approved software THERM.

1.10 QUALIFICATION

Window manufacturer must specialize in designing and manufacturing the type of aluminum windows specified in this section, and have a minimum of 3 years of documented successful experience. Manufacturer must have the facilities capable of meeting contract requirements, single-source responsibility and warranty.

1.11 WARRANTY

Provide Manufacturer's standard performance guarantees or warranties that extend beyond a 1 year period.

PART 2 PRODUCTS

2.1 WINDOWS

Windows design is based on a Kawneer AA900 ISOWEB as basis of design.

Provide windows that comply with AAMA 101 and the requirements specified herein. In addition to compliance with AAMA 101, window framing members for each individual lite of glass must not deflect to the extent that deflection perpendicular to the glass lite exceeds L/175 of the glass edge length when subjected to uniform loads at specified design pressures. Provide Structural calculations for deflection to substantiate compliance with deflection requirements. Provide windows of types, performance classes, performance grades, combinations, and sizes indicated or specified. Design windows to accommodate hardware, glass, weatherstripping, screens, and accessories to be furnished. Each window must be a complete factory assembled unit with or without glass installed. Dimensions shown are minimum. Provide windows with insulating glass and thermal break necessary to achieve a minimum Condensation Resistance Factor (CRF)when tested in accordance with AAMA 1503.

2.1.1 Fixed Windows (F)

Type F-HC40.

2.1.2 Glass and Glazing

Materials are specified in Section 08 81 00 GLAZING.

2.1.3 Calking and Sealing

Are specified in Section 07 92 00 JOINT SEALANTS.

2.1.4 Weatherstripping

AAMA 101.

2.2 FABRICATION

Fabrication of window units must comply with AAMA 101.

2.2.1 Provisions for Glazing

Design windows and rabbets suitable for glass thickness shown . .

2.2.2 Weatherstripping

Provide for ventilating sections of all windows to ensure a weather-tight seal meeting the infiltration requirements specified in AAMA 101. Provide easily replaceable factory-applied weatherstripping. Use molded vinyl, molded or molded-expanded neoprene or molded or expanded Ethylene Propylene Diene Terpolymer (EPDM) compression-type weatherstripping for compression contact surfaces. Use treated woven pile or wool, or polypropylene or nylon pile bonded to nylon fabric and metal or plastic backing strip weatherstripping for sliding surfaces. Do no use neoprene or polyvinylchloride weatherstripping where they will be exposed to direct sunlight.

2.2.3 Fasteners

Fabricated from 100 percent re-melted steel. Use fasteners as standard with the window manufacturer for windows, trim, and accessories. Self-tapping sheet-metal screws are not acceptable for material more than 1/16 inch thick.

2.2.4 Adhesives

Comply with applicable regulations regarding toxic and hazardous materials, GS-36, , and as specified in Section 07 92 00 JOINT SEALANTS.

2.2.5 Drips and Weep Holes

Provide continuous drips over heads of top ventilators. Where fixed windows adjoin ventilators, drips must be continuous across tops of fixed windows. Provide drips and weep holes as required to return water to the outside.

2.2.6 Combination Windows

Windows used in combination must be the same class and grade and will be factory assembled. Where factory assembly of individual windows into larger units is limited by transportation considerations, prefabricate, match mark, transport, and field assemble.

2.2.7 Accessories

Provide windows complete with necessary hardware, fastenings, clips, fins,

anchors, glazing beads, and other appurtenances necessary for complete installation and proper operation. Furnish extruded aluminum subframe receptors and subsill with each window unit.

2.2.7.1 Fasteners

Provide concealed anchors of the type recommended by the window manufacturer for the specific type of construction. Anchors and fasteners must be compatible with the window and the adjoining construction. Provide a minimum of three anchors for each jamb located approximately 6 inches from each end and at midpoint.

2.2.7.2 Window Anchors

Anchoring devices for installing windows must be made of aluminum, cadmium-plated steel, stainless steel, or zinc-plated steel conforming to AAMA 101.

2.2.8 Finishes

Exposed aluminum surfaces must be factory finished with an anodic coating. Color must be as indicated. All windows for each building will have the same finish.

2.2.8.1 Anodic Coating

Clean exposed aluminum surfaces and provide an anodized finish conforming to AA DAF-45 and AAMA 611. Finish must be:

b. Architectural Class I (0.7 mil or thicker), designation AA-M10-C22-A41, clear (natural) anodized.

2.3 THERMAL-BARRIER WINDOWS

Provide thermal-barrier windows, complete with accessories and fittings, where indicated.

Specify material and construction except as follows:

a. Aluminum alloy must be 6063-T6.

b. Frame construction, must be factory-assembled and factory-sealed inner and outer aluminum completely separated from metal-to-metal contact. Join assembly by a continuous, concealed, low conductance divider housed in an interlocking extrusion of the inner frame. Metal fasteners, straps, or anchors will not bridge the connection between the inner and outer frame.

c. Operating hardware for each sash must consist of spring-loaded nylon cushion blocks and pin locks designed to lock in predetermined locations.

d. Sash must be completely separated from metal-to-metal contact by means of woven-pile weatherstripping, plastic, or elastomeric separation members.

e. Operating and storm sash will be factory-glazed with the type of glass indicated and of the quality specified in Section 08 81 00 GLAZING.

2.4 MULLIONS

Provide mullions between multiple-window units where indicated.

Mullions and mullion covers must be the profile indicated, reinforced as required for the specified wind loading, and securely anchored to the adjoining construction. Mullion extrusion will include serrations or pockets to receive weatherstripping, sealant, or tape at the point of contact with each window flange.

Mullion assembly must include aluminum window clamps or brackets screwed or bolted to the mullion and the mullion cover.

Mullion cover must be screw-fastened to the mullion unless otherwise indicated.

Mullion reinforcing members must be steel or aluminum shapes provided by the window manufacturer to meet the specified design loading.

2.5 FINISH

Aluminum window, glazing beadings, trim, and accessory fittings must be thoroughly cleaned and will receive an Architectural Class I natural anodic coating (designation AA-M-12C22A41) in accordance with AA DAF-45. Anodic-coating thickness must be not less than 0.7 mil.

Test the thickness of the anodic coating in accordance with ASTM B 244.

Anodic coating must be continuous and, without being lacquered, will be capable of withstanding 500 hours of salt-spray exposure for Class A anodic coatings and 250 hours of salt-spray exposure for Class B anodic coatings when tested in accordance with ASTM B 117.

2.5.1 Anodized Aluminum Finish

Finish exposed surfaces of aluminum windows with anodic coating conforming to AA DAF-45: Architectural Class II, AA-M10-C22-A31, clear anodic coating, 0.4 to 0.8 mil thick, 204-R1 Natural Color. Finish must be free of scratches and other blemishes.

2.5.2 Color

Color must beas indicated on the drawings.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Method of Installation

Install in accordance with the window manufacturer's printed instructions and details. Build in windows as the work progresses or install without forcing into prepared window openings. Set windows at proper elevation, location, and reveal; plumb, square, level, and in alignment; and brace, strut, and stay properly to prevent distortion and misalignment. Protect ventilators and operating parts against accumulation of dirt and building materials by keeping ventilators tightly closed and locked to frame. Bed screws or bolts in sill members, joints at mullions, contacts of windows

with sills, built-in fins, and subframes in mastic sealant of a type recommended by the window manufacturer. Install and caulk windows in a manner that will prevent entrance of water and wind. Fasten insect screens securely in place.

3.1.2 Dissimilar Materials

Where aluminum surfaces are in contact with, or fastened to masonry, concrete, wood, or dissimilar metals, except stainless steel or zinc, protect the aluminum surfacefrom dissimilar materials as recommended in the Appendix to AAMA 101. Do not coat surfaces in contact with sealants after installation with any type of protective material.

3.1.3 Anchors and Fastenings

Make provision for securing units to each other, to masonry, and to other adjoining construction. Windows installed in masonry walls must have head and jamb members designed to recess into masonry wall not less than 7/16 inch.

3.2 DISSIMILAR MATERIALS

Aluminum must be kept from direct contact with steel or other dissimilar materials by painting, nonabsorptive tape, gasket, or other approved system as recommended by the manufacturer and as specified.

Give aluminum surfaces in contact with steel one coat of zinc-chromate primer applied to a dry-film thickness of not less than 1.5 mils, or one coat of a suitable nonhardening joint compound capable of excluding moisture from the joint during prolonged service.

Give steel surfaces in contact with aluminum one coat of zinc-chromate paint applied to a dry-coat thickness of 1.5 mils, and two or more coats of aluminum paint conforming to SSPC Paint 101, aluminum alkyd, Type II, applied to a dry-film thickness of 1.5 mils for each coat and a total dry-film thickness of 3.0 mils.

Corrosion-resistant, aluminized, or hot-dip galvanized steel placed in contact with aluminum need not be painted.

Give aluminum surfaces placed in contact with wood, concrete, or masonry construction one coat of bituminous paint conforming to SSPC Paint 12, applied to a thickness of at least 1/16 inch.

3.3 CLEANING

Clean interior and exterior surfaces of window units of mortar, plaster, paint spattering spots, and other foreign matter to present a neat appearance, to prevent fouling of weathering surfaces and weather-stripping, and to prevent interference with the operation of hardware. Replace all stained, discolored, or abraded windows that cannot be restored to their original condition with new windows.

3.4 WASTE MANAGEMENT

Separate corrugated cardboard and protective materials in accordance with the Waste Management Plan and place in designated areas for reuse or recycling. Place materials defined as hazardous or toxic waste in designated containers. Close and seal tightly all partly used sealant

containers and store protected in well ventilated fire-safe area at moderate temperature. Place used sealant tubes and containers in areas designated for hazardous materials.

-- End of Section --

SECTION 08 71 00

DOOR HARDWARE
04/07

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM E 283	(2004) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

BHMA A156.1	(2006) Butts and Hinges
BHMA A156.13	(2005) Mortise Locks & Latches, Series 1000
BHMA A156.16	(2002) Auxiliary Hardware
BHMA A156.18	(2006) Materials and Finishes
BHMA A156.21	(2006) Thresholds
BHMA A156.22	(2005) Door Gasketing and Edge Seal Systems
BHMA A156.4	(2000) Door Controls - Closers
BHMA A156.6	(2005) Architectural Door Trim
BHMA A156.7	(2003) Template Hinge Dimensions

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2006) Life Safety Code, 2006 Edition
NFPA 80	(2006) Standard for Fire Doors and Other Opening Protectives

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8	(2003) Recommended Specification for Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir	(2006) Building Materials Directory

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

Hardware schedule; G

Keying system

SD-03 Product Data

Hardware items; G

SD-08 Manufacturer's Instructions

Installation

SD-10 Operation and Maintenance Data

Hardware Schedule items, Data Package 1; G

SD-11 Closeout Submittals

Key Bitting

1.3 HARDWARE SCHEDULE

Prepare and submit hardware schedule in the following form:

Hardware Item	Quantity	Size	Reference Publication Type No.	Finish	Mfr. Name and Catalog No.	Key Control Symbols	UL Mark (If fire rated and listed)	BHMA Finish Designation

1.4 KEY BITTING CHART REQUIREMENTS

Submit key bitting charts to the Contracting Officer prior to completion of the work. Include:

a. Complete listing of all keys (AA1, AA2, etc.).

b. Complete listing of all key cuts (AA1-123456, AA2-123458).

c. Tabulation showing which key fits which door.

d. Copy of floor plan showing doors and door numbers.

e. Listing of 20 percent more key cuts than are presently required in each master system.

1.5 QUALITY ASSURANCE

1.5.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, and closers of one lock, hinge, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

1.6 DELIVERY, STORAGE, AND HANDLING

Deliver hardware in original individual containers, complete with necessary appurtenances including fasteners and instructions. Mark each individual container with item number as shown in hardware schedule. Deliver permanent keys and removable cores to the Contracting Officer, either directly or by certified mail. Deliver construction master keys with the locks.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

Provide hardware to be applied to metal or to prefinished doors manufactured to template. Promptly furnish template information or templates to door and frame manufacturers. Conform to BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

Provide all hardware necessary to meet the requirements of NFPA 80 for fire doors and NFPA 101 for exit doors, as well as to other requirements indicated, even if such hardware is not specifically mentioned under paragraph entitled "Hardware Schedule." Provide the label of Underwriters Laboratories, Inc. for such hardware listed in UL Bld Mat Dir or labeled and listed by another testing laboratory acceptable to the Contracting Officer.

2.3 HARDWARE ITEMS

Clearly and permanently mark with the manufacturer's name or trademark, hinges, pivots, locks, latches, exit devices, bolts and closers where the identifying mark will be visible after the item is installed. For closers with covers, the name or trademark may be beneath the cover.

2.3.1 Hinges

BHMA A156.1, 4-1/2 by 4-1/2 inch unless otherwise indicated. Construct loose pin hinges for exterior doors and reverse-bevel interior doors so that pins will be nonremovable when door is closed. Other antifriction bearing hinges may be provided in lieu of ball-bearing hinges.

2.3.2 Locks and Latches

2.3.2.1 Mortise Locks and Latches

BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2. Provide mortise locks with escutcheons not less than 7 by 2-1/4 inch with a bushing at least 1/4 inch long. Cut escutcheons to suit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges.

Install knobs and roses of mortise locks with screwless shanks and no exposed screws.

2.3.3 Keying System

Provide cylinders, permanent cores and two (2) keys for each new lockset, including locks provided under other sections of this specification. Provide cylinders and cores with seven pin tumblers. Provide cylinders and cores from products of one manufacturer. Mortise cylinders have interchangeable cores, which are removable by special control keys.

The Government will provide the Contractor with a keying schedule identifying the key way code numbers for each lockset. The Contractor shall provide the cores and keys with the associated key way code number marks. The Contractor shall deliver the marked cores and keys to the Government COTR in an enclosed package. The Government Security Office will install the permanent cores in the new locksets.

2.3.4 Lock Trim

Cast, forged, or heavy wrought construction and commercial plain design.

2.3.4.1 Lever Handles

Provide lever handles in lieu of knobs where indicated in paragraph entitled "Hardware Schedule". Conform to the minimum requirements of BHMA A156.13 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when force in excess of that specified in BHMA A156.13 is applied to the lever handle. Provide lever handles return to within 1/2 inch of the door face.

2.3.5 Closers

BHMA A156.4, Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, and other features necessary for the particular application. Size closers in accordance with manufacturer's recommendations, or provide multi-size closers, Sizes 1 through 6, and list sizes in the Hardware Schedule. Provide manufacturer's 10 year warranty.

2.3.5.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation located to be visible after installation.

2.3.6 Door Protection Plates

BHMA A156.6.

2.3.6.1 Sizes of Armor and Kick Plates

2 inch less than door width for single doors; one inch less than door width for pairs of doors. Provide a minimum 36inch armor plates for flush doors.

2.3.7 Door Stops and Silencers

BHMA A156.16. Silencers Type L03011. Provide three silencers for each

single door, two for each pair.2.3.8 Thresholds

BHMA A156.21. Use J35100, with vinyl or silicone rubber insert in face of stop, for exterior doors opening out, unless specified otherwise.

2.3.9 Weather Stripping Gasketing

BHMA A156.22. Provide the type and function designation where specified in paragraph entitled "Hardware Schedule". Provide a set to include head and jamb seals, sweep strips,. Air leakage of weather stripped doors not to exceed 0.5cubic feet per minute of air per square foot of door area when tested in accordance with ASTM E 283. Provide weather stripping with one of the following:2.3.9.1 Extruded Aluminum Retainers

Extruded aluminum retainers not less than 0.050 inch wall thickness with vinyl, neoprene, silicone rubber, or polyurethane inserts. Provide clear (natural) anodized aluminum.2.3.10 Rain Drips

Extruded aluminum, not less than 0.08 inch thick, clear anodized. Set drips in sealant and fasten with stainless steel screws.

2.3.10.1 Door Rain Drips

Approximately 1-1/2 inch high by 5/8 inch projection. Align bottom with bottom edge of door.2.3.11 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, required to service and adjust hardware items.

2.4 FASTENERS

Provide fasteners of proper type, quality, size, quantity, and finish with hardware. Provide stainless steel or nonferrous metal fasteners that are exposed to weather. Provide fasteners of type necessary to accomplish a permanent installation.

2.5 FINISHES

BHMA A156.18. Provide hardware in BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except finish for surface door closers, and except BHMA 652 finish (satin chromium plated) for steel hinges. Provide hinges for exterior doors in stainless steel with BHMA 630 finish or chromium plated brass or bronze with BHMA 626 finish. Furnish exit devices in BHMA 626 finish in lieu of BHMA 630 finish . Match exposed parts of concealed closers to lock and door trim. Match hardware finish for aluminum doors to the doors.

PART 3 EXECUTION

3.1 INSTALLATION

Install hardware in accordance with manufacturers' printed installation instructions. Fasten hardware to wood surfaces with full-threaded wood screws or sheet metal screws. Provide machine screws set in expansion shields for fastening hardware to solid concrete and masonry surfaces. Provide toggle bolts where required for fastening to hollow core construction. Provide through bolts where necessary for satisfactory installation.

3.1.1 Weather Stripping Installation

Handle and install weather stripping to prevent damage. Provide full contact, weather-tight seals. Operate doors without binding.

3.1.2 Installation

Install as specified for stop-applied weather stripping.

3.1.3 Threshold Installation

Extend thresholds the full width of the opening and notch end for jamb stops. Set thresholds in a full bed of sealant and anchor to floor with cadmium-plated, countersunk, steel screws in expansion sleeves.

3.2 HARDWARE LOCATIONS

SDI/DOOR A250.8, unless indicated or specified otherwise.

3.3 FIELD QUALITY CONTROL

After installation, protect hardware from paint, stains, blemishes, and other damage until acceptance of work. Submit notice of testing 15 days before scheduled, so that testing can be witnessed by the Contracting Officer. Adjust hinges, locks, latches, bolts, holders, closers, and other items to operate properly. Demonstrate that permanent keys operate respective locks, and give keys to the Contracting Officer. Correct, repair, and finish, as directed, errors in cutting and fitting and damage to adjoining work.

3.4 HARDWARE SETS

Provide hardware for aluminum doors under this section. Deliver Hardware templates and hardware, except field-applied hardware to the aluminum door and frame manufacturer for use in fabricating the doors and frames.

Provide hardwarefor hollow metal & wood doors under this section. Deliver Hardware templates and hardware, except field-applied hardware to the door and frame manufacturer for use in fabricating the doors and frames. Key door 112 key switch to match lockset Best 7 pin.

Hardware Set no. 1 Single door, 3'-0" x 7'-0" opening, RHR Swing
Door 113B,

Butt hinges	1-1/2 pair	41/2" x 41/2" BB1168 x 626	Hagar
Lockset	1 each	45H-7Rx15H std x 626	Best
Cylinder	1 each	1E-74 x 626 x 7-pin core	Best
Armor plate	1 each	36"x 34"x 0.050 inch x 630	Burns
Silencers	3 each	608 gray	Rockwood
Threshold	1 each	425E	National Guard
Weather Strip	1 set	5050	National Guard
Door Sweep	1 each	600A	National Guard
Elec. Strike	1 each	6212 FSE 24VDC	Von Duprin
Rain Shield	1 each	17D	National Guard
Closer	1 each	1074	LCN

-- End of Section --

SECTION 08 81 00

GLAZING
08/08

PART 1 GENERAL

1.1 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 Z97.1	(2004) Safety Glazing Materials Used in Buildings

ASTM INTERNATIONAL (ASTM)

ASTM C 1036	(2006) Standard Specification for Flat Glass
ASTM C 1048	(2004) Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass
ASTM C 509	(2006) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C 864	(2005) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 2287	(1996; R 2001) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM D 395	(2003) Standard Test Methods for Rubber Property - Compression Set
ASTM E 1300	(2007e1) Determining Load Resistance of Glass in Buildings
ASTM E 773	(2001) Accelerated Weathering of Sealed Insulating Glass Units
ASTM E 774	(1997) Classification of the Durability of Sealed Insulating Glass Units

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2004) Glazing Manual
GANA Sealant Manual	(1990) Sealant Manual

GANA Standards Manual	(2001) Tempering Division's Engineering Standards Manual

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

IGMA TB-3001	(1990) Guidelines for Sloped Glazing
IGMA TM-3000	(1997) Glazing Guidelines for Sealed Insulating Glass Units
IGMA TR-1200	(1983) Commercial Insulating Glass Dimensional Tolerances

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

16 CFR 1201	Safety Standard for Architectural Glazing Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

Drawings showing complete details of the proposed setting methods, mullion details, edge blocking, size of openings, frame details, materials, and types and thickness of glass.

SD-03 Product Data

Glazing Accessories

Manufacturer's descriptive product data, handling and storage recommendations, installation instructions, and cleaning instructions.

SD-04 Samples

Insulating Glass

Sealant

Two 8 x 10 inch samples of each of insulating glass units.

SD-07 Certificates

Certificates stating that the glass meets the specified requirements. Labels or manufacturers marking affixed to the glass will be accepted in lieu of certificates.

Glazing Accessories

Certificates from the manufacturer attesting that the units meet the luminous and solar radiant transmission requirements for heat absorbing glass.

SD-08 Manufacturer's Instructions

Setting and sealing materials

Glass setting

Submit glass manufacturer's recommendations for setting and sealing materials and for installation of each type of glazing material specified.

1.3 SYSTEM DESCRIPTION

Glazing systems shall be fabricated and installed watertight and airtight to withstand thermal movement and wind loading without glass breakage, gasket failure, deterioration of glazing accessories, and defects in the work. Glazed panels shall comply with the safety standards, as indicated in accordance with ANSI Z97.1. Glazed panels shall comply with indicated wind/snow loading in accordance with ASTM E 1300.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver products to the site in unopened containers, labeled plainly with manufacturers' names and brands. Store glass and setting materials in safe, enclosed dry locations and do not unpack until needed for installation. Handle and install materials in a manner that will protect them from damage.

1.5 WARRANTY

1.5.1 Warranty for Insulating Glass Units

Warranty insulating glass units against development of material obstruction to vision (such as dust, fogging, or film formation on the inner glass surfaces) caused by failure of the hermetic seal, other than through glass breakage, for a 10-year period following acceptance of the work. Provide new units for any units failing to comply with terms of this warranty within 45 working days after receipt of notice from the Government.

PART 2 PRODUCTS

2.1 GLASS

ASTM C 1036, unless specified otherwise. In doors and sidelights, provide safety glazing material conforming to 16 CFR 1201.

2.1.1 Clear Glass

For interior glazing (i.e., pass and observation windows), 1/4 inch thick glass should be used.

Type I, Class 1 (clear), Quality q4 (A). Provide for glazing openings not indicated or specified otherwise. Use double-strength sheet glass or 1/8

inch float glass for openings up to and including 15 square feet, 3/16 inch for glazing openings over 15 square feet but not over 30 square feet, and 1/4 inch for glazing openings over 30 square feet but not over 45 square feet.

2.1.2 Tempered Glass

ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class 1 (transparent), Quality q3, 1/4 inch thick, and conforming to ASTM C 1048 and GANA Standards Manual. Color shall be clear.

2.2 INSULATING GLASS UNITS

Two panes of glass separated by a dehydrated airspace and hermetically sealed. Dimensional tolerances shall be as specified in IGMA TR-1200. The units shall conform to ASTM E 773 and ASTM E 774, Class A. Spacer shall be roll-formed, with bent or tightly welded or keyed and sealed joints to completely seal the spacer periphery and eliminate moisture and hydrocarbon vapor transmission into airspace through the corners. Primary seal shall be compressed polyisobutylene and the secondary seal shall be a specially formulated silicone.

2.2.1 Low Emissivity Insulating Glass

Interior and exterior glass panes for Low-E insulating units shall be Type I annealed flat glass, Class 1-clear with anti-reflective low-emissivity coating on No. 3 surface (inside surface of interior pane), Quality q3 - glazing select, conforming to ASTM C 1036. Glass performance shall be R-Value/Winter Nighttime 3.0, shading coefficient 0.4. Color shall match existing building glazing as closely as possible. Final color to be selected by government from manufacturers standard colors..

2.3 SETTING AND SEALING MATERIALS

Provide as specified in the GANA Glazing Manual, IGMA TM-3000, IGMA TB-3001, and manufacturer's recommendations, unless specified otherwise herein. Do not use metal sash putty, nonskinning compounds, nonresilient preformed sealers, or impregnated preformed gaskets. Materials exposed to view and unpainted shall be gray or neutral color.

2.3.1 Sealants

Provide elastomeric sealants.

2.3.1.1 Elastomeric Sealant

ASTM C 920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing metal sash. Sealant shall be chemically compatible with setting blocks, edge blocks, and sealing tapes. Color of sealant shall be white.

2.3.2 Joint Backer

Joint backer shall have a diameter size at least 25 percent larger than joint width; type and material as recommended in writing by glass and sealant manufacturer.

2.3.3 Preformed Channels

Neoprene, vinyl, or rubber, as recommended by the glass manufacturer for the particular condition.

2.3.4 Sealing Tapes

Preformed, semisolid, PVC-based material of proper size and compressibility for the particular condition, complying with ASTM D 2287. Use only where glazing rabbet is designed for tape and tape is recommended by the glass or sealant manufacturer. Provide spacer shims for use with compressible tapes. Tapes shall be chemically compatible with the product being set.

2.3.5 Setting Blocks and Edge Blocks

Closed-cell neoprene setting blocks shall be dense extruded type conforming to ASTM C 509 and ASTM D 395, Method B, Shore A durometer between 70 and 90. Edge blocking shall be Shore A durometer of 50 (+ or - 5). Silicone setting blocks shall be required when blocks are in contact with silicone sealant. Profiles, lengths and locations shall be as required and recommended in writing by glass manufacturer. Block color shall be black.

2.3.6 Glazing Gaskets

Glazing gaskets shall be extruded with continuous integral locking projection designed to engage into metal glass holding members to provide a watertight seal during dynamic loading, building movements and thermal movements. Glazing gaskets for a single glazed opening shall be continuous one-piece units with factory-fabricated injection-molded corners free of flashing and burrs. Glazing gaskets shall be in lengths or units recommended by manufacturer to ensure against pull-back at corners. Glazing gasket profiles shall be as indicated on drawings.

2.3.6.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C 509, Type 2, Option 1.

2.3.6.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C 864, Option 1, Shore A durometer between 65 and 75.

2.3.6.3 Aluminum Framing Glazing Gaskets

Glazing gaskets for aluminum framing shall be permanent, elastic, non-shrinking, non-migrating, watertight and weathertight.

2.3.7 Accessories

Provide as required for a complete installation, including glazing points, clips, shims, angles, beads, and spacer strips. Provide noncorroding metal accessories. Provide primer-sealers and cleaners as recommended by the glass and sealant manufacturers.

PART 3 EXECUTION

3.1 PREPARATION

Preparation, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Determine the sizes to provide the required edge clearances by measuring the actual opening to receive the glass. Grind smooth in the shop glass edges that will be exposed in finish work. Leave labels in place until the installation is approved, except remove applied labels on heat-absorbing glass and on insulating glass units as soon as glass is installed. Securely fix movable items or keep in a closed and locked position until glazing compound has thoroughly set.

3.2 GLASS SETTING

Shop glaze or field glaze items to be glazed using glass of the quality and thickness specified or indicated. Glazing, unless otherwise specified or approved, shall conform to applicable recommendations in the GANA Glazing Manual, GANA Sealant Manual, IGMA TB-3001, IGMA TM-3000, and manufacturer's recommendations. Handle and install glazing materials in accordance with manufacturer's instructions. Use beads or stops which are furnished with items to be glazed to secure the glass in place. Verify products are properly installed, connected, and adjusted.

3.2.1 Sheet Glass

Cut and set with the visible lines or waves horizontal.

3.2.2 Insulating Glass Units

Do not grind, nip, or cut edges or corners of units after the units have left the factory. Springing, forcing, or twisting of units during setting will not be permitted. Handle units so as not to strike frames or other objects. Installation shall conform to applicable recommendations of IGMA TB-3001 and IGMA TM-3000.3.3 CLEANING

Clean glass surfaces and remove labels, paint spots, putty, and other defacement as required to prevent staining. Glass shall be clean at the time the work is accepted.

3.4 PROTECTION

Glass work shall be protected immediately after installation. Glazed openings shall be identified with suitable warning tapes, cloth or paper flags, attached with non-staining adhesives. Reflective glass shall be protected with a protective material to eliminate any contamination of the reflective coating. Protective material shall be placed far enough away from the coated glass to allow air to circulate to reduce heat buildup and moisture accumulation on the glass. Upon removal, separate protective materials for reuse or recycling. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

3.5 WASTE MANAGEMENT

Disposal and recycling of waste materials, including corrugated cardboard recycling, shall be in accordance with the Waste Management Plan. Separate

float glass and reuse or recycle. Upon removal, separate protective materials and reuse or recycle. Separate tempered glass for use as aggregate or nonstructural fill. Close and seal tightly all partly used sealant containers and store protected in well-ventilated, fire-safe area at moderate temperature.

-- End of Section --

SECTION 09 90 00.00 98

PAINTING AND COATING
03/08

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items. Data shall include detailed analysis of each coating material required, with constituents measured as percentages of the total weight of coating.

Inhibitive Metal Primer, G
Alkali Resistant Primer, G
Acrylic Latex, G
Acrylic Epoxy, G

SD-04 Samples

Manufacturer's Standard Color Charts shall be submitted in accordance with paragraph entitled, "Manufacturer's and Materials," of this section.

SD-07 Certificates

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

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for architectural coatings including details of thinning, mixing, handling, and application, in accordance with paragraph entitled, "General," of this section.

1.2 CONTRACTOR PERSONNEL QUALIFICATION

Personnel assigned to the work shall be certified by the Contractor to have had adequate previous experience in the successful application of paints and coatings similar to those specified.

1.3 DELIVERY, HANDLING, AND STORAGE

Materials shall be delivered in their original, unbroken containers bearing the manufacturer's name and product identification. Containers breached by rough handling shall be removed from the site, together with their contents.

Paint materials, thinners, and cleaners 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 materials shall be protected against freezing.

PART 2 PRODUCTS

2.1 MANUFACTURER'S AND MATERIALS

Manufacturer's Standard Color Charts shall be submitted showing manufacturer's recommended finish colors. Three color chips of each color and gloss scheduled shall also be submitted.

The following are suggested paint manufacturers and their products. Other paint manufacturers' products of equal quality will be considered when submitted and approved by the Contracting Officer.

2.1.1 EXTERIOR PAINTING SCHEDULE

Concrete and Masonry (Other Than Concrete Masonry Units) (Satin): (Latex system). Similar to MPI EXT 3.1A.

Metal - Ferrous (Semi-Gloss): (Alkyd Acrylic System).

1. Primer: MPI Product Number 79. Primer, Alkyd, Anti-Corrosive for Metal.
2. Finish Coats: MPI Product 153. 100 percent Acrylic, Waterborne, Semi-Gloss (30-40 units at 60 degrees F.), 3.0 mils DFT/coat.
3. Surfaces: Miscellaneous ferrous metal.
4. Sherwin Williams: Primer, Kem Kromik; Top-Coat, DTM Semi-Gloss.
5. Benjamin Moore: Primer, Industrial Alkyd Metal Primer; Top-Coat, Industrial Maint. Coating D.T.M.
6. CI: Primer, Devguard; Top-Coat, Dulux.

2.1.2 INTERIOR PAINTING SCHEDULE

Concrete Surfaces (Semi-Gloss): (Latex), similar to MPI INT 3.1M.

1. Finish Coats: MPI Product Number 147, Latex Semi-Gloss Enamel (34-45 units at 60 degrees F.), 2.0 - 2.4 mils DFT/coat.
2. Surfaces: Concrete walls and concrete locker bases.
3. Sherwin Williams; Harmony
4. PPG; Pure Performance
5. Benjamin Moore; Pristine Eco Spec

Concrete Masonry Surfaces (Semi-Gloss): (Vinyl Acrylic Latex System), similar to MPI INT 4.2E.

1. Primer: MPI Product Number 4, Vinyl Acrylic Block Filler.
2. Finish Coats: MPI Product Number 147, Vinyl Acrylic Semi-Gloss Enamel (25-35 units at 60 degrees F.), 1.5 DFT/coat.
3. Surfaces: New masonry walls, graphics (do not use in high humidity areas).
4. Sherwin Williams; Primer: PrepRite Block Filler, Topcoat: Harmony Semi Gloss

5. PPG; Primer: Speedhide, Topcoat: Pure Performance
6. ICI; Devoe Coating Bloxfil Acrylic Block Filler, Topcoat: Dulux Lifemaster

Metal - Ferrous (Semi-Gloss): (Alkyd Enamel System, Maximum VOC content 450 grams/liter), similar to MPI INT 5.1E.

1. Primer: MPI Product Number 79, Primer, Alkyd, Anti-Corrosive for Metal, 3 mils DFT/coat
2. Finish Coats: MPI Product Number 47, Alkyd Enamel, Semi-Gloss (40-50 units at 60 degrees F.), 3.0 mils DFT/coat.
3. Surfaces: Hollow metal doors, frames, door mullions, railings, ferrous metal surfaces.
4. Sherwin Williams; Primer:Kem Kromik, Top-Coat: ProMar 200 Alkyd Semi-Gloss.
5. Benjamin Moore; Primer: Industrial Alkyd Metal Primer, Top-Coat: Architectural Coatings Satin Impervo Finish Enamel.
6. ICI; Primer Devguard, Top-Coat: Dulux Ultra

PART 3 EXECUTION

3.1 GENERAL

A Safety Plan shall be submitted for architectural coating systems in accordance with OSHA regulations.

Manufacturer's recommendations for surface preparation, thinning, mixing, handling, and application shall be considered a part of this specification.

3.2 PROTECTION OF FACILITIES

Contractor shall remove and reinstall or provide acceptable protection for hardware, accessories, lighting and electrical components, factory-finished materials, plumbing fixtures and fittings, and any other materials that may become splattered or damaged by the painting work.

3.3 SURFACE PREPARATION

3.3.1 General Requirements

Surfaces shall be clean, dry, and free from contaminants and foreign matter. Mildew and chalking shall be removed and the surface thoroughly sterilized. Chipped, peeling, or blistered paint shall be removed and the surface spot primed. Hard glossy surfaces shall be dulled and roughened to ensure proper adhesion.

3.3.2 Ferrous Metal

Surfaces shall be free from dirt, oil, grease, wax, and other contaminants. Heavy rust and loose mill scale shall be removed by hand, power tool, or blast cleaning.

3.3.3 Aluminum

Surfaces shall be clean, dry, and free from oil and grease. Oxide film and corrosion shall be removed by hand or power tool cleaning.

3.3.4 Masonry

Surfaces shall be free from dirt, oil, grease, wax, form-release compounds, laitance, and other contaminants. Cracks, voids, and other major surface imperfections shall be filled with mortar.

3.4 MIXING AND APPLICATION

3.4.1 General Procedures

No exterior painting shall be allowed in rainy weather or when rain is imminent. No paints or coatings shall be applied when the temperature or humidity is outside the limits recommended by the manufacturer.

Paints and coatings shall be applied by brush, roller, or airless spray.

Each coat of material applied shall be free from runs, sags, bubbles, foreign contaminants, variations in color, gloss, and texture, dry overspray, brush and roller marks, holidays (missed areas), or other evidence of poor application.

Paints and coatings shall be thoroughly worked into corners and crevices.

Newly painted surfaces shall be adequately protected from damage.

3.4.2 Procedures

There shall be at least three coats of paint (primer and two finish coats) applied in accordance with the manufacturer's instructions, unless otherwise noted.

Coatings shall be applied as follows:

Material shall be thoroughly stirred to produce a uniform mixture.

Material shall be thinned for workability and improved spray characteristics, but only according to the manufacturer's instructions.

Each coat shall be applied uniformly at the minimum wet-film thickness specified by the manufacturer.

Special attention shall be given when coating sharp edges, corners, and crevices to ensure complete coverage.

Finish coats shall show good hiding characteristics and uniform appearance.

3.5 ACCEPTANCE PROVISIONS

3.5.1 Inspection

Contractor shall provide qualified personnel for inspection of his work to ensure that the requirements of this section have been fulfilled.

3.5.2 Correction

Spot-painting to correct damaged surfaces will be allowed only when touchup area blends into the surrounding finish. Otherwise, the entire area shall be recoated. Touchup shall be accomplished using the same method of

application as was used to apply the original material.

3.6 PROTECTION

"WET PAINT" signs shall be posted to indicate newly painted surfaces.

-- End of Section --

SECTION 09 96 00

HIGH-PERFORMANCE COATINGS
07/07

PART 1 GENERAL

1.1 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.

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 7 (2007) Brush-Off Blast Cleaning

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Material, Equipment and Fixture List in accordance with paragraph entitled, "Delivery, Handling and Storage," of this section.

SD-03 Product Data

Submit manufacturer's catalog data for the following items including manufacturer's name and identification. Data shall include detailed analysis of each special coating material required for the project, with all the coating constituents measured as percentages of the total weight of the coating. Manufacturer's data concerning application, thinning, and average coverage per gallon shall be included.

Epoxy Coatings

SD-04 Samples

Submit sample Color Chips in accordance with paragraph entitled, "Delivery, Handling and Storage," of this section.

SD-07 Certificates

Submit certificates for following items showing conformance with the referenced standards contained in this section.

Epoxy Coatings

1.3 DELIVERY, HANDLING AND STORAGE

Special coating materials must be delivered to the project in their original containers bearing manufacturer's information as listed below.

Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:

1. Name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. Handling instructions and precautions.

Special coating materials must be stored in tightly closed containers in a covered, well-ventilated area at a minimum ambient temperature of 45 deg F (7 deg C)where they will not be exposed to excessive heat, fumes, sparks, flame, or direct sunlight. Protect water-based coatings against freezing. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

Solvents, thinners, and equipment cleaners must be stored with the same care as the coating materials with ambient temperatures continuously maintained at a minimum 45 degrees F.

Protect materials from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying coatings.

Submit Material, Equipment and Fixture List consisting of a list of proposed equipment to be used in performance of construction work.

Submit three color chips 3 inch by 4 inch or manufacture pull-down of each finish color and gloss as scheduled.

1.4 FIELD TESTS

Government may take dry-film tests from time to time on finished surfaces. Apply additional coatings to surfaces where there is less than the minimum specified dry-film thickness.

1.5 PROTECTIONS AND SAFETY PRECAUTIONS

Protect adjacent materials and equipment against damage from spillage, dripping, and spatter of coating materials. Building materials and equipment must be left clean and with all damaged surfaces corrected. Provide "WET PAINT" signs to indicate newly painted surfaces.

Provide forced ventilation for interior spaces during application and drying of coatings to prevent the buildup of toxic or explosive concentrations of solvent vapors.

Provide fire extinguishers of the required quantity and correct type to combat flammable liquid fires.

Dispose of rags that are used to wipe up coating materials, solvents, and thinners by drenching them with water and placing in a covered metal container.

1.6 QUALITY ASSURANCE

Comply with Master Painters Institute (MPI) Standards indicated and listed in "MPI Approved Products List." Comply with the requirements in "MPI Architectural Painting Specification Manual" before any project is started.

Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

Source Limitations: Obtain primer material for each coating system from the same manufacturer as the finish coats.

1.7 Project Conditions

Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (7 and 35 deg C).

Do not apply coatings in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.

Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.

PART 2 PRODUCTS

2.1 GENERAL

Coating system based on Sherwin Williams products. Other systems will be considered.

Material Compatibility: Provide primers and finish-coat materials that are compatible with one another and substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

Material Quality: Provide manufacturer's highest grade of the various high-performance coatings specified. Materials not displaying manufacturer's product identification are not acceptable.

VOC Classification: Provide high-performance coating materials, including primers and finish-coat materials, that have a VOC classification of 450 g/L or less.

Colors shall be a ratio of 4:1 with 4 parts HAZE GRAY to 1 part WHITE.

2.1.1 Concrete Surface Coatings

Concrete Floor: Provide the following finish systems over interior concrete floor surfaces to a finished dry thickness of 6.0 - 10.0 mils.

EPOXY COATING: One finish coat over an intermediate lite sand broadcasing and a primer.

Primer: Epoxy primer applied at spreading rate recommended by manufacturer.

Sherwin Williams: Armorseal 1000 HS Heavy Duty Epoxy, series B67-2000. 3.0 - 5.0 mils thick dry.

Topcoat: High-gloss Epoxy applied at spreading rate recommended by manufacturer..

Sherwin Williams: Armorseal 1000 HS Heavy Duty Epoxy, series B67V2002. 3.0 - 5.0 mils thick dry.

PART 3 EXECUTION

3.1 SURFACE EXAMINATION

With Applicator present, examine substrates and conditions under which high-performance coatings will be applied, for compliance with coating application requirements.

Apply coatings only after unsatisfactory conditions have been corrected and surfaces to receive coatings are thoroughly dry.

Start of application is construed as Applicator's acceptance of surfaces within that particular area.

Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:

Confirmation of primer's suitability for expected service conditions.

Confirmation of primer's ability to be top coated with materials specified.

Notify Architect about anticipated problems before using the coatings specified over substrates primed by others.

3.2 SURFACE PREPARATION

3.2.1 Concrete Surfaces

Remove plates, machined surfaces, and similar items already in place that are not to be coated. Provide surface-applied protection before surface preparation and coating where removal is impractical or impossible. After completing coating operations, reinstall items that were removed with workers skilled in the trades involved.

Before applying high-performance coatings, clean substrates of substances that could impair bond of coatings. Clean dirt, oil, grease, and

incompatible paints from substrates to ensure bonding. Coordination of shop-applied prime coats with high-performance coatings is critical. Remove incompatible primers. Reprime substrate with compatible primers as required to produce coating systems indicated. Schedule cleaning and coating application so dust and other contaminates from cleaning process will not fall on wet, newly coated surfaces.

3.2.1.1 Concrete Substrates

Remove release agents, curing compounds, efflorescence, and chalk. Maximum Moisture Content of concrete is 12 percent. Moisture content must be measured with electronic moisture meter. Determine alkalinity of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not coat surfaces if moisture content exceeds that permitted in manufacturer's written instructions.

Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi at 6 inch to 12 inch.

Comply with SSPC SP 7 (NACE No. 4), "Brush-Off Blast Cleaning" for abrasive cleaning.

Cementitious Substrates: All concrete shall be abrasive vacuum blasted by Blastrac type equipment. Hand and mechanical scarifiers, scabblers and planers may also be used where necessary providing every effort is made to keep dust and contamination of other surfaces to a minimum. Blasting must be done sufficiently to open all remaining surfaces voids, bugholes, air pockets and other subsurface irregularities, but so as not to overly expose the underlaying aggregate. Dry, oil free air must be used for the operation. The surface profile shall resemble 80 grit sandpaper and international concrete repair institute standards, ICRI CSP3 or CSP4. All dust must be removed by sweeping and vacuuming.

3.3 COATING MATERIAL PREPARATION

3.3.1 General

Mix and prepare coating materials in accordance with the coating manufacturer's printed instructions for the particular material and coat to be applied. Keep materials which are not in actual use in closed containers.

Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.

Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.

Use only the type of thinners approved by manufacturer and only within recommended limits.

Coating materials that have been mixed with an automatic shaker must be allowed to stand to let air bubbles escape, then given a final hand mixing before application. Stir materials so as to produce a mixture of uniform density. Stir at frequent intervals during application to prevent skinning.

3.3.2 Thinning

Thinning must be done in accordance with coating manufacturer's printed directions for the particular material and coat.

Sherwin Williams: Reducer material R7K54 or eqaul.

3.3.3 Tinting

Prime and intermediate coats of paint must be a slightly different tint from the finish coat to facilitate identification of each coat. Tinting must be done by the coating manufacturer and clearly identified as to color and coat.

3.4 APPLICATION OF COATING MATERIALS

3.4.1 General

Do not perform exterior painting in damp or rainy weather. Interior painting must not be allowed until the building is enclosed and has thoroughly dried out. Do not allow painting below 50 degrees Fand above 95 degrees F. Painting application must be in accordance with the coating manufacturer's recommendations, and as specified.

Application of coatings must be done by skilled applicators. Apply coatings to clean and properly prepared surfaces. Apply coatings carefully with clean, high-quality application equipment. Allow sufficient time between coats to ensure complete drying and curing. Surfaces must be sanded and dusted between coatings, as required, to produce a surface free of visible defects. High gloss coatings and clear finishes must be lightly sanded between coats to ensure bond of following coats.

Apply coats to the surfaces in an even film. Do not accept cloudiness, spotting, holidays, laps, application marks, runs, sags, and other similar surface imperfections. Remove defective coating applications and recoat as directed.

Coating lines such as wainscots must be sharp, true, and well-defined. Tape may be used to establish coating lines, providing tape is removed before ragging or sawtooth edges form.

Surfaces, including edges, corners, crevices, welds, and other similar changes in surface plane, must receive a dry-film thickness not less than specified.

Apply high-performance coatings according to manufacturer's written instructions.

Use applicators and techniques best suited for the material being applied.

Do not apply high-performance coatings over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to forming a durable coating film.

Coating colors, surface treatments, and finishes are indicated in the coating system descriptions.

Provide finish coats compatible with primers used.

3.4.2 Scheduling Coating

Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for coating as soon as practicable after preparation and before subsequent surface deterioration.

The number of coats and film thickness required is the same regardless of application method.

Do not apply succeeding coats until previous coat has cured as recommended by manufacturer.

Apply lite broadcasting of sand into the primer coat, at final thickness, while primer coating is still damp. Over broadcasting of sand will not be accepted.

Where manufacturer's written instructions require sanding, sand between applications to produce a smooth, even surface.

3.4.3 Brush Application

Brushes must be clean and the proper size and type for high-quality application of the specified coating materials. Slow-dry coatings must be brushed out. Quick-dry coatings must be brushed only enough to spread out evenly.

Use brushes best suited for material applied and of appropriate size for the surface or item being coated.

Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.

Brush out and work brush coats into surfaces in an even film.

Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.

3.4.4 Roller Application

Roller covers must be clean and of the proper nap length, nap texture, and material for high-quality application of the specified coating materials.

Roller application must be done carefully and must be equivalent in all respects to the same coats applied by high-quality brush application.

Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.

3.4.5 Spray Application

Do not allow spray application of coatings.

3.4.6 Minimum Coating Thickness

Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.

3.4.7 Prime Coats

Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.

Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

3.4.8 Completed Work

Match approved Samples for color, texture, and coverage. Remove, refinish, or recoat work that does not comply with specified requirements.

3.5 ACCEPTANCE PROVISIONS

3.5.1 Repairing

Remove damaged and unacceptable portions of completed work and replace with new work to match adjacent surfaces at no additional cost to the Government.

3.5.2 Cleaning

At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

Application equipment must be cleaned promptly and thoroughly with a suitable solvent after each use and stored in a clean, covered, well-ventilated container.

Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces. Comply with procedures specified in PDCA P1.

Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.

-- End of Section --

SECTION 23 00 00.00 98

GENERAL MECHANICAL PROVISIONS
04/06

PART 1 GENERAL

1.1 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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(2008) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

CODE OF FEDERAL REGULATIONS (CFR)

40 CFR 82	(1996) Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 6	(2007; 14th Ed) UL Standard for Safety for Electrical Rigid Metal Conduit-Steel

1.2 SUBMITTALS

NOT USED

1.3 APPLICABILITY

This section shall apply to, and be a component part of, each section that is a part of Division 23, "Heating, Ventilating, and Air Conditioning".

1.4 SCOPE OF WORK

The Contractor shall furnish all labor, materials, equipment, calculations, and services to construct, install, and test the complete mechanical systems and related work, indicated and specified.

1.5 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows or other specific elements which may be required for proper installation of the work. Such work shall be verified at the site. Additional bends and offsets as required by vertical and horizontal equipment locations or other job conditions shall be provided to complete the work, at no additional cost to the Government.

Except where shown in dimensional detail, the locations of plumbing, mechanical equipment, ducts, piping, and fittings are only approximate; the exact locations shall be determined by the Contractor, subject to approval

by the COTR.

The physical dimensions of equipment indicated are approximate. The Contractor is responsible in verifying that the equipment furnished will fit in the available space. Before installing any equipment, the Contractor shall obtain the exact requirements for the items furnished and shall install plumbing, piping, fittings, supports, and other items of the correct size and shape for the equipment actually installed. Plumbing and piping sizes and equipment ratings shall be taken as a minimum and shall not be reduced without approval.

1.6 CODES AND STANDARDS

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. No equipment or piping, including soldered joints, containing lead shall be installed in potable water systems. No internal fiberglass insulation shall be installed in any air ducts for acoustic or heat flow reduction.

1.7 COORDINATION

Contractor shall coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work will be avoided. All necessary offsets in piping and ductwork, and all fittings, etc., required to install the work properly shall be furnished complete in place at no additional cost to the Government.

1.8 MECHANICAL SYSTEMS IDENTIFICATION

1.8.1 General

The Contractor shall provide a coordinated system of piping identification which includes:

Valves and components shall have a tag to identify the device and system it is installed. Tag engraving shall be as detailed in paragraph "System Component Tags".

Piping identification and color coding as per paragraph "Service Labeling".

The Contractor shall submit the entire identification system for approval prior to proceeding with the work.

1.8.2 System Component Tags

Laminated Plastic Tags:

Identification tags shall be made of laminated plastic. The tag's engraved letters/ numbers shall be black with background color the color listed under color bands under paragraph entitled "Service Labeling". On brown colored tags, provide white letters/numbers.

Tags shall be rectangular 0.125 inch (3 mm) thick, 1.500 inch (38 mm) width by 5.750 inch (146 mm) length for two letter-number rows. The upper row shall indicate the components prefix number. The lower row shall indicate the systems index number for the component. The upper row shall be 0.250 inch (6 mm) from the top beginning 0.750 inch (19

mm) from left end with 0.500 inch (13 mm) by 0.500 inch (13 mm) by 0.125 inch (6 mm) thick block letter-numbers on 0.250 inch (6 mm) spacing with 0.500 inch (13 mm) space between letters and numbers ending 0.500 inch (13 mm) from right end. The lower row shall be 0.250 inch (6 mm) from bottom, 0.250 inch (6 mm) by 0.250 inch (6 mm) by 0.0625 inch (2 mm) thick block letters positioned under the upper row. The left end of the tag shall have a 0.250 inch (6 mm) hole centered in the 0.750 inch (19 mm) by 1.500 inch (38 mm) area for wiring to component.

Tags shall be wired to valve or component items with No. 12 AWG (3 mm) diameter stainless steel wire. Care shall be taken when installing the tags so that valves are not damaged (softened) by hot objects.

All components shall be provided with identification tags displaying the numbers assigned by the COTR. At the completion of the job, a list of all component numbers used, along with a description of component identified, shall be provided.

1.8.3 Service Labeling

All piping and ductwork, including that concealed in accessible spaces; exposed, bare and painted; and insulated, shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction and a color warning band. Labels and system component tag color scheme shall be in accordance with the typical examples below:

SYSTEM AIR DUCTS AND PIPES	BLACK LETTERS ON WHITE BACKGROUND	COLOR BANDS
Air Conditioning Supply	A/C SPLY	White
Air conditioning Return	A/C RTN	White
Exhaust Air	EXH AIR	Gray
Outdoor Air	OUTDR AIR	White
Sanitary	SANI SWR	Brown
Storm	STRM SWR	Brown
A. C. Unit Coil Condensate (Pan Drain)	COND WTR OUT GRAV	Brown

WATER	BLACK LETTERS ON WHITE BACKGROUND	COLOR BANDS
Chilled - Return	CH WTR RTN	Brown
Chilled - Supply	CH WTR SPLY	Brown
Nonpotable Cold	NONPOT DOM WTR	Brown
Potable Cold	DOM WTR	White
Potable Hot	DOM HOT WTR SUP	White
Heating Hot - Return	HTG RTN	Brown
Heating Hot - Supply	HTG SPLY	Brown
Low Pressure Steam	LOW PRESS STEAM	Gray
Steam Condensate Gravity Return	COND GRAV RTN - LOW PRESS	Gray

Similar services with different temperatures or pressures shall be identified. Where pressures may exceed 125 pounds per square inch, gage,

the maximum system pressure shall be included in the label.

Piping shall be labeled and arrowed in accordance with the following:

Each point of entry and exit of pipe passing through walls

Each change in direction, i.e., elbows, tees

In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

In long straight runs, labels shall be located at distances within eyesight of each other but in no case shall the distance between labels exceed 25 feet. All labels shall be visible and legible from the primary service and operating area.

The label and system component tag schedule above shall not be construed as defining or limiting the work.

Preprinted legends such as decalcomanias, snap-on, tie-on, or pressure secured are commercially available and shall be used with approval of the COTR. Stapling label to insulation is not permissible. The color band shall be used to secure each end of label. When such legends are used their fabrication and application must be suitable for the environment in which the are used. Background and letter-numerals, style, size, and color scheme shall match the requirements listed in paragraph "Service Labeling."

1.8.4 Asbestos Free Labeling

All newly installed piping and duct insulation shall be labeled to verify that asbestos containing materials do not exist within the insulation. Labels shall be stick-on type with minimum 3/4 inch high white letters on blue background. Stickers shall be formatted as follows:

ASBESTOS FREE

Stickers shall be attached to piping or duct insulation in accordance with the following:

Each point of entry and exit of piping or duct passing through walls or each change in direction, i.e., elbows, tees.

In long, straight runs of pipe or duct, the distance between labels shall not exceed 25 feet.

Labels are required in exposed and non-exposed areas.

1.9 APPROVAL REQUIREMENTS

Except as otherwise specified, approval of materials and equipment will be based on manufacturer's published data.

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL 2001, and UL 6 will be acceptable as sufficient evidence that the items conform to Underwriters Laboratories requirements. In lieu of such label or listing, the Contractor may submit a written certificate from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the

units conform to the specified requirements. Methods of testing used by the specified agencies shall be outlined.

Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the American Society for Testing and Materials (ASTM), the American Society of Mechanical Engineers (ASME), or other standards, a manufacturer's certificate of compliance of each item will be acceptable as proof of compliance.

Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

1.10 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.

All equipment installed with a factory finish shall be fully protected during construction and shall be maintained free of dust, dirt, and foreign matter. All dents and marred finishes shall be repaired or replaced as per the COTR at no additional cost to the Government.

1.11 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given rust-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123/A 123M for exterior locations.

1.12 OZONE DEPLETING SUBSTANCES USED AS REFRIGERANTS

Releases of Ozone Depleting Substances (ODS) during repair, maintenance, servicing or disposal of appliances containing ODS's will be minimized by complying with all applicable sections of 40 CFR 82 Part 82 Subpart F. Any person conducting repair, maintenance, servicing or disposal of appliances owned by NASA comply with the following:

No Class I or Class II substances used as a refrigerant may be knowingly vented or otherwise released into the environment.

No appliances may be opened without meeting the requirements of 40 CFR 82 Part 82.156 Subpart F, regarding required practices regarding evacuation and collection of refrigerant, and 40 CFR 82 Part 82.158 Subpart F, regarding standards of recycling and recovery equipment.

No work may be conducted on appliances containing refrigerant except by persons who comply with 40 CFR 82 Part 82.161 Subpart F, regarding technician certification.

In addition, copies of all applicable certifications must be provided to the Contracting Officer at least 10 working days prior to initiating maintenance, repair, servicing, dismantling or disposal of appliances, including:

Proof of Technician Certification

Proof of Equipment Certification, if recovery or recycling equipment is to be provided by the Contractor

Proof of availability of certified recovery or recycling equipment, if equipment is to be provided by the Contractor

1.13 USE OF OZONE DEPLETING SUBSTANCES, OTHER THAN REFRIGERANTS

The use of Class I or Class II ODS's listed as nonessential in 40 CFR 82 Part 82.66 Subpart C is prohibited. These prohibited materials and uses include:

Any plastic party spray streamer or noise horn which is propelled by a chlorofluorocarbon

Any cleaning fluid for electronic and photographic equipment which contains a chlorofluorocarbon; including liquid packaging, solvent wipes, solvent sprays, and gas sprays

Any plastic flexible or packaging foam product which is manufactured with or contains a chlorofluorocarbon, including, open cell foam, open cell rigid polyurethane poured foam, closed cell extruded polystyrene sheet foam, closed cell polyethylene foam and closed cell polypropylene foam except for flexible or packaging foam used in coaxial

Any aerosol product or other pressurized dispenser which contains a chlorofluorocarbon, except for those listed in 40 CFR 82 Part 82.66 Subpart C.

A waiver may be requested should a programmatic of facility requirement dictate that a prohibited material is necessary to achieve project goals. A waiver request must be submitted in writing to the Test Operations and Institutional Safety Branch. The waiver will be evaluated and dispositioned by a Hazardous Material Review Subcommittee.

1.14 RECORD DRAWINGS AND MANUALS

The Contractor shall provide, and keep up-to-date, a complete record set of drawings which shall be corrected to show every change from the original specification and drawings. Prints for this purpose may be obtained from the COTR. This set of prints shall be kept on the jobsite and shall be used only as a record set. This shall not be construed as authorization for the Contractor to make changes in the layout or specification without approval. Upon completion of the work and before final payment, the record set of drawings and manuals shall be submitted for approval. Upon approval, the record set of drawings and all manuals will be retained by the COTR.

Manuals shall be bound in a loose leaf, 3-ring binder with index tabs separating and identifying equipment. The manual shall contain copies of controls and major equipment and shall be marked to indicate brand and model furnished with capacity data, parts lists, wiring diagrams, operating and maintenance information, and air/water balancing data. Number of copies shall be the same as for submittals or six (6) minimum.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

In addition to standard manufacturer's identification plates, engraved laminated phenolic identification plates shall be provided for each piece of mechanical equipment. Identification plates shall designate the function of the equipment. Designation shall be submitted with the shop drawings.

Identification plates shall be three layers, black-white-black, engraved to show white letters on black background. Letters shall be upper case. Identification plates 1-1/2-inches high and smaller shall be 1/16-inch thick, with engraved lettering 1/8-inch high; identification plates larger than 1-1/2-inches high shall be 1/8-inch thick, with engraved lettering of suitable height. Identification plates 1-1/2-inches high and larger shall have beveled edges. Identification plates shall be installed using a compatible adhesive and/or setscrews.

2.2 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the equipment manufacturer and shall be located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

2.3 MATERIAL AND EQUIPMENT

Mechanical material and equipment shall meet the requirements indicated and specified and shall be designed for the installation shown. All components bearing the same part number shall be identical in form, fit, and function. All materials and equipment shall be new and free from defects. Any metal exposed to the weather shall be fabricated of aluminum or stainless steel (including bolts, nuts, fasteners, supports and ductwork).

2.4 COUPLING AND BELT GUARDS

All rotating equipment with couplings or V-belt drives shall be furnished with an OSHA approved guard.

2.5 PAINTING

All exposed air handling units, piping (not insulated), pneumatic control tubing, control panels, electric conduits for mechanical controls and equipment, and ductwork (not insulated) installed under this contract and exposed to view in finished areas, shall be painted. See Division 9, "Finishes," for painting of bare and insulated piping and ductwork.

All equipment units shall be painted in accordance with approved equipment manufacturer's standards unless specified otherwise. Field retouching shall be accomplished only if approved; otherwise equipment shall be returned to the factory for refinishing.

2.6 VALVES AND FITTINGS

Carbon steel, class 125 shall be used for steam and condensate piping systems. Ductile or malleable iron, bronze or brass are acceptable for

other piping systems with copper acceptable for water piping systems.

PART 3 EXECUTION

3.1 INSTALLATION

Materials and equipment shall be installed in accordance with the requirements of the contract drawings and approved recommendations of the manufacturers. Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors.

No installation shall be permitted which blocks or otherwise impedes access to any existing machine or system. All hinged doors shall swing open a minimum of 120 degrees. The area in front of all access doors shall be clear a minimum of 3 feet. The area in front of all access doors to electrical circuits shall be clear the minimum distance to energized circuits as specified in OSHA Standards, part 1910.333(Electrical-Safety Related work practices)and an additional 3 feet.

Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations. All indicators, to include gauges, meters, and alarms shall be mounted in order to be easily visible by people in the area.

Materials encountered during the installation of piping and/or equipment may contain asbestos or coated with a lead containing paint. Any asbestos materials encountered shall be handled as per specification Section 02 82 00 98, "ENGINEERING CONTROLS OF ASBESTOS CONTAINING MATERIALS." Lead paint shall be handled as per specification Section 02 83 00.98, "LEAD REMEDIATION."

Insulation materials installed on piping and ductwork must be dry. Any liquid containing insulation shall be replaced before the vapor barrier is sealed; and, if exposed to outdoor conditions, weather proofing is completed.

3.2 EQUIPMENT PADS

Equipment pads shall be provided and shall be of dimensions shown or, if not shown, they shall conform to the shape of each piece of equipment served with a minimum 3-inch margin around the equipment and supports and shall be 4-inch thickness. Equipment bases and foundations, when constructed of concrete or grout, shall cure a minimum of 14 days before being loaded. Chamfer top edges of equipment pads.

3.3 PIPE AND DUCTWORK SUPPORTS

Piping and ductwork shall be supported from, or suspended from, the building steel or concrete structure and <u>not from the roof deck.</u>

Pipe, including electric conduits, and ductwork on the roof shall be supported from an 18-gauge galvanized steel prefabricated curb, unitized construction with integral base plate, continuous welded corner seams, pressure treated wood nailer, counterflashing with lag screws, internally reinforced, 45-degree cant base for flashing, 12-inch minimum height, and 12-inch minimum length.

Note the requirements of the paragraph "Material and Equipment" for materials exposed to weather.

3.4 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching of the building structure.

Holes in exposed locations, in or through existing floors, shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved by the Contracting Officer's Technical Representative.

Holes through masonry walls, floors, or ceilings, to accommodate sleeves, shall be made with an iron pipe masonry core saw.

3.5 CLEANING

Exposed surfaces of piping and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish painting or are enclosed within the building structure.

After piping has been pressure tested and prior to placing systems in operation, all piping and fittings shall be flushed to remove any dirt, grit, rust, scale, grease, oil, or other materials. Water for flushing will be furnished by the Government; but, flushing shall be accomplished in such a manner as to prevent undue water waste.

Before final acceptance, mechanical equipment, including piping, ducting, and fixtures, shall be clean and free from dirt, grease, and finger marks.

When the work area is in an occupied space such as office, laboratory or warehouse all furniture and equipment shall be protected from dirt and debris. Field construction work shall incorporate housekeeping which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 HYDROSTATIC TESTING

3.6.1 General

These guidelines shall be followed for testing systems, that can be filled with a fluid, designed for liquid, gas, or steam.

These guidelines are based on the requirements of the ASME and ANSI Pressure Vessel and Piping Codes and the NASA GRC Operational Safety Manual. The guidelines shall be followed when conducting a hydrostatic test of pressure vessels and piping systems.

See also Section 23 05 93.98 "TESTING ADJUSTING AND BALANCING"

3.6.2 Before Test Requirements

Systems designed for gas or steam may require temporary support or bracing to withstand the weight of the fluid used in the test. All stress loadings that may exist during this test is part of the design. Any Contractor concerns shall be brought in writing to the attention of the COTR prior to conducting the test.

Expansion joints shall be provided with temporary restraints, if required, for the additional test pressure load; or they shall be isolated during the test.

Equipment that is not to be subjected to the pressure test shall be either disconnected from the system or isolated. Valves may be used for this purpose provided the valve is designed for the proposed test pressure. Isolated equipment and piping not being tested shall be vented.

All welded, flanged, threaded, brazed, or soldered joints, and other connections not previously pressure tested, shall not be insulated before testing. They shall be exposed for examination during testing.

Water shall be used as the primary test medium. Test water shall be clean and of such quality as to minimize corrosion of the materials in the system under test. Tests with water shall not be conducted when ambient temperature is below 40-degrees F. The temperature of the water used to apply the test shall not be less than 60-degrees F. or higher than 120-degrees F. If a particular situation warrants, the COTR shall be contacted for approval to use other water temperatures or fluids as the test medium.

Vents shall be provided at all high points to purge any possible air pockets during filling the vessel or piping system. Drain connections shall be provided at low points to remove water at the conclusion of the test.

A calibrated, certified pressure gauge shall be connected to the system to be tested. The range of the gauge shall be at least 1 1/2-times the test pressure, but not greater than 2-times the test pressure. Digital pressure gauges may be used if their accuracy is as good as a calibrated dial pressure gauge.

3.6.3 Test Requirements

Before applying hydrostatic pressure, the test equipment shall be examined to see that it is tight. All low pressure filling lines and other components of the test equipment, that should not be subjected to test pressure, shall be disconnected or isolated.

The system under test shall be isolated from the hydrostatic pump by a hand valve. The calibrated pressure gauge, attached to the system, shall be observed for at least 15-minutes to ensure the leak tightness of the system. leaking will be indicated by a continuous decrease in the system pressure. Temperature changes in the system shall be monitored to correct pressure changes.

Hydrostatic test results shall be documented on the form under Article "Attachments" entitled "Hydrostatic Testing Report" in this Section. Only one vessel or system shall be documented on one report. Multiple vessels or systems require multiple reports.

The hydrostatic pressure shall be increased gradually until the system is subjected to 50% of the test pressure. At this point, the pressure shall be held for at least 10-minutes, documented on the "Hydrostatic Testing Report" under Article "Attachments" in this Section, and the system checked for leaks and other deficiencies.

After 50% of the test pressure is reached, the system pressure shall be increased in 10% increments. Pressure shall be held for at least 10-minutes at each pressure level, documented on the "Hydrostatic Testing Report" under Article "Attachments" in this Section, and visually inspected for leaks at each step. Continue the test until the full test pressure is applied.

The full test pressure shall be continuously maintained for a minimum of 30-minutes. During this time, the system shall be observed for indications of leakage. The pressure shall be documented on the "Hydrostatic Testing Report."

The hydrostatic test pressure at any point in the piping system shall not be less than 1.5-times the design pressure (see drawings for the required test pressure), but shall not exceed the maximum allowable test pressure of any non-isolated component, such as vessels, pumps or valves.

Following the application of the full hydrostatic test pressure, the pressure shall be reduced to not less than 67% of the test pressure. A close examination of all welds, flanged, threaded, brazed, and soldered joints shall be made to pinpoint any leakage.

Upon completion of the test, the following "Hydrostatic Testing Report" shall be given to the COTR.

3.7 HYDROSTATIC TESTING REPORT

Location - Bldg. No. _____ Building Title_____

Tested (vessel/piping) -_____

Pipe Description:

1 - Vessel or Pipe Size: _____

2 - Wall Thickness: _____

3 - Material: _____

4 - Op. Press: _____PSIG* _____kPa*

Hydrostatic Test Parameters:

1 - Testing Date: _____

2 - Gauge Calib. Date: _____

3 - Hydro Fluid Temp: _____deg. F
_____deg. C

4 - Test Press: _____PSIG* _____kPa*

* As shown on drawing CF_____ **(Test Press. = 1.5 X Oper Press)

SPECIFIC CHECK POINTS	PER CENT (%) OF TEST PRESSURE	PRESS PSIG	PRESS kPa	PRESSURE HELD FOR:	PRESSURE TEST WITNESS BY NASA PERSON (INITIALS)	VERIFIED
1	50			10 min.		

Location - Bldg. No. _____ Building Title_____

Tested (vessel/piping) -_____

Pipe Description: Hydrostatic Test Parameters:

2	60			10 min.	
3	70			10 min.	
4	80			10 min.	
5	90			10 min.	
6	100			30 min.	
7	67			INSPECTION	

Remarks:
_____

Hydrostatic Test Performed By:

Contractor: _____Contract: NAS3-_____

Performed By: (Name/Title):_____ Date:_____

Other: (Name/Title):_____ Date:_____

NASA Witness: COTR:_____ Date:_____

Inspector:_____ Date:_____

Other: (Name/Title):_____ Date:_____

-- End of Section --

SECTION 23 05 00.00 98

COMMON WORK RESULTS FOR HVAC
10/06

PART 1 GENERAL

1.1 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 INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2005e13) Manual of Steel Construction

AMERICAN PETROLEUM INSTITUTE (API)

API 602	(2005) Steel Gate, Globe and Check Valves for Sized 4 inches and Smaller for the Petroleum and Natural Gas Industries - Eighth Edition

AMERICAN WELDING SOCIETY (AWS)

AWS WHB-2.9	(2004) Welding Handbook; Volume Two - Welding Processes

ASME INTERNATIONAL (ASME)

ASME A112.19.2	(2003) Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
ASME B16.1	(2005) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.11	(2005) Standard for Forged Steel Fittings, Socket-Welding and Threaded
ASME B16.22	(2006) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.3	(1998) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.34	(2004) Valves Flanged, Threaded, and Welding End
ASME B16.39	(1998) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.4	(2006) Standard for Gray Iron Threaded Fittings; Classes 125 and 250

ASME B40.100	(2005) Pressure Gauges and Gauge Attachments - Incorporating ASME B40.1-1998 and ASME B40.7-1998; Addenda A-12/31/2001
ASME B16.5	(2003) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B16.9	(2007) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.3	(2008) Standard for Process Piping
ASME B36.10M	(2004) Standard for Welded and Seamless Wrought Steel Pipe
ASME BPVC SEC IX	(2004) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A 105/A 105M	(2005) Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A 126/A 126M	(2004) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 183	(2003) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A 197/A 197M	(2000) Standard Specification for Cupola Malleable Iron
ASTM A 216/A 216M	(2008) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 234/A 234M	(2007) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A 278/A 278M	(2001) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)
ASTM A 307	(2007) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 312/A 312M	(2008) Standard Specification for Seamless, Welded, and Heavily Worked Austenitic Stainless Steel Pipes
ASTM A 53/A 53M	(2007) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated,

	Welded and Seamless
ASTM A 563	(2007) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 6/A 6M	(2008) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A 74	(2009) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM B 370	(2009) Standard Specification for Copper Sheet and Strip for Building Construction
ASTM B 62	(2002) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 749	(2003) Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products
ASTM B 88	(2003) Standard Specification for Seamless Copper Water Tube
ASTM C 109/C 109M	(2007) Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)
ASTM C 404	(2007) Standard Specification for Aggregates for Masonry Grout
ASTM C 476	(2008) Standard Specification for Grout for Masonry
ASTM C 553	(2008) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C 564	(2008) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C 67	(2008) Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 2000	(2008) Standard Classification System for Rubber Products in Automotive Applications
ASTM E 1	(2003a) Standard Specification for ASTM Liquid-in-Glass Thermometers
ASTM E 814	(2008) Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM F 104	(2003) Standard Classification System for

Nonmetallic Gasket Materials

FLUID SEALING ASSOCIATION (FSA)

FSA-0017	(1995e6) Standard for Non-Metallic Expansion Joints and Flexible Pipe Connectors Technical Handbook

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

MSS SP-125	(2000) Standard for Gray Iron and Ductile Iron In-Line, Spring-Loaded, Center-Guided Check Valves
MSS SP-58	(2002) Standard for Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-67	(2002a; R 2004) Standard for Butterfly Valves
MSS SP-69	(2003; R 2004) Standard for Pipe Hangers and Supports - Selection and Application
MSS SP-70	(2006) Standard for Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-71	(2005) Standard for Gray Iron Swing Check Valves, Flanged and Threaded Ends
MSS SP-72	(1999) Standard for Ball Valves with Flanged or Butt-Welding Ends for General Service
MSS SP-80	(2008) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2002) Standard for Cast Iron Globe & Angle Valves, Flanged and Threaded Ends

U.S. DEPARTMENT OF DEFENSE (DOD)

MS MIL-E-17813	(1992f) Military Standard for Expansion Joints, Pipe, Metallic Bellows

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1922	(1995, R 2001-Rev A; Notice 1) Shield, Expansion (Caulking Anchors, Single Lead)
CID A-A-1923	(1995, R 2001-Rev A; Notice 1) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-55614	(1995, R 2001) Shield, Expansion (Non-Drilling Expansion Anchors)
CID A-A-55615	(1995, R 2001) Shield, Expansion (Wood

	Screw and Lag Bolt Self-Threading Anchors
FS A-A-1924	(1995, R 2001-Rev A) Standard for Shield, Expansion; (Self Drilling Tubular Expansion Shell Bolt Anchors)
FS A-A-1925	(1995, R 2001-Rev A; Notice 1) Standard for Shield, Expansion (Nail Anchors)

UNDERWRITERS LABORATORIES (UL)

UL 1479	(2003) Standard for Fire Tests of Through-Penetration Fire Stops

1.2 GENERAL REQUIREMENTS

Section 23 00 00.00 98 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

Submit Records of Existing Conditions consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes Contractor's acceptance of the existing conditions.

Include with Equipment Foundation Data for piping systems all plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

Submit Fabrication Drawings for pipes, valves and specialties consisting of fabrication and assembly details to be performed in the factory.

Submit Material, Equipment, and Fixture Lists for pipes, valves and specialties including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information. Provide a complete list of construction equipment to be used.

Submit Manufacturer's Standard Color Charts for pipes, valves and specialties showing the manufacturer's recommended color and finish selections.

Include with Listing of Product Installations for piping systems identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Include in the list purchaser, address of installation, service organization, and date of installation.

Submit Record Drawings for pipes, valves and accessories providing current factual information including deviations and amendments to the drawings, and concealed and visible changes in the work.

Submit Connection Diagrams for pipes, valves and specialties indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or

portion of system) with another, and internal tubing, wiring, and other devices.

Submit Coordination Drawings for pipes, valves and specialties showing coordination of work between different trades and with the structural and architectural elements of work. Detail all drawings sufficiently to show overall dimensions of related items, clearances, and relative locations of work in allotted spaces. Indicate on drawings where conflicts or clearance problems exist between various trades.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists must be submitted for construction equipment to be used.

SD-02 Shop Drawings

Submit the following for pipes, valves and specialties showing conformance with the referenced standards contained within this section.

Record Drawings
Connection Diagrams
Coordination Drawings
Fabrication Drawings

Submit Installation Drawings for pipes, valves and specialties in accordance with the paragraph entitled, "Pipe Installation," of this section.

SD-03 Product Data

Submit equipment and performance data for the following items consisting of corrosion resistance, life expectancy, gage tolerances, and grade line analysis.

Submit Manufacturer's catalog data for the following items:

Pipe and Fittings
Piping Specialties
Valves
Miscellaneous Materials
Supporting Elements

Equipment Foundation Data must be in accordance with paragraph entitled, "General Requirements," of this section.

SD-04 Samples

Submit Manufacturer's Standard Color Charts in accordance with paragraph entitled, "General Requirements," of this section.

SD-05 Design Data

Submit design analysis and calculations for the following items consisting of surface resistance, rates of flow, head losses, inlet and outlet design, required radius of bend, and pressure calculations. Also include in data pipe size, shape, and dimensions, as well as temperature ratings, vibration and thrust limitations minimum burst pressures, shut-off and non-shock pressures and weld characteristics.

Pipe and Fittings
Piping Specialties
Valves

SD-06 Test Reports

Submit test reports on the following tests in accordance with paragraph entitled, "Piping Installation," of this section.

Hydrostatic Tests
Air Tests
Valve-Operating Tests
Drainage Tests
Pneumatic Tests
Non-Destructive Electric Tests
System Operation Tests

SD-07 Certificates

Submit Listing of Product Installations for piping systems verifying proper qualifications.

Submit Records of Existing Conditions by the Contractor prior to start.

Submit Certificates for the following in accordance with paragraph entitled, "Pipe Installation," of this section.

Surface Resistance
Shear and Tensile Strengths
Temperature Ratings
Bending Tests
Flattening Tests
Transverse Guided Weld Bend Tests

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with paragraph entitled, "Operation and Maintenance," of this section.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

2.1.1 Type BCS, Black Carbon Steel

Pipe (1/8 through 12 inches) must be Schedule 40 black carbon steel, conforming to ASTM A 53/A 53M.

Pipe (1/8 through 10 inches) must be Schedule 40 seamless or

electric-resistance welded black carbon steel, conforming to ASTM A 53/A 53M, Type E, Grade B (electric-resistance welded)Type S (seamless). Grade A should be used for permissible field bending, in both cases.

Fittings (2 inches and under) must be 150-pounds per square inch, gage (psig) working steam pressure (wsp) banded black malleable iron screwed, conforming to ASTM A 197/A 197M and ASME B16.3.

Unions (2 inches and under) must be 250 pounds per square inch, wsp female, screwed, black malleable iron with brass-to-iron seat, and ground joint, conforming to ASME B16.39.

Fittings (2-1/2 inches and over) must be Steel butt weld, conforming to ASTM A 234/A 234M and ASME B16.9 to match pipe wall thickness.

Flanges (2-1/2 inches and over) must be 150-pound forged-steel conforming to ASME B16.5, welding neck to match pipe wall thickness.

2.1.2 Type BCS-125, (125-psi Service)

Pipe (1/8 through 1-1/2 inches) must be Schedule 40 steam, Schedule 80 condensate, furnace butt weld, black carbon steel, conforming to ASTM A 53/A 53M, Type F (furnace butt welded, continuous welded) and ASME B36.10M.

Pipe (2 through 10 inches) must be Schedule 40 steam, Schedule 80 condensate, seamless or electric-resistance welded black carbon steel, conforming to ASTM A 53/A 53M Type E, Grade B (electric-resistance welded) Type S (seamless) and ASME B36.10M.

Fittings (2 inches and under) must be 125-psig wsp, cast iron, screwed end, conforming to ASTM A 126/A 126M Class A and ASME B16.4.

Fittings (2-1/2 inches and over) must be wall thickness to match pipe, long radius butt weld, black carbon steel, conforming to ASTM A 234/A 234M, Grade WPB and ASME B16.9.

Couplings (2 inches and under) must be commercial standard weight for Schedule 40 pipe and commercial extra heavy weight for Schedule 80 pipe, black carbon steel where threaded, and 2,000-or 3,000-psi wog forged carbon steel, conforming to ASTM A 105/A 105M and ASME B16.11, where welded.

Flanges (2-1/2 inches and over) must be 150-pound, forged carbon-steel welding neck, with raised face or flat face and concentric serrated finish, conforming to ASTM A 105/A 105M and ASME B16.5.

Conform grooved pipe couplings and fittings to paragraph entitled, "Grooved Pipe Couplings and Fittings."

2.1.3 Type CISP-DWV, Cast-Iron Drain, Waste and Vent

Provide soil pipe drain, waste, and vent bell-and-spigot type pipe cast iron, conforming to ASTM A 74. Caulk and lead all joints in lines where necessary to provide proper leaktight support and alignment; other-wise joints may be two-gasket system type chloroprene, conforming to ASTM C 564. Pipe class must be extra heavy (CISP-DWV-XH).

2.1.4 Type CPR, Copper

2.1.4.1 Type CPR-A, Copper Above Ground

Tubing (2 inches and under) must be seamless copper tubing, conforming to ASTM B 88, Type L (hard-drawn for all horizontal and all exposed vertical lines, annealed for concealed vertical lines).

Fittings (2 inches and under) must be 150-psig wsp wrought-copper solder joint fittings conforming to ASME B16.22.

Unions (2 inches and under) must be 150-psig wsp wrought-copper solder joint, conforming to ASME B16.22.

Solder shall be lead-free containing the following nominal composition:

Silver - 0.05% to 0.15%
Nickel - 0.15% to 0.025%
Copper - 2.5% to 3.5%
Antimony - 4.5% to 3.5%
Tin - Balance

Physical Properties

Solidus - 460 degrees F.
Liquidus - 630 degrees F.
Color - Bright Silver
Elongation - 48%
Tensile Strength - 6600 to 7400 psi
Solder and paste flux shall conform to ASTM B32

2.1.5 Grooved Pipe Couplings and Fittings

Provide housing for all couplings, fabricated in two or more parts, of black, ungalvanized malleable iron castings. Coupling gasket must be molded synthetic rubber, conforming to ASTM D 2000. Coupling bolts must be oval-neck, track-head type, with hexagonal heavy nuts conforming to ASTM A 183.

All pipe fittings used with couplings must be fabricated of black, ungalvanized malleable iron castings. Where a manufacturer's standard-size malleable iron fitting pattern is not available, approved fabricated fittings may be used.

Fittings must be fabricated from Schedule 40 or 0.75-inch wall ASTM A 53/A 53M, Grade B seamless steel pipe; long radius seamless welding fittings with wall thickness to match pipe, conforming to ASTM A 234/A 234M and ASME B16.9.

2.2 PIPING SPECIALTIES

2.2.1 Air Vents

Manual air vents must be 3/8-inch globe valves.

2.2.2 Dielectric Connections

Dissimilar pipe metals must be electrically insulated from each other by couplings, unions, or flanges commercially manufactured for that purpose and rated for the service pressure and temperature.

2.2.3 Expansion Vibration Isolation Joints

Single or multiple arch-flanged expansion vibration isolation joints must be constructed of steel-ring reinforced chloroprene-impregnated cloth materials. Joint must be designed to absorb the movement of the pipe sections in which installed with no detrimental effect on the pipe or connected equipment. Flanges must be backed with ferrous-metal backing rings. Control rod assemblies must be provided to restrict joint movement. All nonmetallic exterior surfaces of the joint must be coated with chlorosulphinated polyethylene. Grommets must be provided in limit bolt hole to absorb noise transmitted through the bolts.

Joints must be suitable for continuous-duty working temperature of at least 250 degrees F .

Arches must be filled with soft chloroprene.

Joint, single-arch, movement limitations and size-related, pressure characteristics must conform to FSA-0017.

2.2.4 Flexible Pipe

Flexible pipe vibration and pipe-noise eliminators must be constructed of wire-reinforced, rubber-impregnated cloth and cord materials and must be flanged. Flanges must be backed with ferrous-metal backing rings. Service pressure-rating must be minimum 1.5 times actual service. Surge pressure must be at 180 degrees F.

Unit pipe lengths, face-to-face, must be not less than the following:

INSIDE DIAMETER	UNIT PIPE LENGTH
To 2-1/2 inches, inclusive	12 inches
3 to 4 inches, inclusive	18 inches
5 to 12 inches, inclusive	24 inches

2.2.5 Flexible Metallic Pipe

Flexible pipe must be the bellows-type with wire braid cover and must be

designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Working pressure minimum rating must be 100 psi at 300 degrees F.

Minimum burst pressure must be four times working pressure at 300 degrees F. Bellows material must be AISI Type 316L corrosion-resistant steel. Braid must be AISI 300 series corrosion-resistant steel wire.

Threaded end connections must be hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A 312/A 312M.

Flanged end connection rating and materials must conform to specifications for system primary-pressure rating.

2.2.6 Flexible Metal Steam Hose

Hose must be bellows type with wire braid cover and must be designed, constructed, and rated in accordance with the applicable requirements of ASME B31.3.

Working steam pressure rating must be 125 psi at 500 degrees F.

Minimum burst pressure must be nine times working steam pressure at 300 degrees F.

Bellows material must be AISI Type 316L corrosion-resistant steel. Braid must be AISI Type 300-series corrosion-resistant steel wire.

Threaded end connections must be hex-collared Schedule 40, AISI Type 316L corrosion-resistant steel, conforming to ASTM A 312/A 312M.

Flanged end connection rating and materials must conform to specifications for system primary-pressure rating.

2.2.7 Metallic Expansion Joints

Expansion joints must be metallic-bellows-type, conforming to MS MIL-E-17813.

Expansion joints must be Type I (corrugated bellows, unreinforced), Class 1 (single bellows, expansion joint),

Joints must be designed and constructed to absorb all of the movements of the pipe sections in which installed, with no detrimental effect on pipe or supporting structure.

Joints must be rated, designed, and constructed for pressures to 125 psig and temperatures to 500 degrees F.

Joints must have a designed bursting strength in excess of fourtimes their rated pressure.

Joints must be capable of withstanding a hydrostatic test of 1.5 times their rated pressure while held at their uncompressed length without leakage or distortion that may adversely affect their life cycle.

Life expectancy must be not less than 10,000 cycles.

Movement capability of each joint must exceed calculated movement of piping by 100 percent.

Bellows and internal sleeve material must be AISI Type 304, 304L, or 321 corrosion-resistant steel.

End connections must require no field preparation other than cleaning.

Flanges of flanged-end expansion joints must conform to the same codes and standard requirements as are applicable to companion flanges specified for the given piping system at the indicated joint location.

Joints, 2-1/2 inches and smaller, must have internal guides and limit stops.

Joints, 3 inches and larger, must be provided with removable external covers, internal sleeves, and purging connection. Sleeves must be sized to accommodate lateral clearance required, with minimum reduction of flow area, and with oversized bellows where necessary. When a sleeve requires a gasket as part of a locking arrangement, the gasket must be provided by the manufacturer. Joints without purging connection may be provided; however, these must be removed from the line prior to, or not installed until, cleaning operations are complete.

Cylindrical end portion of the reinforced bellows element must be provided with a thrust sleeve of sufficient thickness to bring that portion within applicable code-allowable stress. Sleeve must provide 360 degrees support for the element and end-reinforcing ring.

Expansion joints must have four, equidistant, permanent tram points clearly marked on each joint end. Points must be located to prevent obliteration during installation. Distance between tram points indicating installed lengths must be included in shop drawings. Overall dimension after joint installation must be subject to approval.

Each expansion joint must have adjustable clamps or yokes provided at quarter points, straddling the bellows. Overall joint length must be set by the manufacturer to maintain joints in manufacturer's recommended position during installation.

Each joint must be permanently and legibly marked with the manufacturer's name or trademark and serial number; the size, series, or catalog number; bellows material; and directional-flow arrow.

2.2.8 Pressure Gages

Pressure gages must conform to ASME B40.100 and to requirements specified herein. Pressure-gage size must be 3-1/2 inches nominal diameter. Case must be corrosion-resistant steel, conforming to any of the AISI 300 series of ASTM A 6/A 6M, with an ASM No. 4 standard commercial polish or better. Gages must be equipped with adjustable red marking pointer and damper-screw adjustment in inlet connection. Service-pressure reading must be at midpoint of gage range. All gages must be Grade B or better and be equipped with gage isolators.

Steam gages must be fitted with black steel syphons and steam service pressure-rated gage cocks or valves.

2.2.9 Sight-Flow Indicators

Sight-flow indicators for pressure service on 3-inch ips and smaller must be constructed of bronze with specially treated single- or double-glass sight windows and must have a bronze, nylon, or tetrafluoroethylene rotating flow indicator mounted on an AISI Type 304 corrosion-resistant steel shaft. Body may have screwed or flanged end. Assembly must be pressure- and temperature-rated for the applied service. Flapper flow-type indicators are not acceptable.

2.2.10 Sleeve Couplings

Sleeve couplings for plain-end pipe must consist of one steel middle ring, two steel followers, two chloroprene or Buna-N elastomer gaskets, and the necessary steel bolts and nuts.

2.2.11 Thermometers

Thermometers must conform to ASTM E 1, except for being filled with a red organic liquid. Thermometers must be an industrial pattern armored glass model, (well-threaded and seal-welded). Thermometers installed 6 feet or higher above the floor must have an adjustable angle body. Scale must be not less than 7 inches long. Case face must be manufactured from manufacturer's standard polished aluminum or AISI 300 series polished corrosion-resistant steel. Thermometer range must be 30-250 degrees F. Thermometers must be provided with nonferrous separable wells. Lagging extension to accommodate insulation thickness must be provided.

2.2.12 Pump Suction Strainers

Strainer body must be cast iron, rated for not less than 25 psig at 100 degrees F, with flanges conforming to ASME B16.1, Class 125. Strainer construction must be such that there is a machined surface joint between body and basket that is normal to the centerline of the basket.

Minimum ratio of open area of each basket to pipe area must be 3 to 1. Basket must be AISI 300 series corrosion-resistant steel wire mesh with perforated backing.

Mesh must be capable of retaining all particles larger than 1,000 micrometer, with a pressure drop across the strainer body of not more than 0.5 psi when the basket is two-thirds dirty at maximum system flow rate. Reducing fittings from strainer-flange size to pipe size must be provided.

A differential-pressure gage fitted with a two-way brass cock must be provided across the strainer.

Manual air vent cocks must be provided in cap of each strainer.

2.2.13 Line Strainers, Water Service

Strainers must be Y-type with removable basket. Strainers in sizes 2-inch ips and smaller must have screwed ends. In sizes 2-1/2-inch ips and larger, strainers must have flanged ends. Body working-pressure rating must exceed maximum service pressure of system in which installed by at least 50 percent. Body must have cast-in arrows to indicate direction of

flow. All strainer bodies fitted with screwed screen retainers must have straight threads and must be gasketed with nonferrous metal. Strainer bodies 2-1/2-inches and larger, fitted with bolted-on screen retainers, must have offset blowdown holes. All strainers larger than 2-1/2-inches must be fitted with manufacturer's standard ball-type blowdown valve. Body material must be cast bronze conforming to ASTM B 62 . Where system material is nonferrous, metal strainer body material must be nonferrous metal.

Minimum free-hole area of strainer element must be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens must have perforations not to exceed 0.045-inch. Strainer screens must have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material must be AISI Type 304corrosion-resistant steel.

2.2.14 Line Strainers, Steam Service

Strainers must be Y-type with removable strainer element.

Body end connections must be flanged for all valves larger than 2 inches, unless butt weld ends are specified. Screwed weld must be used for sizes 2 inches and under to suit specified piping system end connection and maintenance requirements .

Strainers located in tunnels, trenches, manholes, and valve pits must have welded end connections.

Body working steam pressure rating must be the same as the primary valve rating for system in which strainer is installed, except where welded end materials requirements result in higher pressure ratings. Body must have integral cast or forged arrows to indicate direction of flow. Strainer bodies must be provided with blowdown valves that have discharge end plugged with a solid metal plug. Closure assembly must be made with tetrafluoroethylene tape. Bodies fitted with bolted-on screen retainers must have offset blowdown holes.

Cast iron conforming to ASTM A 126/A 126M, Class B, for service pressures 125-psi wsp and less.

Minimum free-hole area of strainer element must be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens must have perforations not to exceed 0.020 inch or equivalent wire mesh. Strainer screens must have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material must be AISI Type 304 corrosion-resistant steel and must be fitted with backup screens where necessary to prevent collapse.

2.3 VALVES

All valves installed in insulated piping systems shall be provided with extended stems.

2.3.1 Ball and Butterfly Valves

Ball valves must conform to MSS SP-72 for Figure 1A, 1 piece body and must be rated for service at not less than 175 psig at 200 degrees F. Valve bodies in sizes 2 inches and smaller must be screwed-end connection-type constructed of Class A copper alloy. Valve bodies in sizes 2-1/2 inches

and larger must be flanged-end connection type, constructed of Class D material. Balls and stems of valves 2 inches and smaller must be manufacturer's standard with hard chrome plating finish. Balls and stems of valves 2-1/2 inches and larger must be manufacturer's standard Class C corrosion-resistant steel alloy with hard chrome plating. Balls of valves 6 inches and larger may be Class D with 900 Brinell hard chrome plating. Valves must be suitable for flow from either direction and must seal equally tight in either direction. Valves with ball seals held in place by spring washers are not acceptable. All valves must have adjustable packing glands. Seats and seals must be tetrafluoroethylene.

Butterfly valves must conform to MSS SP-67. Valves must be wafer type for mounting between specified flanges and must be rated for 150-psig shutoff and nonshock working pressure. Bodies must be cast ferrous metal conforming to ASTM A 126/A 126M, Class B, and to ASME B16.1 for body wall thickness. Seats and seals must be of the resilient elastomer type designed for field removal and replacement.

2.3.2 Drain, Vent, and Gage Cocks

Drain, vent, and gage cocks must be lever handle, ground key type, with washer and screw, constructed of polished ASTM B 62 bronze, and rated 125-psi wsp. End connections must be rated for specified service pressure.

Pump vent cocks, and where spray control is required, must be UL umbrella-hood type, constructed of manufacturer's standard polished brass. Cocks must be 1/2-inch ips male, end threaded, and rated at not less than 125 psi at 225 degrees F.

2.3.3 Gate Valves (GAV) - Steam Service - 100 psig and Under

All steam service valves shall have Class V or higher seat leakage rating in accordance with FCI 70.2.

Manual Gate valves for low pressure steam supply service, 2 inches and smaller, shall conform to ASTM A 105/A 105M forged carbon steel, API 602, and ASME B16.34. Valves shall be Class 800 and have the following features: threaded ends, union bonnet, spiral-wound gasket, inside screw stem, screw gland, solid wedge, hard faced seats, and 13% cr. trim. Packing shall be made of non-asbestos type materials. Valve control shall be a handwheel with a built-in identification tag.

Gate valves 2 1/2 inches and larger shall conform to ASME B16.34 and ASTM A 216/A 216M Grade WCB cast carbon steel. Valves shall be Class 150 and have the following features: flanged ends, outside screw & yoke (OS&Y), bolted bonnet, flexible wedge disc, and 410 stainless steel stem. Packing shall be made of non-asbestos type materials. Valve control shall be a malleable iron handwheel with stainless steel identification tag.

All gate valves larger than 3 inch size shall have a 1/2 inch globe valve piped across its body to prevent water hammer shock.

2.3.4 Gate Valves (GAV) - Steam Condensate Service - 100 psig and Under

Manual Gate valves for low pressure steam condensate service, 2 inches and smaller, shall conform to MSS SP-80 and ASTM B 62 bronze. Valves shall be Class 150 for SWP & Class 300 for WOG, and have the following features: industrial service, threaded ends, union bonnet, rising stem, gland packed (non-asbestos), and solid wedge disc. Valve control shall be a malleable

iron handwheel with aluminum identification tag.

Gate valves 2 1/2 inches and larger shall conform to ASME B16.34 and ASTM A 216/A 216M Grade WCB cast carbon steel. Valves shall be Class 150 and have the following features: flanged ends, outside screw & yoke (OS&Y), bolted bonnet, flexible wedge disc, and 410 stainless steel stem. Packing shall be made of non-asbestos type materials. Valve control shall be a malleable iron handwheel with stainless steel identification tag.

2.3.5 Gate Valves (GAV) - NON-Steam & Steam Condensate Service 100 psig & Under

Manual Gate valves, 2 inches and smaller, shall conform to MSS SP-80 and ASTM B 62 bronze. Valves shall be Class 300 for WOG, and have the following features: industrial service, threaded ends, union bonnet, rising stem, gland packed (non-asbestos), and solid wedge disc. Valve control shall be a malleable iron handwheel with aluminum identification tag.

Gate valves 2-1/2 inches and larger shall conform to MSS SP-70 and ASTM A 126 Class B cast iron. Valves shall be Class 125 IBBM, 200 WOG, and have the following features: flanged ends, bronze trim, outside screw & yoke (OS&Y), bolted bonnet, rising stem, solid wedge, replaceable seat rings, and 410 stainless steel stem. Packing and gaskets shall be made of non-asbestos type materials. Valve control shall be a ductile iron handwheel with aluminum identification tag.

2.3.6 Globe and Angle Valves (GLV-ANV)

Globe and angle valves 2 inches and smaller, must be 125-pound, 125-psi conforming to MSS SP-85 and to requirements specified herein. Valves located in tunnels, equipment rooms, factory-assembled equipment, and where indicated must be union-ring bonnet, screwed-end type. Disc must be free to swivel on the stem in all valve sizes. Composition seating-surface disc construction may be substituted for all metal-disc construction. Packing must be made of non-asbestos type materials. Disk and packing must be suitable for pipe service installed.

Globe and angle valves 2-1/2 inches and larger, must be cast iron with bronze trim. Valve bodies must be cast iron conforming to ASTM A 126/A 126M, Class A, as specified for Class 1 valves under MSS SP-70. Valve ends must be flanged in conformance with ASME B16.1. Valve construction must be outside screw and yoke (OS&Y) type. Packing must be made of non-asbestos type materials.

2.3.7 Standard Check Valves (SCV)

Standard check valves in sizes 2 inches and smaller must be 125-psi swing check conforming to MSS SP-71, except as otherwise specified. Lift checks must be provided where indicated. Swing-check pins must be nonferrous and suitably hard for the service. Discs must be composition type. Swing-check angle of closure must be manufacturer's standard unless a specific angle is needed.

Check valves in sizes 2-1/2 inches and larger must be cast iron, bronze trim, swing type. Valve bodies must be cast iron, conforming to ASTM A 126/A 126M, Class A. Valve ends must be flanged in conformance with ASME B16.1. Swing-check pin must be AISI Type or approved equal corrosion-resistant steel. Angle of closure must be manufacturer's standard unless a specific angle is needed. Valves must have bolted and

gasketed covers.

Check valves must be provided with , positive-closure devices and valve ends must be flanged.

2.3.8 Nonslam Check Valves (NSV)

Check valves at pump discharges in sizes 2 inches and larger must be nonslam or silent-check type conforming to MSS SP-125. Valve disc or plate must close before line flow can reverse to eliminate slam and water-hammer due to check-valve closure. Valve must be Class 125 rated for 200-psi maximum, nonshock pressure at 150 degrees F in sizes to 12 inches. Valves must be wafer type to fit between flanges conforming to ASME B16.1 . Valve body may be cast iron, conforming to ASTM A 278/A 278M, Class 40 or equivalent strength ductile iron. Disks must be manufacturer's standard bronze, aluminum bronze, or corrosion-resistant steel. Pins, springs, and miscellaneous trim must be manufacturer's standard corrosion-resistant steel. Disk and shaft seals must be Buna-N elastomer tetrafluoroethylene.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Bolting

Flange and general purpose bolting must be hex-head and must conform to ASTM A 307, Grade B (bolts, for flanged joints in piping systems where one or both flanges are cast iron). Heavy hex-nuts must conform to ASTM A 563. Square-head bolts and nuts are not acceptable. Threads must be coarse-thread series.

2.4.2 Elastomer Calk

Polysulfide- or polyurethane-base elastomer calking material must be two-component type, conforming to ASTM C 920.

2.4.3 Escutcheons

Escutcheons must be manufactured from nonferrous metals and must be chrome-plated except when AISI 300 series corrosion-resistant steel is provided. Metals and finish must conform to ASME A112.19.2.

Escutcheons must be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. All escutcheons must have provisions consisting of setscrews for maintaining a fixed position against a surface.

2.4.4 Flashing

Sheet lead must conform to ASTM B 749, UNS Alloy Number L50049 (intended for use in laboratories and shops in general application)

Sheet copper must conform to ASTM B 370 and must be of not less than 16 ounces per square foot weight.

2.4.5 Flange Gaskets

Compressed non-asbestos sheet, conforming to ASTM F 104, coated on both sides with graphite or similar lubricant, with nitrile composition, binder rated to 750 degrees F.

2.4.6 Grout

Shrink-resistant grout must be a premixed and packaged metallic-aggregate, mortar-grouting compound conforming to ASTM C 404 and ASTM C 476.

Shrink-resistant grout must be a combination of premeasured and packaged epoxy polyamide or amine resins and selected aggregate mortar grouting compound conforming to the following requirements:

Tensile strength		1,900 psi, minimum
Compressive strength	ASTM C 109/C 109M	14,000 psi, minimum
Shrinkage, linear		0.00012 inch per inch, maximum
Water absorption	ASTM C 67	0.1 percent, maximum
Bond strength to		1,000 psi, minimum steel in shear minimum

2.4.7 Pipe Thread Compounds

Tetrafluoroethylene tape not less than 2 to 3 mils thick must be used in potable and process water and in chemical systems for pipe sizes to and including 1-inch ips. Tetrafluoroethylene dispersions and other suitable compounds may be used for all other applications upon approval by the Contracting Officer; however, no lead-containing compounds may be used in potable water systems.

2.5 SUPPORTING ELEMENTS

All necessary piping systems and equipment supporting elements must be provided, including but not limited to: building structure attachments; supplementary steel; hanger rods, stanchions, and fixtures; vertical pipe attachments; horizontal pipe attachments; anchors; guides; and spring-cushion, variable, or constant supports. All supporting elements must be suitable for stresses imposed by systems pressures and temperatures and natural and other external forces normal to this facility without damage to supporting element system or to work being supported.

Supporting elements must conform to requirements of ASME B31.3, MSS SP-58, and MSS SP-69 except as noted.

Attachments welded to pipe must be made of materials identical to that of pipe or materials accepted as permissible raw materials by referenced code or standard specification.

Supporting elements exposed to weather must be hot-dip galvanized or stainless steel. Materials must be of such a nature that their apparent and latent-strength characteristics are not reduced due to galvanizing process. Supporting elements in contact with copper tubing must be electroplated with copper.

Type designations specified herein are based on MSS SP-58 and MSS SP-69. Masonry anchor group-, type-, and style-combination designations must be in accordance with CID A-A-1922, CID A-A-1923, FS A-A-1924, FS A-A-1925 , CID A-A-55614, and CID A-A-55615. Support elements, except for supplementary steel, must be cataloged, load rated, commercially manufactured products.

2.5.1 Building Structure Attachments

2.5.1.1 Anchor Devices, Concrete and Masonry

Anchor devices must conform to CID A-A-1922, CID A-A-1923, FS A-A-1924, FS A-A-1925 , CID A-A-55614, and CID A-A-55615

Cast-in, floor mounted, equipment anchor devices must provide adjustable positions.

Powder-actuated anchoring devices must not be used to support any mechanical systems components.

2.5.1.2 Beam Clamps

Beam clamps must be center-loading MSS SP-58 Type 20 .

When it is not possible to use center-loading beam clamps, eccentric-loading beam clamps, MSS SP-58 Type 19 may be used for piping sizes 2 inches and less and for piping sizes 2 through 10 inches provided two counterbalancing clamps are used per point of pipe support. Where more than one rod is used per point of pipe support, rod diameter must be determined in accordance with referenced standards.

2.5.1.3 C-Clamps

C-Clamps may be used to support piping sizes 1-1/2 inches and smaller. C-clamps shall be FM approved and UL listed, with hardened cup-tip setscrew, locknut, and retaining strap. Retaining-strap section shall be not less than 1/8 inch by 1 inch. Beam-flange thickness to which clamps are attached shall not exceed 0.60 inches.

2.5.1.4 Inserts, Concrete

Concrete inserts must be MSS SP-58 Type 18. When applied to piping in sizes 2 inches ips and larger and where otherwise required by imposed loads, a 1-foot length of 1/2-inch reinforcing rod must be inserted and wired through wing slots. Proprietary-type continuous inserts may be submitted for approval.

2.5.2 Horizontal Pipe Attachments

2.5.2.1 Single Pipes

Piping in sizes to and including 2-inch ips must be supported by MSS SP-58 Type 6 solid malleable iron pipe rings, except that split-band-type rings may be used in sizes up to 1-inch ips.

MSS SP-58 Type 1 and Type 6 assemblies must be used on vapor-sealed insulated piping and must have an inside diameter larger than pipe being supported to provide adequate clearance during pipe movement.

Where thermal movement of a point in a piping system 4 inches and larger would cause a hanger rod to deflect more than 4 degrees from the vertical or where a horizontal point movement exceeds 1/2 inch, MSS SP-58 Type 41 pipe rolls must be used.

Piping in sizes larger than 8-inch ips must be supported with MSS SP-58 Type 41pipe rolls.

MSS SP-58 Type 40 shields must be used on all insulated piping. Area of the supporting surface must be such that compression deformation of insulated surfaces does not occur. Longitudinal and transverse shield edges must be rolled away from the insulation.

Insulated piping without vapor barrier on roll supports must be provided with MSS SP-58 Type 39 saddles.

Spring supports must be as indicated.

2.5.2.2 Parallel Pipes

Trapeze hangers fabricated from structural steel shapes, with U-bolts, must be used in congested areas and where multiple pipe runs occur. Structural steel shapes must be of commercially available, proprietary design, rolled steel.

2.5.3 Vertical Pipe Attachments

Vertical pipe attachments must be MSS SP-58 Type 8.

Shop drawing data must include complete fabrication and attachment details of any spring supports.

2.5.4 Hanger Rods and Fixtures

Only circular cross section rod hangers may be used to connect building structure attachments to pipe support devices. Pipe, straps, or bars of equivalent strength must be used for hangers only where approved by the Contracting Officer.

Turnbuckles, swing eyes, and clevises must be provided as required by support system to accommodate temperature change, pipe accessibility, and adjustment for load and pitch. Rod couplings are not acceptable.

2.5.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, such supplementary steel must be designed and fabricated in accordance with AISC 325.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

Certificates must be submitted for pipes, valves and specialties showing conformance with test requirements as contained in the reference standards contained in this section. Certificates must verify Surface Resistance, Shear and Tensile Strengths, Temperature Ratings, Bending Tests, Flattening Tests and Transverse Guided Weld Bend Tests.

Test reports for Hydrostatic Tests, Air Tests, Valve-Operating Tests, Drainage Tests, Pneumatic Tests, Non-Destructive Electric Tests and System Operation Tests must be provided by the Contractor, in compliance with referenced standards contained within this section.

Piping systems must be fabricated and installed in accordance with ASME B31.3, MSS SP-69, and AWS WHB-2.9.

Installation Drawings must be submitted for pipes, valves and specialties. Drawings must include the manufacturer's design and construction calculations, forces required to obtain rated axial, lateral, or angular movements, installation criteria, anchor and guide requirements for equipment, and equipment room layout and design. Drawing must specifically advise on procedures to be followed and provisions required to protect expansion joints during specified hydrostatic testing operations.

Connections between steel piping and copper piping must be electrically isolated from each other with dielectric couplings (or nipples) rated for the service.

Final connections to equipment must be made with unions provided every 100 feet of straight run. Unions must be provided in the line downstream of screwed- and welded-end valves.

All pipe ends must be reamed before joint connections are made.

Screwed joints must be made up with specified joint compound and not more than three threads must show after joint is made up.

Joint compounds must be applied to the male thread only and care must be exercised to prevent compound from reaching the unthreaded interior of the pipe.

Screwed unions, welded unions, or bolted flanges must be provided wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system for maintenance.

Piping systems must be securely supported with due allowance for thrust forces, thermal expansion and contraction, and must not be subjected to mechanical, chemical, vibrational or other damage as specified in ASME B31.3.

Field welded joints must conform to the requirements of the AWS WHB-2.9, ASME B31.3, and ASME BPVC SEC IX.

All necessary precautions must be taken during installation of flexible pipe and hose including flushing and purging with water, steam, and compressed air to preclude bellows failure due to pipe line debris lodged in bellows. Installation must conform to manufacturer's instructions.

3.2 VALVES

Valves must be provided in piping mains and all branches and at equipment where indicated and as specified.

Valves must be provided to permit isolation of branch piping and each equipment item from the balance of the system.

Riser and downcomer drains above piping shutoff valves in piping 2-1/2 inches and larger must be provided. Shutoff valve body must be tapped and fitted with a 1/2-inch plugged globe valve.

Valves unavoidably located in furred or other normally inaccessible places must be provided with access panels adequately sized for the location and located so that concealed items may be serviced, maintained, or replaced.

3.3 SUPPORTING ELEMENTS INSTALLATION

Supporting elements must be provided in accordance with the referenced codes and standards.

Piping must be supported from building structure. No piping must be supported from roof deck or from other pipe.

Piping must run parallel with the lines of the building. Piping and components must be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there must be no less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other must be arranged to be in line with each other and parallel to the lines of the building.

Piping support elements must be installed at intervals specified hereinafter, at locations not more than 3 feet from the ends of each runout, and not over 1 foot from each change in direction of piping.

Load rating for all pipe-hanger supports must be based on insulated weight of lines filled with water and forces imposed. Deflection per span must not exceed slope gradient of pipe. Supports must be in accordance with the following minimum rod size and maximum allowable hanger spacing for specified pipe. For concentrated loads such as valves, the allowable span must be reduced proportionately:

PIPE SIZE INCHES	ROD SIZE INCHES	STEEL PIPE FEET	COPPER PIPE FEET
1 and smaller	3/8	8	6
1-1/4 to 1-1/2	3/8	10	8
2	3/8	10	8
2-1/2 to 3-1/2	1/2	12	12
4 to 5	5/8	16	14
6	3/4	16	16
8 to 12	7/8	20	20

Vertical risers must be supported independently of connected horizontal piping, whenever practicable, with fixed or spring supports at the base and at intervals to accommodate system range of thermal conditions. Risers must be guided for lateral stability. For risers subject to expansion, only one rigid support must be provided at a point approximately one-third down from the top. Clamps must be placed under fittings unless otherwise specified. Carbon-steel pipe must be supported at each floor and at not more than 15-foot intervals for pipe 2 inches and smaller and at not more than 20-footintervals for pipe 2-1/2 inches and larger.

3.4 PENETRATIONS

Effective sound stopping and adequate operating clearance must be provided to prevent structure contact where piping penetrates walls, floors, or ceilings into occupied spaces adjacent to equipment rooms; where similar penetrations occur between occupied spaces; and where penetrations occur from pipe chases into occupied spaces. Occupied spaces must include space above ceilings where no special acoustic treatment of ceiling is provided. Penetrations must be finished to be compatible with surface being penetrated.

3.5 SLEEVES

Sleeves must be provided where piping passes through roofs, masonry, concrete walls and floors.

Sleeves passing through steel decks must be continuously welded to the deck.

Sleeves that extend through floors, roofs, load bearing walls, and fire barriers must be continuous and fabricated from Schedule 40 steel pipe, with welded anchor lugs. All other sleeves must be formed by molded linear polyethylene liners or similar materials that are removable. Diameter of sleeves must be large enough to accommodate pipe, insulation, and jacketing without touching the sleeve and must provide a minimum 3/8-inch clearance. Sleeve size must accommodate mechanical and thermal motion of pipe to preclude transmission of vibration to walls and the generation of noise.

Space between a pipe, bare or insulated, and the inside of a pipe sleeve or a construction surface penetration must be packed solid with a mineral fiber conforming to ASTM C 553 Type V (flexible blanket), (to 1,000 degrees F). This packing must be provided wherever the piping passes through firewalls, equipment room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction surface penetrations occur between conditioned and unconditioned spaces, the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction surface penetration must be filled with an elastomer calk to a depth of 1/2 inch. All surfaces to be calked must be oil- and grease-free.

Through-Penetration fire stop materials and methods must be in accordance with ASTM E 814 and UL 1479.

Exterior wall sleeves shall be fabricated from Schedule 40 stainless steel pipe with welded anchor lugs and calked sealed watertight with mechanically expandable chloroprene inserts with mastic-sealed metal components.

Sleeve height above roof surface must be a minimum of 12 and a maximum of 18 inches.

3.6 ESCUTCHEONS

Escutcheons must be provided at all penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, escutcheons must be provided on both sides of the partition. Where suspended ceilings are installed, plates must be provided at the underside only of such ceilings. For insulated pipes, the plates must be large enough to fit around the insulation. Escutcheons must be chrome-plated in all occupied spaces and of size sufficient to effectively conceal openings in building construction. Escutcheons must be firmly attached with setscrews.

3.7 FLASHINGS

Flashings must be provided at penetrations of building boundaries by mechanical systems and related work.

3.8 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals must be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions. Test data must be clear and readily legible.

-- End of Section --

SECTION 23 05 93.98

TESTING, ADJUSTING AND BALANCING
04/06

PART 1 GENERAL

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

ASHRAE 111	(1998) Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems

ASME INTERNATIONAL (ASME)

ASME B40.100	(1998) Pressure Gauges and Gauge Attachments

ASSOCIATED AIR BALANCE COUNCIL (AABC)

AABC MN-1	(2002) National Standards for Total System Balance

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB TABES	(1998) Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems

SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA TAB HVAC SYSTEMS	(2002) HVAC Systems - Testing, Adjusting and Balancing

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment and Performance Data shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-06 Test Reports

Test Reports shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-07 Certificates

Certificates shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

1.3 GENERAL REQUIREMENTS

Section 23 00 00.00 98, "GENERAL MECHANICAL PROVISIONS," applies to work specified in this section.

Equipment and Performance Data shall be submitted for instruments and equipment to be used during testing.

Test Reports shall be submitted to the Contracting Officer for approval. Six bound copies of the testing, adjusting, and balancing report shall be provided.

Certificates shall be submitted by the Contractor showing independent laboratory certification of test-apparatus calibration data, dated after the award of the contract.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 WATER SYSTEM INTEGRITY TESTING

Prior to acceptance of the work, systems shall be tested in the presence of the Contracting Officer.

Tests shall be performed prior to insulation of surfaces, painting, and concealment of work. Systems containing repaired defects shall be retested to original criteria for acceptance, except when waived by the Contracting Officer.

Tests shall be hydrostatic. See Section 23 00 00.00 98, "GENERAL MECHANICAL PROVISIONS" for Hydrostatic Testing requirements. Water used for testing shall be potable.

Government will supply testing water, but the Contractor shall provide for approved disposal of contaminated water.

Contractor may conduct tests for his own purposes, but the acceptance test shall be conducted as specified herein.

If the test demonstrates that leakage rate exceeds specified limits, the source(s) of leakage shall be determined, defective materials and workmanship shall be repaired or replaced, and the system shall be retested until specified requirements are met.

Other than standard piping flanges, plugs, caps, and valves, only commercially manufactured expandable-elastomer plugs shall be used for sealing off piping for test purposes. Safe test-pressure rating of any plug used shall be not less than two times the actual test pressure being applied.

Precautions shall be taken to vent the expansive force of compressed air trapped during high-pressure hydrostatic testing to preclude injury and damage.

Contracting Officer may require the removal of system components, such as plugs or caps, to ascertain that the water has reached all parts of the system if purging or vent valves are not provided.

Piping system components, such as valves, shall be checked for functional operation under system test pressure. Components that could sustain damage due to test pressure shall be removed from piping systems prior to hydrostatic testing.

Leaking gasket joints shall be remade with new gaskets. Leaking copper joints shall be remade with new fittings and new tube ends.

Temperature of water used for testing shall not cause condensation on system surfaces.

Test media shall not be added to a system during a test for a period specified or to be determined by the Contracting Officer.

Duration of a test will be determined by the Contracting Officer and shall be for a minimum of 2 hours, with a maximum of 24 hours. Test may be terminated by direction of the Contracting Officer at any time during this period after it has been determined that the permissible leakage rate has not been exceeded.

Test records of piping systems tests shall be prepared and maintained. Records shall show test personnel responsibilities, dates, test gage identification numbers, ambient and test water temperatures, pressure ranges, rate of pressure drop, leakage rates, and other system characteristics.

3.1.1 Test Gages

Test gages shall have a 4-1/2 inch or larger dial, be accurate to plus or minus one-half of 1 percent of full-scale range, and have dial graduations and pointer width compatible with readability and one-half the accuracy extremes. Maximum permissible scale range for a given test shall be such that the pointer shall have a test pressure position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 calendar days prior to use, test gage number, and project number.

3.1.2 Test and Acceptance Criteria

Aboveground water systems shall be tested per contract drawings and the applied test pressure shall be maintained without further addition of test media for not less than 2 hours. All joints must remain dry.

Duration of each leakage test shall be not less than 2 hours. During the test, the main shall be subjected to 200 psi pressure, based on the elevation of the lowest section under test and corrected to the elevation of the test gage.

Leakage is defined as the additional quantity of water supplied into

the laid pipe, or any valved section thereof, that is necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

Maximum allowable leakage for the piping installation (gallons per hour) shall be 0.1.

Backflow prevention devices in potable water systems and other water system devices shall be tested for proper functioning under conditions normal to their application.

3.2 AIR AND HYDRONIC SYSTEMS TESTING AND ADJUSTMENT

Operational balancing and adjustment of air-handling and hydronic systems shall be performed under the direction of an independent certified balancing agency. All work shall be done in accordance with NEBB TABES, ASHRAE 111, AABC MN-1 or SMACNA TAB HVAC SYSTEMS, where applicable, the requirements of the contract documents, and in the presence of the Contracting Officer.

Government reserves the right to require recalibration of any or all test apparatus in accordance with the frequency recommended by the component manufacturer, or when reasonable doubt of accuracy exists.

Hydronic systems structural and leakage testing shall be performed in accordance with requirements specified herein under "Water Systems Testing."

Air-handling systems structural and leakage testing shall be performed in accordance with requirements specified herein under "Air-Handling System Testing."

Components of the various air systems shall be adjusted to operate within the design and operating characteristics published by the equipment manufacturer. Government will require the services of an authorized representative of the manufacturer if the Contractor is unable to adjust any equipment.

Equipment shall not be operated until properly lubricated and brought into specified service condition.

Air- and hydronic-system final adjustments shall be permanently marked to be readily restorable if disturbed.

Systems acceptance is predicated upon successful completion of specified work, receipt by the Contracting Officer of certified data summarizing the performance of all systems within design intent, and approval thereof. Data shall be arranged by system and identified by apparatus and item, using standard forms, where possible, and supplementing with reasonable facsimiles, where necessary.

3.2.1 Air-Handling Systems

3.2.1.1 Balancing, Adjustment, and Acceptance Criteria

All new air handling systems shall be balanced.

Final volume conditions for all systems shall be within the following

limits:

Air-handler delivery: Plus 5 percent, minus 0 percent of design cfm at design temperature

Primary air delivery: Plus or minus 5 percent of design cfm at design temperature

3.2.1.2 Balancing and Adjustment, Apparatus and Procedures

Balancing and adjustment apparatus and procedures shall be in accordance with SMACNA TAB HVAC SYSTEMS or NEBB TABES or AABC MN-1.

Instrumentation shall be provided to record air movement data, motor kilowatt (kW) input, and power factor. If motor identification plate current value is exceeded, the next size larger motor, starter, and wiring (if necessary) shall be provided.

3.2.1.3 Test Reports

Test reports shall be provided on all systems tested together with test-apparatus data and air-diffusion device flow coefficients, and the following:

Air-handling apparatus data

Exhaust-fan data

Air-diffusion devices data

Duct-traverse data for the following:

Main supply duct
Main exhaust duct
Outside air-intake duct
Other ducts as indicated

Duct zone-traverse data for the following:

All zones
Air-handling apparatus
Air-diffusion devices data
Each main duct, exhaust duct, and outside intake data

Filter apparatus data, including visual condition, inlet pressure, and differential pressure for each filter installation

Coil data, including visual condition, inlet pressure, and differential pressure for each coil installation

3.2.2 Hydronic Systems

3.2.2.1 System Balancing, Adjustment, and Acceptance Criteria

Systems final flow conditions shall be within the following limits:

Flow station delivery: Plus or minus 5 percent of design gpm at design temperature

3.2.2.2 Test Apparatus and Procedures

Test apparatus shall consist of devices required for hydronic systems flow measuring and balancing including:

Pressure gages and fittings

Dry bulb thermometers

Wet bulb thermometers

Pyrometers

Balancing-cock adjustment wrenches

Differential-pressure gages or manometers

Thermometer wells, where necessary for balancing, but where permanent installation of thermometers is not indicated or required

Complete air balance shall have been accomplished before water balance begins.

3.2.2.3 Hydronic Systems Preparation

Hydronic systems shall be prepared in the following manner:

Proper installation of valves and balancing devices shall be verified.

Valves shall be opened to full-open position, including coil-stop valves, bypass valves, and return-line balancing cocks.

Strainer screens shall be removed and cleaned.

Water in each system shall be examined to determine that it has been treated.

Rotation of pumps shall be checked only after obtaining approval.

Expansion tanks shall be checked to determine that they are not air-bound and that system is full of water.

Air vents shall be checked at high points to verify proper installation and operation.

Temperature controls shall be set so that coils are on full cooling. Automatic bypass valves at coils and liquid chiller should close. Follow the same procedure when balancing heating coils are set on full heating.

Water temperature shall be checked at inlet side of cooling coils. Note rise or drop of temperature from source.

Next, each coil shall be balanced.

Upon completion of flow reading and adjustment of coils, all settings shall be marked and all data recorded.

Pressure drop through coils shall be measured at set flow rate on call for full cooling and on full heating.

Instrumentation shall be provided to record apparatus motor kW input and power factor. If motor identification plate current capacity and larger starter is exceeded, next-size larger motor and wiring shall be provided, as necessary.

Cooling-water flow shall be checked.

3.2.2.4 Operational Test Report

Operational test report shall provide data on systems tested, test apparatus data, and orifice or Venturi data, and shall include:

For each heating and cooling element:

Pressure drop across each circuit setter or
Inlet water temperature

Leaving water temperature

Inlet air temperature

Leaving air temperature

Pressure drop across each element

Pressure drop across bypass valve

Calculated and measured flow rates through coils and radiation elements

3.2.3 System and Temperature-Control Adjustment

3.2.3.1 Adjustment and Acceptance Criteria

After balance and adjustment operations have been completed, the system

shall be tested as a whole to see that components perform as an integral part of the system and that temperature and conditions are evenly controlled. Corrections and adjustment shall be made as necessary to meet the specified design requirements.

3.2.3.2 System Test Report

Test report shall be provided on the system and shall include:

Outdoor temperature

Room-by-room temperature and humidity conditions (center of cooled area at table top)

Calculation for total British thermal units per hour (Btu/hr) cooling required, including time of day and dry bulb outside temperature

Calculation for total Btu/hr heating required, including time of day and dry bulb outside temperature

3.3 STEAM AND CONDENSATE SYSTEMS TESTING

Prior to acceptance of the work, completed systems shall be tested in the presence of the Contracting Officer.

System shall be subjected to pressure tests to determine structural integrity, and to operational and cyclic tests, as necessary, to determine that system functions and operates as required.

After pressure tests and cleaning operations have been satisfactorily completed, system components shall be adjusted for proper operation within the design and operating characteristics published by the component manufacturer. In addition to the services of an authorized representative of the manufacturer, the Government reserves the right to require the services of an authorized representative of a component manufacturer if the Contractor is unable to adjust a component. Contractor shall arrange for such services and defray the cost.

3.3.1 Test Duration

Duration of a test will be determined by the Contracting Officer.

A pressure test shall be held for a minimum of 2 hours and a maximum of 24 hours.

See also "Operational Testing"

A test may be terminated by the Contracting Officer at any time after it has been determined that the system meets specified requirements.

3.3.2 Test Gages

Contractor's test gages shall conform to ASME B40.100 and shall have 8-inch or larger dials. Maximum permissible scale range for a given test shall be such that the pointer shall have a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 calendar days prior to use, test gage number, and project number.

3.3.3 Acceptance Pressure Testing

Testing shall take place during steady-state ambient temperature conditions.

Tests shall be hydrostatic.

Tests of steam and condensate systems shall be made using potable water.

Systems shall be tested at 1-1/2 times primary working steam pressure rating of system components, and the applied pressure shall be maintained without further addition of test media for not less than 1 hour. Maximum allowable pressure drop shall be 1 psi, or as approved.

Contractor may conduct tests for his own purposes, but the acceptance test shall be conducted as specified herein.

If testing reveals that leakage exceeds specified limits, the leaks shall be isolated and repaired, defective materials shall be replaced where necessary, and the system shall be retested until specified requirements are met. Leaking gasket joints shall be remade with new gaskets and new flange bolting. Old gaskets and bolting shall be discarded. Leaking tubing joints shall be remade with new fittings and new tube ends.

Other than standard piping flanges, plugs, caps, and valves, only commercially manufactured expandable elastomer plugs shall be used for sealing off piping for test purposes. Safe test-pressure rating of any plug used shall be not less than two times the test pressure.

Precautions shall be taken, when venting compressed air trapped during high-pressure hydrostatic testing, to preclude injury and damage. If adequate purging or vent valves are not provided to ensure removal of compressed-air cushion, the Contracting Officer may require the removal of any system component such as plugs and caps to ascertain that the water has reached all parts of the system. Components shall be removed from piping systems prior to hydrostatic testing whenever the component could be damaged by shock or test pressure.

Movement limiting provisions shall be used to protect expansion joints against overextension from system pressures.

Piping system components, such as valves, shall be checked for functional operation under system test pressure.

Piping shall be subjected to shock developed by a vigorously applied 2-pound hammer, as directed by the Contracting Officer.

Temperature of water used for testing shall not cause condensation on system surfaces.

3.3.4 Operational Testing

System shall be cycled five times, from start to operating thermal conditions, to verify adequacy of construction, system controls, and component performance, unless otherwise approved.

3.4 TEST REPORTS

Final test reports shall be provided to the Contracting Officer. Reports

shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports.

-- End of Section --

SECTION 23 09 23.98

DIRECT DIGITAL CONTROL SYSTEM
04/06

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

Section 23 00 00.00.98, "GENERAL MECHANICAL PROVISIONS", applies to work specified in this section.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

Microprocessor
Microprocessor Components
Control Devices
Temperature Sensors

Interface Components
Valves
Dampers
Operators
Cabinetry/Enclosures

SD-04 Drawings

CONTROL SCHEMATICS

Schematic drawings shall be submitted for Control and Instrumentation systems showing the relative location of all sensors and control output devices, control diagrams, and final terminations.

Sequence of Operations shall be shown on the Control Diagram drawings.

Submit a complete written Sequence of Operations for all portions of the system to be controlled by the Direct Digital Control System. Sequence of operation to be in English Language and following approximately the written Sequence of Operation as shown on the drawings.

Upon completion of the job any corrections necessary due to field programming changes will be incorporated into this Sequence of Operation and resubmitted as an AS-BUILT copy.

WIRING DIAGRAMS

Installation drawings shall be submitted, showing the complete wiring diagrams with all component devices labeled to reflect field wiring numbers.

SD-06, Instructions

Operating Instructions shall be submitted for Control and Instrumentation consisting of standard operating procedures and shall include start up, shutdown, programming and software use instructions and emergency operation procedures.

Submit a complete Printout of all software, including all control algorithms, calculations, and entire control sequence. The program print out shall be in English Language source code, and each line shall be annotated with remark describing the action of that line. The remarks may be printed out as part of the program or may be added by hand to a copy of the actual print out.

The Contractor shall provide classroom and Field Instructions in operation and maintenance of systems equipment where required by the technical provisions. These services shall be directed by the Contractor using the manufacturer's factory trained personnel or qualified representative. The Contracting Officer's Technical Representative (C.O.T.R.) shall be given fourteen calendar days materials belonging to the manufacturer or vendor; e.g., lists, static exhibits, visual aids shall be made available to the C.O.T.R.

SD-07 Schedules

Submit a list of all input and output points to the microprocessor including port numbers, description and location of the device, and English language character designation for the device with all variables, set points, flags, and alarms.

Material, Equipment, and Fixture Lists shall be submitted for complete system including manufacturers style or catalog numbers, specification and drawing reference numbers, warrantee information, and fabrication site information.

Submit a list of recommended spare parts.

Final submittal of schedule to include all items as noted above with all schedules in AS-BUILT form.

SD-09 Reports

FINAL REPORTS (SYSTEM TESTING)

Test Reports shall be submitted for the DDC System in accordance with the paragraph entitled, "Testing, Calibration, and Acceptance" of this section.

SD-19 Operation and Maintenance Manuals

The Contractor shall submit 6 copies of the Operation and Maintenance Manuals 14 calendar days prior to final testing the DDC Systems. Data shall be updated and resubmitted for final

approval no later than 30 days prior to contract completion.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to fading. Pages for vendor data and manuals shall have 3/8 inch holes and be bound in a 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets, in a loose leaf binder. The binder shall lie flat with printed sheets that are easy to read. Caution and warning labels shall be clearly labeled. Equipment catalog cuts shall be clearly marked to indicate the item furnished.

In addition, prior to final approval all Manufacturers Software Packages including electronic compact disks and package manuals, one back up
copy of the software, and two copies of programs incorporating all field changes shall be submitted to the C.O.T.R. All software and programs submitted shall be on electronic compact disk and compatible with
existing Government hardware and software.

1.3 DESCRIPTION OF SYSTEM

The Direct Digital Control (DDC) System, referred to herein shall be a complete and total, "turn key" system incorporating a microprocessor unit with all of its software and hardware components, all portions of the necessary pneumatic control and sensing devices, and all portions of the electrical system including all control and limited power wiring. All necessary hardware, software, electronic, electrical and pneumatic components, training, testing, calibration as defined herein, on the drawings, or the sequence of operation to be considered as part of the "complete system".

The DDC System shall be a fully automated field monitoring and control system capable of performing its assigned control and energy management functions as a stand alone unit. It shall be capable of being incorporated into the Energy Management Control System (EMCS) for communication with or management
by the EMCS. See Part 1.4.1.1 for information on existing EMCS. As necessary additional slave units as dictated by the scope of work, sequence of operation, and spare capacity requirements shall be included.

All portions of the "complete" DDC System to be supplied by and to be the responsibility of the Temperature and Controls (TC) Contractor.

1.3.1 Direct Digital Control System

The Direct Digital Control System shall be fully integrated into the existing EMCS as follows:

1.3.1.1 Existing System

The NASA Glenn EMCS is composed of distributed microprocessor-based field panel configured in four (4) peer-to-peer networks that are supervised by a host computer. The host computer provides database management and operator

interface through five (5) PC-based workstations: System vendor is Siemens Building Technologies, Inc., Cleveland, Ohio --(216) 332-7360.

1.3.1.2 Building Network

All new master microprocessors shall be configured as unique node(s) on the existing EMCS peer to peer network. Network transmission shall be RS-485 via twisted shielded cable. All communication hardware, software, database and start-up shall be provided to accomplish seamless integration with the existing EMCS building network including (1) high speed data transfer rates for alarm reporting, report generation, data up-line/down-line loading, two (2) message and alarm buffering, three (3) error detection, correction, and retransmission to guarantee data integrity, and four (4) synchronization of real-time clocks.

1.3.1.3 Floor Networks

New or existing Master DDC panels shall support up to three (3) local floor-level networks for bi-directional communication with the Master DDC. Each floor network may support a family of Application Specific Controllers (ACSs) or other point expansion panels. See the sequence of operation for specific configuration requirements.

PART 2 PRODUCTS

2.1 MICROPROCESSOR UNITS

2.1.1 Stand Alone Capability

The master microprocessor shall have the capability to function as a stand alone unit. Each additional slave unit (as and if required) need to have stand alone capability provided that each slave panel is tied to the master
panel as a true slave with a hard wired communication and power link.

2.1.2 Communication Capability

Each master microprocessor (and slave unit through the master or as stand alone unit) shall be capable of being interfaced with the existing Government EMCS with the addition of communication hardware and all required programming such that the master panel (and all slave panels) can communicate with and be supervised by the EMCS.

The microprocessor shall be capable of performing its full control and energy management functions, regardless of the condition of the communication link with the EMCS.

2.1.3 Quantity of Microprocessor Units

The TC Contractor shall be responsible for providing the quantity of microprocessor units to satisfy all of the following conditions:

Microprocessor unit(s) must have capacity to fully implement the requirements contained within the specifications for both control and energy management as well as having capacity for memory to accomplish all historical, time clock, and field programmable programs as defined herein.

Microprocessor unit(s) must be capable of fully implementing all portions of the sequence of operations including all sensing, read only, and control

output points as defined within the body of the sequence of operation and by the drawing schematics.

Microprocessor unit(s) must have a minimum of 25 additional (spare) capacity based on the required quantity of digital and analog inputs and outputs utilized to completely implement the system. As necessary to complete the spare capacity requirements, an additional slave panel(s) shall be installed including all power and communication links and have battery backup capacity. The system shall have a minimum spare capacity of not less than 8 inputs and 8 outputs.

Regardless of the number of panels indicated on the drawings (or elsewhere), the number provided shall accommodate the above capacity criteria.

2.1.4 Application Specific Controllers (ACSs)

2.1.4.1 General

Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (ASCs). Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time, digital control processor. The spare point requirement, unless specified elsewhere, shall not apply to ASCs.

Each ASC shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.

ASCs shall be configured on floor networks in a functional relationship manner with Master DDC controllers. For example, a VAV terminal unit controller shall be on a floor originating from the DDC Controller that is controlling its corresponding air handling unit.

2.1.4.2 Unitary Controllers (UCs)

Provide UCs where indicated by the sequence of operation. Each UC shall have sufficient memory to accommodate its point database and operating programs. All databases shall be stored in non-volatile memory. Programs shall be fully customized to meet the exact sequence.

Controllers that utilize pre-packaged or "canned" programs shall not be acceptable where unitary controller is used.

2.1.5 Expandability

The DDC System shall be expandable in the future by the installation of additional slave panels. Total system capacity shall be expandable to at least 180 input and 180 output points.

2.1.6 Battery Backup

The microprocessor shall incorporate a battery backup system capable of retaining the programs Random Access Memory (RAM)for all units for not less than 30 hours.

The battery backup shall incorporate an automatic battery charger.

2.1.7 Hand/Off/Auto Capability

Each and every output point of the microprocessor shall have a manual three position switch marked "Hand/Off/Auto" (HOA) which is capable of overriding the microprocessor output signal when in the "hand" or "off" positions. The microprocessor shall be capable of interpreting the HOA switch position and communicating the position of this switch.

Switching the output signal of any single output point to "Hand" or "Off" shall not affect the signal of any other output point, except as necessary by program function or logic.

All HOA switches shall be contained within the microprocessor cabinet and not be accessible without opening the panel cover.

All HOA switches shall be viewable through a clear plexiglass viewing window in the cabinet cover panel.

All HOA switches shall be coupled with pilot lights (also viewable through the plexiglass window) indicating the position of the HOA switch.

2.1.8 Control Functions

2.1.8.1 Control

Control Algorithms shall be available and resident in the digital system controller to permit Proportional, Integral and Derivative control modes in any combination to meet the needs of the applications. Other control modes such as incremental, floating or two position shall be available to adopt to job needs.

All control shall be performed in a digital manner using the digital signal from the microprocessor based controller converter through electronic circuitry for modulation through transducers to produce the pneumatic signal for actuation of pneumatic actuators.

2.1.8.2 Energy Management

The digital system controller shall be capable of performing all the energy management functions, whether or not required at this time, necessary to reduce energy consumption. These programs shall include but not be limited to:

Supply air reset using space load demand and outside air temperatures

Economizer control.

Time of Day Scheduling

Optimal start using an adaptive algorithm to prevent the need for manual adjustment of parameters.

Client tailored programs. The library of routines available in firmware must be capable of generating additional programs as may be required for specific requirements. These should include but not be limited to:

Chiller Efficiency
Boiler Efficiency
Intermediate Seasonal (dead band) Control
VAV Fan Matching and Supply Fan Control
Trending of Variables
Totalizing

Specific program requirements shall be as needed to completely accomplish the requirements of the sequence of operations as defined on the construction drawings, and to accomplish the requirements of this specification.

2.1.9 Historical Data Storage

The microprocessor must be capable of storing all input and output values in its Random Access Memory. For each variable stored the length of time between samples shall be adjustable via software. The microprocessor shall be capable of retaining at least 24 samples of each input/output in its memory. The amount of memory required for storage of historical data shall be in addition to the amount of memory required for other functions defined herein.

2.1.10 Off Hour Programming and Override Capability

The microprocessor shall be capable of "off hour" programming both for evening and weekends. The instructions for "off hour" timing are defined in the Sequence of Operation.

As denoted in the Sequence of Operation and on the drawings the microprocessor may be required to respond to several override switches each of which governs its own system and area. The microprocessor shall be programmed to respond to each of those areas independently of other areas. All switches are to be timed out switches with a minimum override time of two hours and a maximum override time of eight hours. Unless otherwise specified, override to be adjustable turn knob.

2.1.11 Holiday Programming

The microprocessor shall operate on a "real time" calendar. As such it shall be capable of responding to at least ten pre-programmed holidays including New Years Day, Martin Luther King Day, Presidents Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day, and Christmas Day. In addition the microprocessor shall have the capability of having at least six additional "off" days programmed into it and further have the capability of adding these additional days to its "real time" calendar for permanent storage.

2.1.12 Field Programmable

The controller shall contain all necessary mathematic, logic, utility functions and all standard energy calculations and control functions in Read Only Memory (ROM) to be available in any combination for field programming the unit. These routines shall include but not be limited to:

Math Routines:
Basic Algebra
Binary Logic
Relational Logic
Fixed Formulas for Psychometric Calculations

Utility Routines for:
- Process entry and exit
- Variable adjustments and output
- Alarm indication
- Restart

Control Routines for:
- Signal compensation
- Loop control
- Energy conservation
- Timed programming

2.1.13 Calibration Compensation

To maintain long term analog accuracy in the controller sensing circuits, the DDC System shall sense the voltage being supplied to the resistance sensing element and through firmware compensate for power supply changes due to long term drift or drift due to ambient temperature changes at the power supply.

2.1.14 Diagnostics

The DDC System shall contain in its program a self test procedure for checking the indication lights on the digital display, and by means of nondestructive memory, check the computer.

2.1.15 Default Operating Procedure and Alarms

All variables shall be identified as being reliable or unreliable. When a calculation is required to use a value (sensed or calculated), which is being identified as being unreliable, the unreliable data shall flash. The calculation will use a default value programmed into the unit.

All alarms (for example, a fan did not start) and all deviation alarms (for example, temperature out of range of programmed set point) shall send an alarm signal and light a red light. A scan can then identify all alarms conditions and their identifier.

2.1.16 UL Approval

The DDC microprocessor shall be an approved U.L. system, with U.L. listing as a signaling system.

2.2 SOFTWARE

2.2.1 Language

The software shall be written in an easily understood computer language. A sample of the language to be used shall be submitted for approval by the C.O.T.R.

Terminology used shall be in accordance with ASHRAE 85.

2.2.2 Software Accessibility

The software shall be written such that field changes and general accessibility to the microprocessor unit are limited by password protection.

There shall be a minimum of 3 password protected levels, as follows, with the most accessible (least protected) level listed first.

The least protected level shall allow access with "read only" and "print" (if it does not compromise other levels) capability. At this level, through a field connected IBM compatible PC unit (or, if available, through a phone modem), the user shall have the ability to recall program variables and view them. Further, the user shall have the capability of printing screen and historical data programs previously written and stored in the microprocessor RAM. No other accessibility beyond "read and print" only is requested or desired and any capability beyond this for this level is to be identified in writing for approval.

The next level shall allow all as identified in the first (lowest) level listed above plus the following:

It shall allow access to change variables and set points previously installed in the program and identified in the Sequence of Operation as "adjustable".

It shall allow the user to define and extrapolate historical data parameters.

It shall allow the user to recognize and acknowledge any alarms and flags.

It shall allow the user to make changes to the real time clock and will allow the user to change holiday and off hour scheduling.

It shall allow the user to override the program and enable or disable control input or outputs. NOTE THAT WHEN ANY OF THE PROGRAM INPUT OR OUTPUTS ARE IN THE DISABLE MODE THIS SHALL CLEARLY AND BOLDLY BE RECOGNIZED WHEN READING VARIABLE AND SET POINT VALUES.

The highest level shall allow the user to do all as identified in the first two levels listed above plus the following:

It shall allow the user to enter and modify the program logic and further shall allow the user to incorporate changes into the permanent memory of the microprocessor.

It shall allow the user to assign new passwords and to reject previously assigned passwords.

2.2.3 Software Programming

The software program shall be written to fully implement the Sequence of Operation, as shown on the drawings, and to accommodate all requirements as defined herein.

In addition the software program shall accommodate the following:

The software program shall be written such that changes to variables and setpoints can be made without accessing the program logic statements.

All inputs, outputs, variables, and setpoints shall be referenced throughout the software by an "alphanumeric" designation. This designation shall be consistent as possible in character, shall be as

descriptive as possible of the physical device, and as much as possible define the physical location of the device (for example **I.RMSEN.1** could be used to define the Input of the **RooM**. **SEN**sor located in microprocessor number **1**). Further, these designations shall be consistent between the program statements and all submitted lists, drawings, and schedules. A list of designations shall be submitted to the C.O.T.R. for approval prior to installation in the microprocessor.

All displayed units (historical or point in time data) shall be in standard English units such as Degrees Fahrenheit, Pounds-per-square Inch, Inches-of-Water Column.

Final values for all variables and set points, including alarm ranges, shall be approved by the C.O.T.R. and changes to these variables, up until the time of final acceptance, shall be made at no cost to the Government.

2.2.4 Alarms

2.2.4.1 Preset Alarm Requirements

Alarm values shall be preset for all input points to the microprocessor. If the alarm value is exceeded a flag shall denote the alarm. The flag shall remain denoted until the flag is acknowledged.

2.2.4.2 Future Considerations for Alarms

The TC Contractor shall provide an alarm management application program inherent to the DDC Controller(s) that will update the existing building network and host computer and support existing host-level alarm management functions such as custom messaging, graphical displays, archiving functions, and destination routing. The TC Contractor shall implement and demonstrate the local alarm management program and its compatibility to the host-level alarm software. All host-level alarm management additions or modifications for this project's work shall be by the TC Contractor (See also Part 2.6 of this Section).

2.2.5 Software Loading and Downloading Capability

Approved programs shall be loaded into the microprocessor via owned IBM compatible PC with a electronic compact disk.

At completion of the job, after all final debugging has occurred, and the program has been proven to be operational the TC Contractor shall provide the Government with two (2) copies of the final program and software to run the program. Copies shall be provided on electronic compact disks and shall be compatible with government owned hardware and software.

Software shall allow for future downloading and reloading of the program, including all permanent changes made to the program by authorized government personnel, from and into the microprocessor.

2.2.6 Trend Logging

TC Contractor shall demonstrate the use of trend logging for all equipment, alarms, variable, set points, and historical data collected. The TC Contractor shall trend variables/setpoints (20 as defined by COTR) to prove operation as specified.

2.3 CENTRAL CONTROL CABINET

2.3.1 General

Control cabinet, for housing of control devices such as transducers and read out gages, shall consist of an enclosed wall mounted modular cabinet section. The front face shall be a hinged cover complete with incorporated cabinet type key lock. **NOTE: All locked cabinets to be keyed such that one key is capable of opening all lockable cabinets, including the microprocessor cabinet, regardless of quantity used.** Four keys shall be provided to the C.O.T.R. at completion of the project.

Control cabinets damaged in shipment shall be replaced. Microprocessor Cabinets shall be replaced entirely including all internal components and boards. Control Device Cabinets shipped with control components installed shall have all components replaced also. Control Device Cabinets shipped without control devices installed can have damaged parts (door, tub, back plates) replaced.

2.3.2 Microprocessor Control Cabinet(s)

Cabinet for the microprocessor shall incorporate all requirements as shown on the drawings and as specified herein. Microprocessor cabinet can be manufacturers standard unit provided that it meets or exceeds all requirements stated herein for "Control Cabinets" and provided that all requirements for switches, visibility of switches, and indicator lighting are also satisfied.

Finish for the microprocessor control cabinet to be manufactures standard finish.

NOTE: All finish and painting of the microprocessor cabinet shall be done in the manufacturers shop prior to the installation of any components.

2.3.3 Control Device Cabinet(s)

Control Device Cabinet(s) are cabinets supplied by the Controls Contractor to house devices such as transducers, readout gauges, control air gauges, etc.

Cabinets shall be made of steel or aluminum and shall provide a flat faced, rigid front panel. Finish shall be manufacturer's standard.

Surfaces shall be free of scale, welding slag, and dirt, and shall be flat without waves. Handling during installation shall not distort the cabinet.

Cutouts shall be square with panels to ensure that instruments can be installed level and square. Finished cutouts and holes shall be free of burrs and sharp edges.

Where multiple cabinets are required, cabinets shall be made up of modular or fabricated sections and no individual section shall exceed 915 millimeters wide by 1220 millimeters high. Cabinet section joints shall be aligned to each other and installed with bottom parallel to the floor. Each cabinet shall be anchored to the wall or floor as required.

Exterior hardware (screws, hinges, latches) shall be a high grade steel with a polished-nickel or chrome plated finish.

Interior hardware (screws, nuts) shall be cadmium plated steel.

Access door shall be provided with hinges, latches, and locks. Use of right or left side hinges to be as shown on drawings or to fit application if not shown. Cabinet frame shall be reinforced to prevent doors from sagging when open.

NOTE: All locked cabinets to be keyed such that one key is capable of opening all lockable cabinets, including the microprocessor cabinet regardless of quantity used.

Field touch up of Control Cabinets shall only be done after all internal components have been removed. Covering these components prior to touch up is not acceptable alternative. An alternative for field touch up of doors is to remove the door from the cabinet, cover the cabinet with plastic to prevent construction dust from entering the cabinet, and make necessary touch up to door away from the cabinet.

NOTE: All finish and painting of the Control Device Cabinet shall be done in the Control's Contractors shop (or in the field) prior to the installation of any components.

2.4 SENSORS

2.4.1 General

All electronic sensors shall have characteristics compatible to the device to which they are connected.

All analog sensors shall utilize industry standard signals (4 to 20 milliamps or 0 to 20 volts D.C.) to facilitate future expansion. Sensors based on proprietary equipment **are not** acceptable.

All sensors shall be isolated from environments which could adversely affect their ability to accurately perform their function. For example, thermostats installed on exterior walls shall be thermally isolated from the affect of outdoor conditions.

All sensors shall be placed such that they can accurately measure the conditions of the environment being sampled. If the appropriate location differs from that shown on the drawing, it is the responsibility of the TC Contractor to inform the C.O.T.R. of the suggested location prior to installation of wiring or conduit for the sensor.

2.4.2 Room or Duct Temperature Sensors/Thermostats

Temperature sensor signals shall be directly proportional to the variations in the measured temperature. The linearity shall be within plus or minus 1/2 of 1 percent for a 93 degree C span, and plus or minus 1 percent for a 10 degree C span, throughout the scale range.

Thermostats shall have adjustable knob for set point and thermometer included.

2.4.3 Electrical Low-Limit Duct Thermostat

Air-handling unit freeze protection shall be provided. Lowest temperature across any 12 inches of bulb length, single tube, shall be sufficient to

trip a snap-acting, single-pole, single-throw switch when the temperature sensed is equal to, or below, set point. Minimum length of bulb shall be 20 feet. One limit thermostat shall be provided for every 20 square feet of coil surface. Thermostats shall have manual reset.

2.4.4 Temperature Sensors for Water Service

Well type temperature sensors shall have the same degree of accuracy as room type sensors for a given temperature span.

Wells shall be extended into at least 75% of the total depth of the inside diameter of the pipe and shall not impede the flow of fluid in the pipe. Where insulated piping is being installed the sensor shall be furnished with an extension such that the sensor connection is outside the insulation.

Where a question exists the C.O.T.R. is to be contacted for a final decision on well style, depth, and location.

The water temperature sensor shall be inserted in a non-ferrous separable socket well.

2.4.5 Building or Air Handling Unit Static Pressure Transmitter

Building static-pressure controller shall be a double-bell, differential type with temperature compensation. Scale range shall be minus 124 to plus 124 pascals, and sensitivity shall be within plus or minus 12.0 pascals. The controller shall be supplied with an adjustable setpoint over the full scale range, an adjustable throttling range (proportional band), and electronic output.

Total system accuracy shall not be less than 12.0 pascals.

2.4.6 Air, Water or Steam Pressure Transmitters

Pressure transmitters shall be the indicating type for gas, liquid, or steam service. Transmitter range shall be selected for system operating characteristics. Output shall be proportional to system pressure and shall be electronic.

Total system accuracy shall not be less than 1/2 percent of the system range.

2.5 CONTROL SYSTEM VALVES

Valve bodies, 2 inch iron pipe size (ips) and smaller, shall be bronze with screwed end connections. Valve bodies, 2-1/2 inch ips and larger, shall be cast iron and shall have flanged end connections.

Valves shall be single seated for dead-end service except where otherwise indicated.

Modulating service valves shall have plugs matched to the characteristics of the coil for effective control. Valve-stem packing shall be tetrafluoroethylene, spring-loaded, and self-adjusting.

Valve stem shall be top and bottom guided and shall be AISI 303 corrosion-resistant steel. Cage construction is acceptable.

Valves shall be provided with position indicators and, where indicated or

required for proper operation, shall be provided with positioners.

Valve linkage shall have an adjustment for valve lift.

2.5.1 Hydronic

Hydronic system valve bodies and trim shall be rated for service pressures through 125 psi at 250 degrees F.

Hydronic system valves shall have replaceable plugs and seats of SAE 72 brass, selected for maximum life depending on application conditions.

Maximum pressure drop across any hydronic system valve at maximum flow shall be 5 feet of water.

2.5.2 POWER-OPERATED DAMPERS

2.5.2.1 Frame and Blade Assembly

Frames and blades shall be constructed of extruded aluminum.

Resilient seals shall be mechanically attached, field replaceable seals. Attachment by adhesive shall not be acceptable. Jamb seals shall be flexible metal compression-type constructed of aluminum.

Frames shall have corner reinforcement and stay rods, where necessary. Frames shall be fabricated by welding or riveting. Damaged galvanized surfaces shall be repaired by coating with an equal weight of zinc.

For static pressures in excess of 3 inches wg, master-blade-driven dampers with blades longer than 24 inches shall have a maximum blade width of 8 inches. Maximum blade width for other services shall be 10 inches. Maximum blade length shall be 48 inches. Dampers more than 48 inches wide shall be made in two or more sections with intermediate mullions; each section shall be mechanically interlocked with adjoining section or sections.

Minimum shaft size shall be 1/2 inch, round.

Where linkage is such that operator torque is applied to a master blade and transmitted therefrom, that blade shall be reinforced and the shaft shall be full length. This type construction shall be limited to 2 inch wg, static pressure.

Blades shall be attached to round shafts by hardened cup-point setscrews, or by being pinned. A minimum three-thread engagement shall be provided. Where setscrews are used, two setscrews, 90 degrees apart, shall be provided to secure master blade. Shaft end retainers may be secured by pins or spring washers in grooved shaft or by similar construction.

Frames shall be calked with elastomer compounds to prevent bypass leakage.

Blades without resilient seals shall have interlocking edges.

Maximum leakage of dampers shall be 1% of rated wide open flow.

2.5.2.2 Bearings

Shaft bearings shall be graphite-impregnated nylon sleeve type, except as

otherwise indicated. Thrust washers shall be provided at bearings, when necessary to maintain blade alignment.

Linkage pivot bearings shall be graphite-impregnated nylon.

2.5.2.3 Installation

Dampers shall be installed in accordance with the manufacturer's instructions.

2.5.3 Operators

Motor operators shall provide smooth proportional control under operating conditions normal to the system.

Spring-return operators shall be provided for two-position control.

Spring returns shall be provided on reversible operators where required for fail-safe operation.

Operators operating in sequence with other operators shall have adjustable operating ranges and set points.

Operators shall have sufficient power on closeoff to provide tight sealing against maximum system pressures.

Operators shall close valves and dampers to fail-safe position indicated.

2.5.4 Dampers

Dampers shall be equipped with operators of sufficient power to control dampers, without flutter or hunting, through the entire operating range at air velocities at least 20 percent greater than maximum design velocity.

2.5.5 Electric Operators

Electric motor operators for modulating control shall be reversible type.

Electric motor operators shall be split-phase type with oil-immersed gear train. Motor shall have ample capacity to handle applied loads under operating conditions normal to the system. Locations where temperatures fall below minimum operating temperature of operator shall be heated.

2.6 DATABASE MODIFICATIONS

The TC Contractor shall provide all database additions and modifications to the central host computer to operate the EMCS, including databases for alarm management, historical archiving, time-of-day programming, building equipment and floor plan graphical presentations. The Temperature Controls (TC) Contractor shall insure that the equipment and software provided under this project is fully compatible with the existing ECMS operating software and file structure. Floor plan graphical presentations shall be approved by the COTR.

2.7 SERVICE CONTRACT

TC Contractor shall provide a one year service contract including but not limited to a complete checkout of controls, including confirmation of transducer accuracy, system program operation, and calibration of all

operator devices and sensors. Service to be provided twice (one-summer and one-winter) per full year following final acceptance. TC Contractor to submit a written report within 30 calendar days of inspection.

PART 3 EXECUTION

3.1 INSTALLATION

Special tools shall be provided as required for the operation and adjustment of controllers, instruments, or other control system devices.

Installation of the complete DDC System, including all portions of this sectionand all control and limited power wiring (as defined below) shall be by a single TC Contractor.

All control components shall be done by a qualified control and instrumentation specialist, working under the direction of the manufacturer's representative.

Installation shall conform to the published or written instructions of the manufacturer, except as otherwise specified herein.

Installation of electrical work to be performed by the TC Contractor shall conform to the specifications in Division 26 unless specified differently herein.

3.2 MICROPROCESSOR AND CONTROL DEVICE CABINET INSTALLATION

Microprocessors shall be installed in locations as indicated on the drawings. All portions of the cabinetry including related components and control devises in separate cabinets shall be mounted adjacent to each other.

A minimum of 1 meter clear space shall be provided in front of the face of the hinged cabinet door. For cabinet installations with doors greater than three feet wide, clear space shall be provided in front of the panel to open the door 105 degrees from a closed position.

Cabinets shall be mounted such that the center of the panel is 1.5 meters above finished floor. In no case shall the top of a panel exceed 2.2 meters above finished floor.

Stacking of panels is prohibited unless specifically shown otherwise on the drawings, or approved by the C.O.T.R..

CONTRACTOR TO COORDINATE THE INSTALLATION OF CONTROL PANELS SUCH THAT ALL BUILDING MATERIAL FINISHES ARE COMPLETE ENOUGH THAT THERE WILL BE NO SPRAY PAINTING IN ROOMS AFTER THE MICROPROCESSOR CONTROL CABINET OR CONTROL DEVICE CABINET (WITH CONTROLS INSTALLED IN CABINET) HAVE BEEN INSTALLED. IF TOUCH UP PAINTING IS REQUIRED AFTER INSTALLATION IT SHALL BE BY BRUSH ONLY OR THE MICROPROCESSOR AND/OR CONTROL CABINET (WITH CONTROLS INSTALLED IN CABINET) SHALL BE REMOVED.

3.3 SOFTWARE

"Approved" software packages shall be entered into the microprocessor in the field and debugged after all necessary components (such as air

handlers, room sensors, control components) have been installed and proven operational. Work on portions of the system is allowed where all components of that portion can function as a stand alone system.

Prior to on-line operation a complete demonstration and readout of the computer real time responsibilities of sensing and control shall be demonstrated in the presence of the C.O.T.R. and project managers representative.

3.4 ELECTRICAL AND ELECTRONIC EQUIPMENT INSTALLATION

The following requirements shall supersede any requirements as shown in the Electrical portion of this specification (Division 26).

3.4.1 Limited Power Wiring Requirements

The Contractor is responsible for providing sufficient power to a junction box within 1.8 meters of the microprocessor master panel. Appropriate circuit
breakers shall be provided by the Electrical Contractor. The exact power requirements are to be determined by the TC Contractor.

The Contractor is responsible for providing a clean and direct ground at the above junction box. By "clean" and "direct" it is meant that one of the following two methods of grounding shall be provided.

Preferred method is a direct ground line to a properly installed ground rod.

Option is a ground wire "Cad-Welded" to a building ground wire which is directly connected to a building ground. Note that it is not acceptable to connect to building steel as a ground source.

Power wiring from junction box (as defined above) to the microprocessor shall include the following:

- Connection devices, including any terminal strips required
- Surge protection devices
- Ground system (see definition below)
- Any and all power wiring between microprocessor and control devises including linking wiring.
- Any and all power wiring necessary for the operation of motorized dampers, control valves, control devices, controlled directly and/or indirectly by the microprocessor.

NOTE: THE TERM "POWER WIRING" USED ABOVE SHALL BE CONSTRUED TO MEAN ALL WIRE, CONDUIT, FITTINGS, JUNCTION BOXES AS IS NECESSARY FOR A COMPLETE AND TOTAL SYSTEM. FURTHER ALL "POWER WIRING" SHALL BE DONE IN FULL COMPLIANCE WITH DIVISION 26 "ELECTRICAL," HEREIN UNLESS SPECIFICALLY EXCEPTED ABOVE.

3.4.2 Control Wiring

Contractor shall be responsible for the complete installation of the entire control wiring package including higher voltage (110 volt thermostat) control wiring.

All control wiring to be as required in Division 26 of this specification.

NOTE: THE TERM "CONTROL WIRING" USED ABOVE SHALL BE CONSTRUED TO MEAN ALL WIRE, CONDUIT, FITTINGS, JUNCTION BOXES AS IS NECESSARY FOR A COMPLETE AND

TOTAL SYSTEM.

3.4.3 Grounding System

All grounded devices, relative to and including the microprocessor unit shall be individually grounded with a direct tie to the "clean" and "direct" ground line as defined in above paragraph entitled, "Limited Power Wiring Requirements."

The use of grounding terminal strips is permitted provided that each strip is tied directly to the "clean" and "direct" ground line.

NO DAISY CHAIN GROUNDING SHALL BE PERMITTED.

The only exception to the requirements for grounding shall be that grounding done at and by the manufacturer's factory shall be per the manufacturers standards. Note that components assembled by the TC Contractor, whether in his shop or in the field shall not be considered to be factory installed.

All panels including the microprocessor and control device cabinets shall be individually grounded back to the "clean" and "direct" line described above.

3.5 SURGE SUPPRESSION

All surge suppression devices are to be sized, furnished and installed by the TC Contractor.

All surge suppression devices to be direct grounded to the "clean" and "direct" ground line provided by the Electrical Contractor.

All surge protection devices to be fuse protected at the device.

3.5.1 Surge Suppression for Power Wiring

All power wiring to the microprocessor and control cabinet to be protected by a surge suppression device. Devices to be selected such that they fully protect the microprocessor and all down stream equipment based on the manufacturers recommendation.

Where multiple power line inputs are used with multiple microprocessors or control device cabinets a separate surge protection device will be used for each device.

3.5.2 Surge Suppression for Communication and/or Phone Connection

The surge suppression device for the microprocessor shall be equipped with phone line class surge protection regardless of whether or not a communication card or phone modem system is provided.

If a separate surge protection device is used for the phone, it shall be direct connected to the "clean" and "direct" ground line.

3.6 ELECTRO MAGNETIC FIELD INTERFERENCE

Manufacturer's recommendations are to be followed relative to the placement of microprocessor units, field routing of sensing, control, and communication wiring, and required shielding as necessary to prevent

interference from Electro-Magnetic Fields (EMF) inherent in electrical power equipment.

If not specified in the manufacturers literature the following minimum guidelines shall be followed:

No microprocessor, control cabinet, or exposed control wiring shall he placed within 6.1 meters of an electrical power source (for example, transformer-feed side voltage rating, switch gear, motor) that is operating at higher than 500 volts.

No microprocessor, control cabinet, or exposed control wiring shall be placed within 3.1 meters of an electrical power source (for example, transformer-feed side voltage rating, switch gear, motor) that is operating between 300 and 500 volts.

No Control wiring, installed in conduit, shall be run within 4.6 meters of
power wiring, not encased in metal conduit, operating above 500 volts.

No control wiring, installed in conduit, shall be run within 2.2 meters of
power wiring, not enclosed in metal conduit, operating between 300 and 500 volts.

No Control wiring, installed in conduit, shall be run within 3.1 meters of
power wiring, encased in metal conduit, operating above 500 volts.

No control wiring, installed in conduit, shall be run within 1.5 meters of
power wiring, encased in metal conduit, operating between 300 and 500 volts.

Sensing equipment shall follow the same guidelines as noted for the control wiring installed in conduit.

EXCEPTION: AS NECESSARY SENSORS WILL BE ALLOWED CLOSER WHERE THERE FUNCTION DICTATES SUCH. (i.e. Pressure transmitter around filters on air handling units may necessarily be installed inside the minimum distances noted above because of proximity of filters to motor, however every effort should be made to maximize the distance between the sensor and voltage source.)

3.7 TESTING, CALIBRATION, AND ACCEPTANCE (COMMISSIONING)

After the inspection has been completed, all systems shall be checked for continuity. All control equipment shall be tested and adjusted, relative to design, function, and performance, and shall otherwise be made ready for air handling system acceptance tests. A report showing set points and final adjustments of all equipment and controls shall be submitted to the Government C.O.T.R.

After air handling system acceptance and after systems have operated in normal service for two weeks, The adjustments on all equipment and devices shall be checked and a report submitted indicating all items tested. All items found to be out of order shall be corrected. When all HVAC systems are in specified operating condition and when all other pertinent

specification requirements have been met, and when training is complete the Temperature and Control package will be accepted.

Equipment necessary to check the calibration of the control system components shall be provided by the contractor. Components not in calibration shall be corrected or replaced.

3.8 OPERATING INSTRUCTION

Written and verbal operating instructions on sequence of operations and controls shall be provided. Training shall be completed within two weeks of the final test and calibration. Time for training shall be coordinated through the Contracting Officer.

3.9 SPECIAL TOOLS

Special tools shall be provided as required for the operation and adjustment of controllers, instruments, or other control system devices.

-- End of Section --

SECTION 23 22 13.35 40

STEAM TRAPS
06/06

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM A 216/A 216M	(2004) Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 278/A 278M	(2001; R 2006) Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C)

1.2 GENERAL REQUIREMENTS

Section 23 00 00.0098 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

Manufacturer's Catalog Data shall be submitted for steam traps in accordance with referenced standards contained in this section.

Installation Drawings for steam traps shall be in accordance with the manufacturer's published instructions.

Listing of Product Installation shall be submitted for steam traps, indicating at least five installed units, similar to those proposed for use, that have been in successful service for a minimum of five years.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Manufacturer's Catalog Data shall be submitted for steam traps in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Installation Drawings shall be submitted for steam traps in accordance with paragraph entitled, "General Requirements," of this section.

SD-07 Certificates

Listing of Product Installation shall be submitted for steam trap assemblies in accordance with paragraph entitled, "General Requirements," of this section.

Certificates shall be submitted for the following in accordance with paragraph entitled, "Materials," of this section.

Steam Traps
Trap Bodies and Components

PART 2 PRODUCTS

2.1 MATERIALS

Traps exposed to weather shall be freezeproof.

Certificates shall be submitted for Steam Traps and Trap Bodies and Components showing conformance with the referenced standards contained in this section.

2.2 TRAP APPLICATION

SERVICE	TRAP TYPE
Steam mains, risers, branches	Type IB, inverted bucket with thermostatic air vent where necessary
Steam mains, risers, and branches, weather-exposed and subject to freezing	Refer to drawings
Steam coils associated with fans	Type F&T, float and thermo-static
Steam coils not associated with fans and not subject to freezing	Type T, thermostatic

2.3 TRAP-SIZING CRITERIA

Traps in steam mains, risers, and branches shall be sized to provide an actual capacity, under normal operating conditions, of not less than three times the normal condensing rate.

Traps in steam mains, risers, and branches, weather-exposed and subject to freezing, shall be sized to provide an actual capacity, under normal operating conditions, of two times normal condensing rate and shall be duplexed. Two identical traps shall be provided, sized appropriately at each drainage point.

Traps draining steam coils under modulating control shall be sized to provide an actual capacity, under conditions normal to the system and including 1/2-pound per square inch (psi) coil pressure, of two times normal condensing rate and shall be capable of opening at maximum coil

steam pressure.

Traps in all other services shall be sized to provide an actual capacity, under normal operating conditions, of three times normal condensing rate.

Trap safety factors are minimal and shall be increased where necessary to ensure proper system drainage for a given application but shall not be decreased without written approval.

2.4 TRAP TYPE, CONSTRUCTION, AND MATERIALS

Trap bodies and components shall have a primary working steam pressure (wsp)-rating equal to or in excess of the maximum wsp of the steam system to which applied.

Trap bodies for pressures 125-psi wsp and under shall be cast iron in accordance with ASTM A 278/A 278M, Class 30.

Welded end connection trap bodies shall be cast steel in accordance with ASTM A 216/A 216M, Grade WCB.

Traps shall have permanent external identification of service rating and orifice size.

2.4.1 Type IB

Inverted bucket traps shall have AISI 300 Series corrosion-resistant steel floats and operating mechanisms and hardened, 13 percent chrome corrosion-resistant steel seats and valves.

Thermostatic elements shall be bimetallic type.

Traps shall be designed to permit removal and replacement of all operating and wearing parts without disturbing piping connections to trap body.

Strainers shall be provided as an integral part of the body.

Bodies shall be provided with plugged priming and draining openings.

Test cocks shall be provided.

2.4.2 Type F&T

Float and thermostatic traps shall have AISI 300 series corrosion-resistant steel, heliarc-welded floats and operating mechanisms, and hardened, 13 percent chrome corrosion-resistant steel seats and valves.

Thermostatic elements shall be balanced pressure type, with corrosion-resistant alloy bellows charged with a fluid that will provide most rapid response to changes in temperature.

Bellows shall be suitable for service with condensate having a pH of 6.0.

Traps shall be designed to permit removal and replacement of all operating and wearing parts without disturbing piping connections to trap body.

Bellows shall be designed to permit removal while hot without overexpansion and shall be shielded from direct blast of steam and condensate.

Bodies shall be fitted with drain plug.

2.4.3 Type T

Thermostatic traps shall be balanced pressure type, with corrosion-resistant alloy bellows charged with a fluid that will provide most rapid response to change in temperature.

Bellows shall be suitable for service with a condensate having a pH of 6.0. Bellows shall be shielded from direct blast of steam and condensate and shall be designed to permit removal while hot without overexpansion.

Valves and valve seats shall be hardened, 13 percent chrome corrosion-resistant steel.

Traps shall be designed to permit removal and replacement of all operating and wearing parts without disturbing piping connections.

PART 3 EXECUTION

3.1 TRAP INSTALLATION

Traps shall be installed in accordance with the manufacturer's instructions.

3.2 COMPONENT INSTALLATION

Trap components shall be installed in accordance with the manufacturer's instructions.

-- End of Section --

SECTION 23 22 23

STEAM CONDENSATE PUMPS
08/08

PART 1 GENERAL

1.1 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.

ASME INTERNATIONAL (ASME)

ASME BPVC SEC VIII D1	(2007) Boiler and Pressure Vessel Code; Section VIII, Pressure Vessels Division 1 - Basic Coverage

HYDRAULIC INSTITUTE (HI)

HI M100	(2005) Complete Set of Centrifugal, Reciprocating, Rotary and Vertical Centrifugal/Vertical Pump Standards

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; Corrigendum 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerance - International Restrictions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2007) Standard for Motors and Generators

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit the following in accordance with paragraph entitled, "General Requirements," of this section.

Connection Diagrams
Control Diagrams
Fabrication Drawings
Installation Drawings

SD-03 Product Data

Submit Manufacturer's catalog data for condensate pumps showing and equipment and performance data including performance curves and indicating brake power, headgpm, and NPSH.

SD-06 Test Reports

Ensure test reports for condensate pumps consist of pump flow capacity tests in accordance with the paragraph entitled, "Testing," of this section.

Pump Flow Capacity Tests
Efficiency Tests
Vibration Tests

SD-07 Certificates

Listing of product installations for the following items shall include identification of five installed units similar to those proposed for use, that have been in successful service for a minimum period of five years. Include within list, purchaser, address of installation, service organization, and date of installation.

Condensate Return Pump Units
Condensate Receiver
Reciprocating Steam Pumps

Submit certificates for the following items showing conformance with the referenced standards contained in this section.

Condensate Return Pump Units

1.3 GENERAL REQUIREMENTS

Connection Diagrams for condensate pumps shall show details of cable and motor connections.

Submit Control Diagrams for condensate pumps showing motor starters, relays, or any other component necessary for safe operation.

Fabrication Drawings for condensate pumps shall indicate size, type, and efficiency rating.

Ensure Installation Drawings for condensate pumps are in accordance with the manufacturer's recommended instructions.

Submit Manufacturer's catalog data for condensate pumps showing equipment foundation data and equipment and performance data including performance curves and indicating brake power, head (gpm), and NPSH.

PART 2 PRODUCTS

2.1 CONDENSATE RETURN PUMP UNITS

Factory assemble condensate-return pump units and include condensate receivers, motor-driven pump(s), manual and automatic liquid-level controls, and other accessories as specified herein or which may be

necessary for complete and satisfactorily operating units(s).

Pump(s) and all accessories mounted on the receiver and unit(s) shall be complete with all intercomponent piping and wiring. Receiver and unit(s) shall be complete with all intercomponent piping and wiring. Receiver shall have integral cast lugs for securing to mounting surface. Pump suction piping shall contain a shutoff valve for pump servicing.

Condensate-return pump units shall be simplex type.

Condensate-return pump unit shall be factory tested for capacity and pressure.

2.1.1 Pumps

Pumps shall be close coupled or flexible coupled with guard centrifugal volute vertically or horizontally mounted on or next to receiver. Pumps shall conform to applicable requirements of HI M100 standards and shall be bronze mounted. Casing shall be close-grained cast iron with renewable wearing ring. Provide tapped openings for automatic venting, draining, and pressure-gage connection. Pump shaft shall be AISI Type 300 series corrosion-resistant steel. Pump seal shall be manufacturer's standard for continuous service at 250 degrees F, minimum, at seal rotating and stationary members interface and 209-degree F pumped fluid. Compensate impeller for hydraulic thrust, balance rotating assembly, and ensure strength of shafting such that when pump is operating at its worst hydraulic condition, vibration readings conform to ISO 1940-1. Pumps shall be capable of handling 209-degree F condensate without cavitation or vapor binding while delivering specified capacity.

2.1.2 Motor Requirements

Motors shall be vertical or horizontal and conform to NEMA MG 1, requirements specified under the electrical sections of the specifications and to the following additional requirements.

Motor insulation shall be Class H or manufacturer's standard and be suitable for satisfactory operation under the following conditions:

Still air at 65 percent relative humidity, with service-location temperatures to 122 degrees F

Thermal conduction along motor shaft immersed in 209-degree F water

Proximity of motor to receiver surfaces at 209 degrees F

Lubricants shall be specifically suitable for high-temperature service.

2.1.3 Receiver

Condensate receiver shall be a single tank constructed of close-grained cast iron with a minimum receiver wall thickness of 5/16 inch or steel with a rust-resistant interior coating.

Fit each receiver with:

Redline borosilicate gage glass and nonferrous shutoff valve assembly for use in case of glass breakage.

External inlet strainer with removable basket for pump protection.

Thermometer with separable well conforming to requirements specified elsewhere in this section.

Receiver top-vent connection and drain at lowest point. Assemble drain closures with tetrafluoroethylene tape.

2.1.4 Controls

Simplex-unit control shall consist of a float-operated switch UL rated for the load imposed and wired to the motor. Float and float arm shall be AISI Type 304 or 316 corrosion-resistant steel. Copper float mechanisms are not acceptable.

2.2 CONDENSATE RECEIVER

Design and construct receiver in accordance with ASME BPVC SEC VIII D1 for operation under atmospheric conditions but certified as hydrostatically tested at 100 pounds per square inch, gage.

Receiver shall be manufacturer's standard vessel.

2.2.1 Materials and Construction

Construct receiver of cast iron withindicated openings including those for vent, inlets, discharge, drain, gage-glass connections, and level-control devices. Minimum tank opening shall be 1-inch iron pipe size. Couplings shall be forged carbon steel. Nozzle-piping weight shall be Schedule 80. Piping, flanges, and fittings shall conform to specifications for connecting condensate piping system.

Mount receiver as indicated.

2.2.2 Accessories

Provide receiver with a shutoff-valve-equipped gage-glass assembly to indicate liquid level over not less than 80 percent of receiver diameter from the bottom. Gage glass shall be red-lined borosilicate glass and fitted with wire or sheet-metal guards.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

Based on the motor nominal operating speed, align the Pump and driver to the following specifications:

Speed(RPM)	angle(mils)	offset(mils/inch)

600	6.0	2.0
900	5.0	1.5
1200	4.0	1.0
1800	3.0	0.5
3600	1.5	0.4
7200	1.0	.03

3.2 TESTING

3.2.1 Acceptance Testing

Prior to pump final acceptance, use vibration analysis to demonstrate that pump and motor are aligned as specified, and ensure misalignment does not impart more than .04 inches per second vibration level at 2 times run speed.

Vibration analysis shall also verify pump conformance to specifications. Vibration levels shall not be more than .075 in/sec at 1 times run speed and at pump frequency, and .04 in/sec at other multiples of run speed.

Demonstration that the pump is non-overloading at any operating point and that the flow capacity is as specified.

Provide final test reports to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION 23 31 11.11 40

DUCTS, LOW PRESSURE
07/07

PART 1 GENERAL

1.1 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 INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2005e13) Manual of Steel Construction

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 36/A 36M	(2005) Standard Specification for Carbon Structural Steel
ASTM A 653/A 653M	(2006a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM F 1137	(2000) Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2002; Errata 2003; Errata 2005) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1481	(1995e2) HVAC Duct Construction Standards - Metal and Flexible

UNDERWRITERS LABORATORIES (UL)

UL 181	(2005) Standard for Factory-Made Air Ducts and Air Connectors

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for low pressure ductwork systems in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

The following shall be submitted for low pressure ductwork systems in accordance with paragraph entitled, "Design Requirements," of this section.

Connection Diagrams
Fabrication Drawings
Installation Drawings
Record Drawings

SD-03 Product Data

Design Analysis and Calculations shall be submitted for low pressure ductwork systems in accordance with paragraph entitled, "Design Requirements," of this section.

Manufacturer's catalog data shall be submitted for the following items:

Galvanized Steel Ductwork Materials
Flexible Duct Materials
Power Operated Dampers
Flexible Connectors
Gravity Backdraft and Relief Dampers
Manual Volume Dampers

SD-04 Samples

Manufacturer's Standard Color Chart shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-06 Test Reports

Test reports shall be submitted for low pressure ductwork systems on the following tests in accordance with the paragraph entitled, "Ductwork Leakage Tests" and "Fire Damper Tests," of this section.

Operation Tests
Ductwork Leakage Tests

SD-07 Certificates

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

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be provided for:

Power Operated Dampers

1.3 PERFORMANCE REQUIREMENTS

Section 23 00 00.0098 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

1.4 DESIGN REQUIREMENTS

Low-pressure systems shall encompass ductwork and plenums where maximum air velocity is 2,000 feet per minute(fpm) and maximum static pressure is 2 inches water gage (wg), positive or negative.

Rigid fibrous-glass ductwork shall not be used.

Fabrication Drawings shall be submitted for low pressure ductwork systems consisting of fabrication and assembly details to be performed in the factory. Drawings shall show details of equipment room layout and design.

Connection Diagrams shall be submitted for low pressure ductwork systems indicating the relation and connection of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Design Analysis and Calculations shall be submitted for low pressure ductwork systems indicating the manufacturer's recommended air velocities, maximum static pressures, temperature calculations and acoustic levels.

Installation Drawings shall be submitted for low pressure ductwork systems in accordance with the manufacturer's recommended instructions.

Record Drawings shall provide current factual information including deviations from, and amendments to the drawings and concealed or visible changes in the work, for low pressure ductwork systems.

Manufacturer's Standard Color Chart shall indicate the manufacturer's standard color selections and finishes for low pressure ductwork.

1.5 GENERAL REQUIREMENTS

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

Material, Equipment, and Fixture Lists shall include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

PART 2 PRODUCTS

2.1 GALVANIZED STEEL DUCTWORK MATERIALS

Galvanized steel ductwork sheet metal shall be carbon steel, of lock-forming quality, hot-dip galvanized, with regular spangle-type zinc coating, conforming to ASTM A 653/A 653M, G235. Duct surfaces to be painted shall be treated by phosphatizing.

Sheet metal gages and reinforcement thickness shall conform to SMACNA 1481, except for minimum standards stated herein.

MINIMUM SHEET METAL GAGE

DUCT WIDTH INCHES	GAGE
0 - 12	24
13 - 30	22
31 - 60	20

2.1.1 Duct Hangers

Duct hangers in contact with galvanized duct surfaces shall begalvanized steel painted with inorganic zinc.

2.1.2 Mill-Rolled Reinforcing and Supporting Materials

Mill-rolled structural steel shall conform to ASTM A 36/A 36M and, whenever in contact with sheet metal ducting, shall be galvanized in accordance with ASTM A 123/A 123M.

Equivalent strength, proprietary-design, rolled-steel structural support systems may be submitted for approval in lieu of mill-rolled structural steel.

2.2 FLEXIBLE DUCT MATERIALS

Flexible duct connectors shall be in accordance with UL 181, Class 1 material and shall comply with NFPA 90A.

Wire-reinforced fibrous-glass duct shall consist of a minimum 1 pound/cubic foot density fibrous glass bonded to and supported by corrosion-protected spring helix. Vapor barrier shall be a 4 mil minimum, pigmented polyvinylchloride film. Duct shall be bendable without damage through 180 degrees with an inside bend radius not greater than two duct diameters. Minimum wall thickness shall be 1 inch. Thermal conductivity shall be not greater than 0.23 Btu per hour per square foot per degrees F at 75 degrees F mean. Permeance shall be not greater than 0.10 perm. Working pressure range shall be from minus 1/2 inch wg to plus 1-1/2 inches wg. Working temperature shall range from minus 20 to plus 250 degrees F. Minimum sustained velocity without delamination shall be 2,400 fpm. Materials shall conform to NFPA 90A. Total length of flexible duct must not exceed 48 inches. Acceptable manufacturer: "Flexmaster USA".

2.3 MANUAL VOLUME DAMPERS

Volume damper construction shall conform to SMACNA 1481.

Dampers shall be equipped with an indicating quadrant regulator with a locking feature externally located and easily accessible for adjustment. Where damper rod lengths exceed30 inches , a regulator shall be provided at each end of damper shaft.

All damper shafts shall have two-end bearings.

Splitter damper shall be 2 gages heavier than duct in which installed. Hinges shall be full length piano-type.

Damper shaft shall be full length and shall extend beyond damper blade. A 3/8 inch square shaft shall be used for damper lengths up to 20 inches and a 1/2 inch square shaft shall be used for damper lengths 20 inches and larger. Where necessary to prevent damper vibration or slippage, adjustable support rods with locking provisions external to duct shall be provided at damper blade end.

Dampers in ducts having a width perpendicular to the axis of the damper that is greater than 12 inches shall be multiblade type having a substantial frame with blades fabricated of 16-gage metal. Blades shall not exceed 10 inches in width and 48 inches in length and shall be welded to 1/2 inch diameter shafts. Dampers greater than 48 inches in width shall be made in two or more sections with intermediate mullions, each section being mechanically interlocked with the adjoining section or sections. Blades shall have graphite-impregnated nylonbearings and shall be connected so that adjoining blades rotate in opposite directions.

2.4 GRAVITY BACKDRAFT AND RELIEF DAMPERS

Frame shall be constructed of not less than 1-1/2- by 4 inchreinforced16 -gagegalvanized carbon steel. Frames and mullions shall be solidly secured in place and sealed with elastomer calking against air bypass.

Maximum blade width shall be 9 inches , and maximum blade length shall be 36 inches . Blade material shall be 16-gage galvanized steel Blades shall be provided with mechanically retained seals and 90-degree limit stops.

Dampers used for relief service shall have blades linked together to open not less than 30 degrees on 0.05 inch wg differential pressure.

Shaft bearings shall be graphite-impregnated nylon

Counterbalanced dampers shall be equipped with fixed or adjustable counterbalancing weights.

Gravity backdraft dampers in sizes 18 by 18 inches or smaller, when furnished integral with air moving equipment, may be equipment manufacturer's standard construction.

2.5 POWER-OPERATED DAMPERS

Dampers shall conform to applicable requirements specified under Section 23 09 .23.98 DIRECT DIGITAL CONTROL SYSTEM.

2.6 FLEXIBLE CONNECTORS FOR SHEET METAL

Connectors shall be UL-listed, 20-ounce, fire-retardant, airtight, woven fibrous-glass cloth impregnated with chloroprene. Clear width, not including clamping section, shall be 3 to 5 inches.

PART 3 EXECUTION

3.1 INSTALLATION

Sheet metal construction shall be provided in accordance with the SMACNA 1481 and NFPA 90A.

Supplementary steel shall be designed and fabricated in accordance with AISC 325.

Fabrication shall be airtight and shall include necessary reinforcements, bracing, supports, framing, gasketing, sealing, and fastening to provide rigid construction and freedom from vibration, airflow-induced motion, noise, and excessive deflection at specified maximum system air pressure.

Dampers located behind architectural intake or exhaust louvers shall be enclosed by a rigid sheet metal collar and sealed to building construction with elastomers for complete air tightness.

Outside air-intake ducts and plenums shall be sheet metal and shall have soldered watertight joints.

Offsets and transformations shall be provided as required to avoid interference with the building construction, piping, or equipment.

Sheet metal surfaces to be painted or surfaces to which adhesives will be applied shall be clean and free of oil, grease, and deleterious substances.

Where interiors of ducting may be viewed through air diffusion devices, the viewed interior shall be sheet metal and shall be painted flat black.

Duct strength shall be adequate to prevent failure under pressure or vacuum created by fast closure of ductwork devices. Leaktight automatic relief devices shall be provided.

Plenum anchorage provisions, sheet metal joints, and other areas shall be made airtight and watertight by calking mating galvanized steel and concrete surfaces with a two-component elastomer.

3.2 RECTANGULAR SHEET METAL DUCTS

Ductwork airtight traverse connection system shall be leak-free, gasketed flanged rigid galvanized steel, static pressure rating: 4" WG, as manufactured by "Ductmate Industries, Inc. ." of E. Monongahela, PA (or NASA approved equivalent).

Standard seam joints shall be sealed with an elastomer compound to comply with SMACNA 1481 Seal Class A, B or C as applicable.

Crossbreaking shall be limited to 4 feet and shall be provided on all ducts 8inches wide and wider. Bead reinforcement shall be provided in lieu of crossbreaking where panel popping may occur. Where rigid insulation will be applied, crossbreaking is not required.

3.2.1 Longitudinal Duct Seams

For duct sizes through 12 inches, corner seams shall be button-punch snap

lock. For duct sizes 13 inches and larger, corner locks shall be used.

3.2.2 Joints and Gaskets

Companion angle flanges shall be bolted together with 1/4 inch diameter bolts and nuts spaced 6 inches on center. Flanged joints shall be gasketed with chloroprene full-face gaskets 1/8 inch thick, with Shore A 40 durometer hardness. Gaskets shall be one piece and vulcanized at joints.

3.2.3 Flexible Duct Joints

Joints between flexible duct without sheet metal collars and round metal ductwork connections shall be made by trimming the ends, coating the inside of the flexible duct for a distance equal to depth of insertion with elastomer calk, and by securing with sheet metal screws or binding with a strap clamp.

3.2.4 Square Elbows

Single-vane duct turns shall be provided in accordance with SMACNA 1481, and may be used on ducts 12 inches wide and narrower.

Double-vane duct turns shall be provided in accordance with SMACNA 1481.

3.2.5 Radius Elbows

Radius elbows shall conform to SMACNA 1481. Radius elbows shall have an inside radius equal to the width of the duct. Where installation conditions preclude use of standard elbows, the inside radius may be reduced to a minimum of 0.25 times duct width and turning vanes shall be installed in accordance with the following schedule.

WIDTH OF ELBOWS INCHES	RADIUS OF TURNING VANES IN PERCENT OF DUCT WIDTH VANE NO. 1	VANE NO. 2	VANE NO. 3
Up to 16	56	--	--
17 to 48	43	73	--
49 and over	37	55	83

Where two elbows are placed together in the same plane in ducts 30 inches wide and larger, the guide vanes shall be continuous through both elbows rather than spaced in accordance with above schedule.

3.2.6 Outlets, Inlets, and Duct Branches

Branches, inlets, and outlets shall be installed so that air turbulence will be reduced to a minimum and air volume properly apportioned. Adjustable splitter dampers shall be installed at all supply junctions to permit adjustment of the amount of air entering the branch. Wherever an air-diffusion device is shown as being installed on the side, top, or bottom of a duct, and whenever a branch takeoff is not of the splitter type, a commercially manufactured air extractor shall be provided to allow adjustment of the air quantity and to provide an even flow of air across the device or duct it services.

Where a duct branch is to handle more than 25 percent of the air handled by

the duct main, a complete 90-degree increasing elbow shall be used with an inside radius of 0.75 times branch duct width. Size of the leading end of the increasing elbow within the main duct shall have the same ratio to the main duct size as the ratio of the related air quantities handled.

Where a duct branch is to handle 25 percent or less of the air handled by the duct main, the branch connection shall have a 45 degree side take-off entry in accordance with SMACNA 1481 Fig 2-6.

3.2.7 Duct Transitions

Where the shape of a duct changes, the angle of the side of the transition piece shall not exceed 15 degrees from the straight run of duct connected thereto.

Where equipment is installed in ductwork, the angle of the side of the transition piece from the straight run of duct connected thereto shall not exceed 15 degrees on the upstream side of the equipment and 22-1/2 degrees on the downstream side of the equipment.

3.2.8 Branch Connections

Radius tap-ins shall be constructed in accordance with SMACNA 1481.

3.2.9 Access Openings

Access doors and panels shall be installed in ductwork upstream from coils adjacent to fire dampersand at controls or at any item requiring periodic inspection, adjustment, maintenance, or cleaning, and every 20 feet for indoor air quality housekeeping purposes.

Minimum size of access opening shall be 12 by 18 inches , unless precluded by duct dimensions or otherwise indicated.

Access door construction shall be in accordance with SMACNA 1481, except that sliding doors may be used only for special conditions upon prior approval. Insulated doors shall be double-panel type.

Access doors that leak shall be made airtight by adding or replacing hinges and latches or by construction of new doors adequately reinforced, hinged, and latched.

3.2.10 Duct Supports

Selection of hanging system shall be at the Contractor's option. The following support sizes, configurations, and spacings are given to show the minimal type of supporting component required. Where installed loads are excessive for the specified hanger spacings, hangers, and accessories, the hanger spacing may be reduced. After system startup, any duct support device which, due to length, configuration, or size, vibrates or causes possible failure of a member or damage to ducting shall be replaced or the condition shall be alleviated.

Hanger rods, angles, and straps shall be attached to beam clamps. Concrete inserts and masonry anchors and fasteners shall be approved for the application.

Hardened high-carbon spring-steel fasteners fitted onto beams and miscellaneous structural steel are acceptable upon prior approval of each proposed application and upon field demonstration of conformance to specification requirements. Fasteners shall be made from steel conforming to AISI Type C1055, and shall be treated and finished in accordance with ASTM F 1137, zinc phosphate base. A 72-hour load-carrying capacity shall be verified by a certified independent laboratory. 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.

Ductwork and equipment shall not be hung from roof deck, piping, or other ducts or equipment. Maximum span between any two points shall be 10 feet with lesser spans for duct assemblies, interferences, and loads imposed or permitted.

There shall be not less than one set of hangers for each point of support. Hangers shall be installed on both sides of all duct turns, branch fittings, and transitions.

Hangers shall be sufficiently cross-braced to eliminate vertical and lateral sway.

Rectangular ducts up to 36 inches shall be supported by strap hangers attached at not less than three places to not less than twoduct surfaces in different planes.

Perforated strap hangers shall not be acceptable.

Rectangular ducting,36 inches and larger, shall be supported by trapeze hangers. Ducts situated in unconditioned areas and required to have insulation with a vapor-sealed facing shall be supported on trapeze hangers. Hangers shall be spaced far enough out from the side of the duct to permit the duct insulation to be placed on the duct inside of the trapeze. Under no circumstances shall duct hangers penetrate the vapor-sealed facing.

Where trapeze hangers are used, the bottom of the duct shall be supported on angles sized as follows:

WIDTH OF DUCT, INCHES	MINIMUM BOTTOM ANGLE SIZE, INCHES
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

Where ductwork system contains heavy equipment, excluding air-diffusion devices and single-leaf dampers, such equipment shall be hung independently of the ductwork by means of rods or angles of sizes adequate to support the load.

Ducting supported from roof purlins shall be supported at points not greater than one-sixth of the purlin span from the roof truss. Load per hanger shall not exceed 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. When support is not halfway between purlins, the allowable hanger load shall be the product of 400 times the inverse ratio of the longest distance to purlin-to-purlin spacing.

When the hanger load exceeds the above limits, reinforcing of purlin(s) or additional support beam(s) shall be provided. When an additional beam is used, the beam shall bear on the top chord of the roof trusses and bearing shall be over gusset plates of top chord. Beam shall be stabilized by connection to roof purlin along bottom flange.

Purlins used for supporting fire-protection sprinkler mains, electrical lighting fixtures, and electrical power duct or cable tray shall be considered fully loaded, and supplemental reinforcing or auxiliary support steel to support ductwork shall be provided for these purlins.

3.3 MANUAL VOLUME DAMPERS

Balancing dampers of the splitter, butterfly, or multilouver type, shall be provided to balance each respective main and branch duct.

Dampers regulated through ceilings shall have regulator concealed in box mounted in the ceiling, with a cover finish aesthetically compatible with ceiling surface. Where ceiling is of removable construction, regulators shall be above ceiling, and location shall be marked on ceiling in a manner acceptable to the Contracting Officer.

3.4 FLEXIBLE CONNECTORS FOR SHEET METAL

Air handling equipment, ducts crossing building expansion joints, and fan inlets and outlets shall be connected to upstream and downstream components by treated woven-cloth connectors.

Connectors shall be installed only after system fans are operative, and vibration isolation mountings have been adjusted. When system fans are operating, connectors shall be free of wrinkle caused by misalignment or fan reaction. Width of surface shall be curvilinear.

3.5 INSULATION PROTECTION ANGLES

Galvanized 20-gage sheet steel, formed into an angle with a 2 inch exposed long leg with a 3/8 inch stiffening break at outer edge, and with a variable concealed leg, depending upon insulation thickness shall be provided.

Angles shall be installed over insulation edges terminating by butting against a wall, floor foundation, frame, and similar construction. Angles shall be fastened in place with blind rivets through the protection angle, insulation, and sheet metal duct or plenum. Angles shall be installed

after final insulation covering has been applied.

3.6 DUCT PROBE ACCESS

Holes shall be provided with neat patches, threaded plugs, or threaded or twist-on caps where indicated, and where necessary, for air-balancing pitot tube access. Extended-neck fittings shall be provided where probe access area is insulated.

3.7 OPENINGS IN ROOFS AND WALLS

Building openings are fixed and equipment shall be provided to suit. Contractor may propose to alter these openings upon prior approval, and at his expense.

Openings indicated in outside walls and roof are approximate.

3.8 DUCTWORK CLEANING PROVISIONS

Open ducting shall be protected from construction dust and debris in a manner approved by the Contracting Officer. Dirty assembled ducting shall be cleaned by subjecting main and branch interior surfaces to air streams moving at velocities two times the specified working velocities, at static pressures within maximum ratings. Ducting shall be cleaned by a method approved by the Contracting Officer. Compressed air used for cleaning ducting shall be water- and oil-free. Prior to acceptance of the work, dust and debris shall be removed from exterior surfaces.

3.9 OPERATION AND MAINTENANCE

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

-- End of Section --

SECTION 23 37 13.00 40

DIFFUSERS, REGISTERS, AND GRILLES
06/06

PART 1 GENERAL

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

ASHRAE 113	(2005) Method of Testing for Room Air Diffusion (Repeatable Method of Testing Steady - State Air Diffusion Performance in Occupied Zones of Building Spaces)
ASHRAE-03	(2005) Handbook, Fundamentals (IP Edition)
ASHRAE-06	(2004) Handbook, HVAC Systems and Equipment (IP Edition)

1.2 GENERAL REQUIREMENTS

Section 23 00 00.00 98 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

Material, Equipment, and Fixture Lists shall include the manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

Records of Existing Conditions shall be submitted consisting of the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work shall constitute acceptance of existing conditions.

Fabrication Drawings shall be submitted for air-diffusion devices consisting of fabrication and assembly details to be performed in the factory.

Manufacturer's Standard Color Chart shall indicate the manufacturer's standard color selections and finishes for air-diffusion devices.

1.3 PERFORMANCE REQUIREMENTS

Air diffusion devices shall be certified as having been tested and rated in accordance with ASHRAE-06, Chapter 17; ASHRAE-03, Chapter 31, and ASHRAE 113, where such certification is required.

Equipment and Performance Data shall be submitted for air-diffusion devices consisting of sound data in terms of sound-power level in octave bands second through eighth and Noise Criteria (NC) index for the capacity range of the device. Where room attenuation is not specified or indicated, 18 decibels shall be assumed. Where space or sound data are not specified or

indicated, NC40 shall be assumed.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

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

Material, Equipment, and Fixture Lists
Records of Existing Conditions

SD-02 Shop Drawings

Fabrication Drawings shall be submitted for air-diffusion devices in accordance with paragraph entitled, "General Requirements," of this section.

Installation Drawings shall be submitted for air-diffusion devices in accordance with the paragraph entitled, "Installation," of this section.

SD-03 Product Data

Equipment and Performance Data shall be submitted for air-diffusion devices in accordance with paragraph entitled, "Performance Requirements," of this section.

SD-04 Samples

Manufacturer's Standard Color Chart shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

PART 2 PRODUCTS

2.1 AIR-DIFFUSION DEVICE CONSTRUCTION

Air-diffusion device construction and mounting shall preclude flutter, rattle, or vibration. Devices shall have the modifications and accessories necessary for mounting in indicated surface construction.

Color selection shall be from manufacturer's standard color chips.

Color selection shall match architectural background.

Supply diffusers shall be provided with combination damper and equalizing grid. Dampers shall be extracting-splitter type, except as otherwise indicated.

Air-diffusion device volume and pattern adjustments shall be made from the

face of the device. Volume adjustments shall be made by removable key.

Gaskets shall be provided for supply-terminal air devices mounted in finished surfaces.

2.2 TYPES OF AIR-DIFFUSION DEVICES

2.2.1 Type GR

Type GR return grilles shall be single deflection type with fixed face bars.

Grilles installed in vertical surfaces shall have horizontal face bars set downward at 35 degrees from vertical.

Grilles installed in horizontal surfaces shall have face bars straight and parallel to short dimension.

Finish shall be baked enamel.

Construction shall be aluminum.

2.2.2 Type RS

Type RS shall be supply register, double-deflection type, with adjustable face bars parallel to short dimension and adjustable rear bars parallel to long dimension. Dampers shall be opposed-blade type.

Finish shall be baked enamel.

Construction shall be aluminum.

PART 3 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as indicated and specified and in accordance with manufacturer's recommendations.

Wall-mounted supply registers shall be mounted 6 inches below ceiling.

Wall-mounted return registers shall be mounted 6 inches above the finished floor.

Installation Drawings shall be submitted for air-diffusion devices. Drawings shall indicate overall physical features, dimensions, ratings, service requirements, and equipment weights.

-- End of Section --

SECTION 23 73 13.00 40

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS
07/07

PART 1 GENERAL

1.1 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.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

AMCA 211	(2005) Certified Ratings Programme - Product Rating Manual for Air Fan Performance
AMCA 99	(2003) Standards Handbook

AIR-CONDITIONING AND REFRIGERATION INSTITUTE (ARI)

ARI 430	(1999) Standard for Central-Station Air-Handling Units

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

ASHRAE 51	(1999; Errata, 2006) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
ASHRAE 52.1	(1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter

ASTM INTERNATIONAL (ASTM)

ASTM A 653/A 653M	(2006a) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B 117	(2003) Standing Practice for Operating Salt Spray (Fog) Apparatus

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerance - International Restrictions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2006) Standard for Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2002; Errata 2003; Errata 2005) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 900	(2004) Standard for Air Filter Units

1.2 GENERAL REQUIREMENTS

Section 23 00 00.00 98 GENERAL MECHANICAL PROVISIONS applies to work specified in this section.

Equipment and Performance Data shall be submitted for air handling units in accordance with the specification. Data shall consist of use life, total static pressure and coil face area classifications, and performance ratings.

All drawings and manuals submitted shall include a spare parts data sheet, with manufactures recommended stock levels.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings shall be submitted for air handling units in accordance with paragraph entitled, "AHU Equipment Installation," of this section.

SD-03 Product Data

Equipment and Performance Data shall be submitted for air handling units in accordance with paragraph entitled, "General Requirements," of this section.

Manufacturer's catalog data shall be submitted for the following items:

Unit Cabinet
Fan
Drain Pans
Insulation
Plenums

Blow-Through AHU
Spare Parts

SD-07 Certificates

Listing of Product Installations shall be submitted for air

handling units in accordance with paragraph entitled, "AHU Equipment Installation," of this section.

Certificates shall be submitted for following items showing conformance with the referenced standards contained in this section.

Unit Cabinet
Fan
Drain Pans
Insulation
Plenums

Blow-Through AHU
Spare Parts

SD-10 Operation and Maintenance Data

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

PART 2 PRODUCTS

2.1 AIR HANDLING UNIT (AHU)

Air handling unit (AHU) shall be central-station type, factory fabricated, and sectionally assembled. AHU shall include components and auxiliaries in accordance with ARI 430. AHU fan and motor shall be balanced to ISO 1940-1 -1986, G6,3.

Total static pressure and coil face area classification shall conform to AMCA 99.

Fans with enlarged outlets shall not be permitted.

AHU fan shall be double-width, double-inlet, centrifugal scroll type.

2.2 UNIT CABINET

AHU cabinet shall be suitable for pressure class shown and shall have leaktight joints, closures, penetrations, and access provisions. Cabinet shall not expand or contract perceptibly during starting and stopping of fans and shall not pulsate during operation. Cabinet surfaces with deflections in excess of 0.004167 of unsupported span shall be reinforced prior to acceptance. Pulsating panels, which produce low frequency noise due to diaphragming of unstable panel walls, shall be stiffened to raise natural frequency to an easily attenuated level. Enclosure shall be fabricated from continuous hot-dipped galvanized steel no lighter than 20 gage thickness, to match industry standard. Mill-galvanized sheet metal shall conform to ASTM A 653/A 653M 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. Primed and painted black carbon steel cabinet construction shall comply with this specification.

Provide removable panels to access the interior of the unit cabinet. All seams shall be welded, bolted or gasketed and sealed with a rubber-based

mastic. Entire floor as well as ceiling unit shall be hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

AHU cabinet shall be suitable for pressure class indicated and shall have leaktight joints, closures, penetrations, and access provisions. Cabinet shall not expand or contract perceptibly during starting and stopping of fans and shall not pulsate during operation. Cabinet surfaces with deflections in excess of 0.002778 of unsupported span shall be reinforced prior to acceptance by the Contracting Officer. Pulsating panels, which produce low frequency noise due to diaphragming of unstable panel walls, shall be stiffened to raise natural frequency to an easily attenuated level. Enclosure shall be fabricated from mill-galvanized or primed and painted carbon steel sheet of required thickness. Mill-galvanized sheet metal shall conform to ASTM A 653/A 653M 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. Primed and painted black carbon steel cabinet construction shall comply with this specification.

Provide removable panels to access the interior of the unit cabinet. All seams shall be welded, bolted or gasketed and sealed with a rubber-based mastic. Entire floor as well as ceiling unit shall be hot-dipped galvanized steel. Provide removable access doors on both sides of all access, filter, and fan sections for inspection and maintenance.

Where cabinet size is such that personnel access is possible, cabinet floor shall be strengthened to permit entry without damage to any component. Access doors and panels shall be hinged and latched at a spacing sufficiently close to preclude leaks caused by distortion, and shall be effectively gasketed.

All door handles shall be operable from inside the casing.

Black carbon steel cabinet construction shall be acceptable when the following conditions are met:

All interior and exterior surfaces, including lapped contacting surfaces, shall be coated with a corrosion-protective coating.

Coating shall be certified as passing a 500-hour exposure salt-spray fog test in accordance with ASTM B 117.

Immediately after completion of the test, the specimen shall show no signs of wrinkling, cracking or loss of adherence, and no signs of rust creepage beyond 1/8 inch on either side of the scratch mark.

After 11 months of service and prior to expiration of guarantee, cabinet shall pass inspection of interior and exterior surfaces for the same defects as the salt-spray fog test specimen.

Interior surfaces of cabinets constructed of intact mill-galvanized steel shall require no further protection.

Exterior surfaces of cabinets constructed of mill-galvanized steel shall be left unpainted

Cabinets and casings shall be double walled with 2 inch insulation.

Interior wall shall be galvanized.

Fan wheels shall be dynamically and statically balanced at the factory. Maximum fan RPM shall be 25 percent less than the first critical speed. Fan shaft shall be solid, ground and polished steel and coated with a rust inhibitor. V-belt driven fans shall be designed for 50 percent overload capacity. Variable air volume air handling units that shall be provided with variable frequency drives shall have their fans balanced over the entire range of operation (20 percent - 100 percent RPM). Balancing fans of only 100 percent design of RPM shall not be acceptable for air handling units to be used with variable frequency drives.

Mount fans on isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with 2-inch. Install flexible canvas ducts or vibration absorbent fan discharge seal between fan and casings to ensure complete isolation. Flexible canvas ducts shall comply with NFPA 90A.

Weigh fan and motor assembly at air handling unit manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions.

Factory install all motors on slide bases to permit adjustment of belt tension.

Fan motors shall be heavy duty, open drip-proof, operable at 208 volts, 60 hertz, 3-phase. All motors shall be high efficiency. Refer to specification Section 26 05 73.00 40 OVERCURRENT PROTECTIVE DEVICES.

A marine-type, vapor proof service light shall be provided in the fan segment. Light shall be 100 watt service and shall be wired to an individual switch. Light shall require 115 Volt, single phase, 60 Hertz service that is separate from the main power to the AHU. A single 115 volt outlet shall be provided at the light switch.

2.3 FAN

Overall fan-section depth shall be equal to or greater than the manufacturer's free-standing fan.

Fans shall be single-wheel.

Location of fan inlet shall provide not less than one-half fan-wheel diameter clearance from cabinet wall or adjacent fan inlet where double wheels are permitted.

AHU fan motor and drive shall be installed inside fan cabinet. Motor shall conform to NEMA MG 1 and be installed on an adjustable base. An access door of adequate size for servicing motor and drive shall be provided. A belt guard shall be provided inside the cabinet, or the access door shall be interlocked with the supply fan so that power to the fan will be interrupted when the access door is opened.

2.4 DRAIN PANS

Intermediate-coil, 3-inch deep drip pans shall be provided for each tiered coil bank.

Top pan shall extend 12 inches beyond face of coil, and bottom pan shall extend not less than 24 inches beyond face of coil. Where more than two pans are used, pan extension shall be proportional. Adequate supports shall be made from the same type material as pans or hot-dip galvanized angle iron with isolation at interface. Pan material shall be 22-gage AISI Type 304 corrosion-resistant steel with silver-soldered joints. Minimum size of drain opening shall be 1-1/4 inches. Pan shall be piped to drain.

Integral cabinet drain pan shall extend under all areas where condensate must be collected and shall be watertight with welded or brazed joints, piped to drain, corrosion protected in condensate collection area, and insulated against sweating. Sheet metal shall be minimum 14-gage, except that 16-gage double-drain-pan construction shall be acceptable.

Cooling coil ends shall be enclosed by cabinet and shall be factory insulated against sweating or shall drain to a drain pan.

All drain pans shall be double pan construction, thermally isolated from the exterior casing with 1-inch thick fiberglass insulation. All drain pans shall slope to drain and shall drain substantially dry by gravity alone when drains are open.

All pans shall have a double slope to the drain point.

2.5 INSULATION

Unit shall be internally fitted at the factory with a sound-attenuating, thermal-attenuating, fibrous-glass material not less than 2 inch thick with 1-1/2 inch density neoprene coated fiberglass. Insulation effectiveness shall preclude any condensation on any exterior cabinet surface under conditions normal to the unit's installed location. Acoustic treatment shall attenuate fan noise in compliance with specified noise criteria. Material shall be applied to the cabinet with waterproof adhesives and permanent fasteners on 100 percent coverage basis. Adhesive and insulating material shall be in accordance with NFPA 90A.

Plenums and bypasses shall be insulated.

2.6 PLENUMS

Plenums shall be provided in the following minimum widths:

6 inches for mounting temperature controls and to separate two or more coils of different size mounted in series

14 inches between face and bypass dampers and upstream accessories and at change in cross section

24 inches for access sections

2.7 BLOW-THROUGH AHU

Blow-through AHU shall be fitted with pressure equalizing baffles.

2.8 COILS

2.8.1 Coil Section

Coil section shall encase cooling coils and drain pipes. Coils shall be arranged for horizontal air flow. Provide intermediate drain pans for multiple coils installation. Coil headers shall be completely enclosed with the insulated casing with only connections extended through the cabinet.

2.8.2 Coil Pressure and Temperature Ratings

Coils shall be designed for the following fluid operating pressures and temperatures:

SERVICE	PRESSURE	TEMPERATURE
Steam	200 PSI	250 degrees F
Chilled Water	200 PSI	40 degrees F

Coils shall be air-pressure tested under water at the following minimum pressures:

SERVICE	PRESSURE
Steam and Chilled Water	250 PSI

2.8.3 Coil Casings

Coil casings shall be stainless steel. Coil headers shall be cast iron, brass, or copper. Water coil headers shall be fitted with .25 inch ops spring-loaded plug drains and vent petcocks. Automatic air vents with ball type isolation valves shall be provided for each coil piped to the drain pan.

Coils shall be factory tested, dehydrated, vacuum tested, purged with inert gas, and sealed prior to shipment to the job site.

2.8.4 Chilled Water coils

Tubing for coils shall be copper 0.625 inch outside diameter. Fins shall be aluminum mechanically bonded by tubing expansion with a maximum spacing of 12 fins per 1 inch unless otherwise noted. Coils shall have supply and return connections on the same end. Provide a maximum of four coil rows.

2.8.5 Steam Coils

Heating coils shall have copper tubing and aluminum fins.

2.8.6 Drainable Coils

Drainable coils shall be capable of being purged free of water with compressed air.

Self-draining coils shall have a drain point at the end of every tube and shall be pitched to that point. Drain provisions shall include: drained headers; U-bends with integral plugs; or nonferrous plugs in cast-iron headers. Each tube shall drain substantially dry by gravity alone when drains and vents are open.

2.9 FILTERS

2.9.1 Filter Housing

Provide factory fabricated filter section of the same construction and finish as unit casings. Filter sections shall have filter guides and full height, double wall, hinged and removable access doors for filter removal. Provide air sealing gaskets to prevent air bypass around filters. Provide visible identification on media frames showing model number and airflow direction. Where filter bank is indicated or required, provide means of sealing to prevent bypass of unfiltered air. Performance in accordance with ASHRAE 52.1.

2.9.2 Outside Air Filters

The factory assembled air filters of the extended surface type with supported cartridges for removal of particulate matter in air conditioning, heating, and ventilating systems. Filter units shall be of the extended surface type fabricated for disposal when the dust-load limit is reached as indicated by maximum (final) pressure drop.

Filter Classification: UL approved for Class 1 or 2 conforming to UL 900.

Filter Grades, Nominal Efficiency and Application:

Grade B: 80-85 percent nominal efficiency afterfilter
Grade D: 25-30 percent nominal efficiency prefilter

Filter Media: Grade B Supported (Rigid Pleated) Type: Media shall be composed of high density glass fibers or other suitable fibers. Fastening methods used to maintain pleat shape, aluminum separators shall be sealed in a proper enclosing frame to ensure no air leakage for life or filter. Staples and stays are prohibited.

Grade D Type: Media shall be composed of synthetic/natural fibers. A metal grid backing shall be bonded to the air leaving side of the media to maintain uniform pleat shape and stability for proper airflow and maximum dist loading. The media frame shall be constructed of high strength moisture resistant fiber or beverage board. The pleated media pack shall be bonded on all four edges to ensure no air leakage of the life of the filter. Staples and stays are prohibited.

Filter Efficiency and Arrestance: Efficiency and arrestance of filters shall be determined in accordance with ASHRAE 52.1 Standard Atmospheric dust spot efficiency and synthetic dust weight arrestance shall not be less than the following:

	Initial Efficiency (Percent)	Average Efficiency (Percent)	Average Efficiency (Percent)
Grade B	58	79	98
Grade D	Less than 20	22	89

	Initial Efficiency (Percent)	Average Efficiency (Percent)	Average Efficiency (Percent)

Maximum initial and final resistance, inches of water gauge, for each filter cartridge when operated at 500 feet per minute face velocity:

	Initial Resistance	Final Resistance
Grade B (Rigid Pleated)	0.60	1.00
Grade D (2 inches Deep)	0.32	0.70

Dust Holding Capacity: When tested to 1.00 inch w.g. at 500 feet per minute face velocity, the dust holding capacity from each 24-inch by 24-inch (face area) filter shall be at least the values listed below. For other filter sizes, the dust holding capacity shall be proportionally higher or lower.

Grade B (Rigid Pleated)	6.17 ounces
Grade D (2 inches Deep)	2.29 ounces

Minimum Media Area: The minimum net effective area in square feet for each 24-inch by 24-inch (face area) filter at 500 feet per minute face velocity shall be at least the values listed below. For other filter sizes the net effective media shall be proportionally higher or lower.

Grade B (Rigid Pleated)	57.0
Grade D (2 inches Deep)	14.8

2.9.3 Air Filter Gauges

Provide manometer air filter gauges of the inclined tube differential type, of solid acrylic plastic construction with built-in level vial and with an adjustable mirror-polished scale. Gauges shall be equipped with vent valves for zeroing and over-pressure safety traps. Gauge range shall be adequate for the particular installation. Gauges shall be as manufactured by Dwyer or approved equal.

Provide one (1) air filter gauge at each filter bank.

PART 3 EXECUTION

3.1 AHU EQUIPMENT INSTALLATION

Equipment shall be installed in accordance with manufacturer's recommendations.

Installation drawings shall be in accordance with referenced standards in this section.

Listing of Product Installations shall be submitted for air handling units showing a minimum of 5 installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. List shall include purchaser, address of installation, service organization, and date of installation.

3.2 VIBRATION ANALYZER

Contractor shall use an FFT analyzer to measure vibration levels. It shall have the following characteristics: A dynamic range greater than 70 dB; a minimum of 400 line resolution; a frequency response range of 5 Hz-10 KHz; the capacity to perform ensemble averaging, the capability to use a Hanning window; auto-ranging frequency amplitude; a minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB.

An accelerometer, either stud-mounted or mounted using a rare earth, low mass magnet and sound disk(or finished surface) shall be used with the FFT analyzer to collect data. The mass of the accelerometer and its mounting shall have minimal influence on the frequency response of the system over the selected measurement range.

3.3 ACCEPTANCE

Prior to final acceptance, dial indicator gages shall be used to demonstrate that fan and motor are aligned as specified.

Prior to final acceptance, vibration analysis shall verify conformance to specifications. Vibration levels shall not be more than 0.075 in/sec at 1 times run speed and at fan/blade frequency, and 0.04 in/sec at other multiples of run speed.

3.4 AHU TESTING

AHU and components shall be performance tested and rated in accordance with AMCA 211 and ASHRAE 51. AHU ratings shall be in accordance with ARI 430.

Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

Air handling unit start-up shall be performed in the presence of the Contracting Officer.

3.5 OPERATION AND MAINTENANCE

Contractor shall submit Operation and Maintenance Manuals prior to testing the air handling units. Data shall be updated and resubmitted for final approval no later than 30 calendar days prior to contract completion.

3.6 COORDINATION

Contractor shall coordinate the size and location of concrete equipment pads, variable frequency drives, control and electrical requirements.

3.7 TEMPORARY CONSTRUCTION FILTERS

Temporary construction filters shall be in place during normal building construction whenever the air handling units are run for general ventilation, building dehumidification, and for other purposes during construction. Install two (2) layers of blanket filter at a time. Replace temporary construction filters as required during construction and after completion of duct system cleaning.

After systems have been cleaned and temporary construction filers are removed, and before test and balance operations are started, install set of final filters. Final filters shall not be in place while general building construction is taking place, to avoid unnecessary loading with construction dust. Clean permanent filter bank before testing and balancing.

All required installation, Fabrication and Connection drawings shall be submitted and approved prior to the start of work detailed on these drawings.

Operation tests shall be performed on each fire damper in the presence of the Contracting Officer by removing the fusible link and demonstrating the operation of the damper.

Maximum number of coil rows shall be four (4). Maximum number of fins per inch shall be ten (10).

-- End of Section --

SECTION 26 00 00.00 98

GENERAL ELECTRICAL PROVISIONS
04/06

PART 1 GENERAL

1.1 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 Z535.1	(2006) Standard for Safety Color Code

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2008) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS A-A-59214	(2004) Junction Box: Extension, Junction Box; Cover, Junction Box (Steel, Coated With Corrosion-Resistant Finish)

UNDERWRITERS LABORATORIES (UL)

UL Elec Const Dir	(2008) Electrical Construction Equipment Directory

1.2 SUBMITTALS

Not Used

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

It is the intent of these specifications and the contract drawings to provide a complete and workable facility.

Design drawings are diagrammatic and do not show all offsets, bends, elbows, or other specific elements that may be required for proper installation of the work. Such work shall be verified at the site. Additional bends and offsets, and conduit as required by vertical and horizontal equipment locations or other job conditions, shall be provided to complete the work at no additional cost to the Government.

Except where shown in dimensional detail, the locations of switches, receptacles, lights, motors, outlets, and other equipment shown on plans are approximate. Such items shall be placed to eliminate interference with ducts, piping, and equipment. Exact locations shall be determined in the

field. Door swings shall be verified to ensure that light switches are properly located.

Equipment sizes indicated are minimum. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and shall install wire, conduit, disconnect switches, motor starters, heaters, circuit breakers, and other items of the correct size for the equipment actually installed. Wire and conduit sizes shown on the drawings shall be taken as a minimum and shall not be reduced without written approval.

1.4 CODES AND STANDARDS

Equipment design, fabrication, testing, performance, and installation shall, unless shown or specified otherwise, comply with the applicable requirements of NFPA 70 and IEEE C2 to the extent indicated by the references.

1.5 COORDINATION

Installation of the electrical work shall be coordinated with the work of other trades.

1.6 APPROVAL REQUIREMENTS

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories (UL), the label of, or listing with re-examination, in UL Elec Const Dir will be acceptable as sufficient evidence that the items conform to the requirements.

Where materials or equipment are specified to be constructed or tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized standards, a manufacturer's certificate of compliance indicating complete compliance of each item with the applicable NEMA, ANSI, ASTM, or other commercial standards specified will be acceptable as proof of compliance.

1.7 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given a rust-inhibiting treatment and the standard finish by the manufacturer when used for most indoor installations. Aluminum shall not be used in contact with earth or concrete. Dissimilar metals in intimate contact shall be protected by approved fittings, barrier material, and treatment. Ferrous metals such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123/A 123M for exterior locations and cadmium-plated in conformance with FS A-A-59214 for interior locations.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

Identification plates shall be 2-layer black-white, engraved to show black letters on a white background. Letters shall be uppercase. Identification plates 1-1/2 inches high and smaller shall be 1/16-inch thick with engraved lettering 1/8-inch high. Identification plates larger than 1-1/2 inches high shall be 1/8-inch thick with engraved lettering not less than 3/16-inch high. Identification plates having edges of 1-1/2 inches high and larger

shall be beveled.

2.2 WARNING SIGNS

Each item of electrical equipment operating at 480 volts and above shall be provided with conspicuously located warning signs conforming to the requirements of Occupational Safety and Health Agency (OSHA) standards.

Any equipment with externally powered wiring shall be marked with a laminated plastic nameplate having 3/16-inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

Safety color coding for identification of warning signs shall conform to ANSI Z535.1.

2.3 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or slabs.

2.4 PAINTING

Enclosures of the following listed items shall be cleaned, primed, and factory-painted inside and outside in accordance with MS MIL-T-704 and the equipment sections of this specification.

ITEM	FINISH COLOR
Safety Switches	Manufacturer's standard
Panelboards	Manufacturer's standard
Electric Heaters	Manufacturer's standard
Motors	Manufacturer's standard
Limit Switches	Manufacturer's standard
Control Components	Manufacturer's standard

PART 3 EXECUTION

3.1 INSTALLATION

Installation shall be accomplished by workers skilled in this type of work. Installation shall be made so that there is no degradation of the designed fire ratings of walls, partitions, ceilings, and floors. Except as otherwise indicated, emergency switches and alarms shall be installed in conspicuous locations.

3.2 PAINTING APPLICATION

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks, if not factory painted, shall be thoroughly cleaned and painted as specified in the equipment sections in this specification unless otherwise noted. Work shall be left in a neat and clean condition at final completion of the contract.

Emergency equipment, such as fire-alarm boxes, shall be cleaned, primed, and painted red.

3.3 IDENTIFICATION PLATE INSTALLATION

Identification plates shall be fastened by means of corrosion-resistant steel or nonferrous metal screws. Hand lettering, marking, or embossed self-adhesive tapes are not acceptable.

3.4 EQUIPMENT PADS

Equipment pads shall be constructed with a minimum 4-inch margin around the equipment and supports.

3.5 CUTTING AND PATCHING

Contractor shall install his work in such a manner and at such time as will require a minimum of cutting and patching on the building structure.

Holes in or through existing masonry walls and floors in exposed locations shall be drilled and smoothed by sanding. Use of a jackhammer will be permitted only where specifically approved.

3.6 DAMAGE TO WORK

Required repairs and replacement of damaged work shall be done as directed by and subject to the approval of the Contracting Officer, and at no additional cost to the Government.

3.7 CLEANING

Exposed surfaces of wireways, conduit systems, and equipment that have become covered with dirt, plaster, or other material during handling and construction shall be thoroughly cleaned before such surfaces are prepared for final finish or painting or are enclosed within the building structure.

Before final acceptance, electrical equipment, including lighting fixtures and glass, shall be clean and free from dirt, grease, and fingermarks.

3.8 FIELD TESTING AND TEST EQUIPMENT

All Field testing specified in Divisions 26 electrical specification shall be made with test equipment specially designed and calibrated for the purpose. Test equipment used shall be calibrated and certified by an approved testing laboratory. Date of last calibration and certification shall not be more than 90 calendar days old at the time of field testing.

-- End of Section --

SECTION 26 05 00.00 98

BASIC ELECTRICAL MATERIALS AND METHODS
04/06

PART 1 GENERAL

1.1 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 Z535.1	(2006) Standard for Safety Color Code

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 480	(1981) Toggle Switches

INTERNATIONAL CODE COUNCIL (ICC)

ANSI/ICC A117.1	(2003 R 2004) Standard for Accessible and Usable Buildings and Facilities

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA FB 1	(2007) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
ANSI/NEMA OS 1	(2003) Standard for Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA KS 1	(2001) Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA PB 1	(2006) Standard for Panelboards
NEMA RN 1	(2005) Standard for Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA VE 1	(2002) Standard for Metallic Cable Tray Systems
NEMA WD 1	(1999) Standard for General Requirements for Wiring Devices
NEMA WD 6	(2002) Standard for Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005) Standard for Flexible Metal Conduit
UL 1242	(2006) Standard for Electrical Intermediate Metal Conduit - Steel
UL 489	(2004) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 6	(2007) Standard for Electrical Rigid Metal Conduit-Steel
UL 797	(2007) Standard for Electrical Metallic Tubing
UL 870	(2008) Standard for Wireways, Auxiliary Gutters, and Associated Fittings

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the following:

Conduits, Raceway sand Fittings
Wire and Cable
Splices and Connectors
Switches
Receptacles
Outlets, Outlet Boxes, and Pull Boxes
Circuit Breakers
Panelboards
Lamps and Lighting Fixtures

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Conduits, Raceway sand Fittings
Wire and Cable
Splices and Connectors
Switches
Receptacles
Outlets, Outlet Boxes, and Pull Boxes
Circuit Breakers -G
Panelboards -G

Lamps and Lighting Fixtures -G
Spare Parts

SD-06 Test Reports -G

Continuity and Insulation Resistance Test
Phase-Rotation Tests
Insulation Resistance Test

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted.

1.3 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall have the standard finish by the manufacturer when used for most indoor installations. Aluminum shall not be used in contact with earth or concrete and, where connected to dissimilar metal, shall be protected by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

1.4 GENERAL REQUIREMENTS

Material, Equipment, and Fixture Lists shall be submitted for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Manufacturer's Instructions shall be submitted including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

2.1.1 Rigid Steel Conduit

Rigid steel conduit shall be in accordance with UL 6 and shall be galvanized by the hot-dip process. Where underground and in corrosive areas, rigid steel conduit shall be polyvinylchloride (PVC) coated in accordance with NEMA RN 1 or shall be painted with bitumastic.

Fittings for rigid steel conduit shall be threaded.

Gaskets shall be solid. Conduit fittings with blank covers shall have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers shall have captive screws and shall be accessible after the work has been completed.

2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be in accordance with UL 797 and shall be zinc coated steel. Couplings and connectors shall be zinc-coated, raintight, gland compression with insulation throat. Crimp, spring, or setscrew type fittings shall not be acceptable.

2.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall be in accordance with UL 1 and shall be galvanized steel.

Fittings for flexible metallic conduit shall be specifically designed for such conduit.

Liquidtight flexible metallic conduit shall be provided with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Fittings for liquidtight flexible metallic conduit shall be specifically designed for such conduit.

2.1.4 Intermediate Metal Conduit

Intermediate metal conduit shall be in accordance with UL 1242 and shall be galvanized.

2.1.5 Wireways and Auxiliary Gutters

Wireway and auxiliary gutters shall be a minimum 4- by 4 inch trade size conforming to UL 870.

2.1.6 Surface Raceways and Assemblies

Surface metal raceways and multi-outlet assemblies shall conform to NFPA 70. Receptacles shall conform to NEMA WD 1, Type 5-20R.

2.1.7 Cable Trays

Cable trays shall be ladder type conforming to NEMA VE 1.

2.2 WIRE AND CABLE

Conductors installed in conduit shall be copper 600-volt type THHN/THWN. All conductors AWG No. 8 and larger, shall be stranded. All conductors smaller than AWG No. 8 shall be solid.

Flexible cable shall be Type SO and shall contain a grounding conductor with green insulation.

Conductors installed in plenums shall be marked plenum rated.

2.3 SPLICES AND CONNECTORS

Splices in AWG No. 8 and smaller shall be made with approved indentor crimp-type connectors and compression tools.

Splices in AWG No. 6 and larger shall be made with indentor crimp-type

connectors and compression tools . Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

2.4 SWITCHES

2.4.1 Safety Switches

Safety switches shall be in accordance with NEMA KS 1, and shall be the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, with the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and shall be so constructed that an external tool must be used to open the cover. Provisions shall be made to lock the handle in the "OFF" position, but the switch shall not be capable of being locked in the "ON" position.

Safety switches to be the products of Cutler Hammer, General Electric, Siemens Electric, or Square D.

Switches to be horsepower rated fusible or non-fusible type as required. Switch rating to be 250 volt or 600 volt as required to match system voltage.

Switches to be 2 pole, 3 pole or 3 pole solid neutral as required. Switches to have rejection type fuse clips.

Safety switches located indoors in dry areas to have NEMA 12 enclosures. Safety switches located outdoors or in damp areas indoors to have NEMA 3R enclosures. Others as noted.

Switches shall be of the quick-make, quick-break type. Terminal lugs shall be approved for use with copper conductors.

Safety color coding for identification of safety switches shall conform to ANSI Z535.1.

Install safety switches as shown on Drawings, top at 6'-0".

Coordinate exact switch location with equipment, ductwork, piping, etc. to ensure Code required clearances and accessibility.

Where switches cannot be mounted to a wall, building structure, or equipment, furnish and install rigid angel iron or unistrut stand for mounting switch.

2.4.2 Motor Starters

2.4.2 Toggle Switches

Toggle switches shall be in accordance with EIA 480, and shall control incandescent, mercury, and fluorescent lighting fixtures and shall be of the heavy duty, general purpose, noninterchangeable flush-type.

Toggle switches shall be commercial grade toggle type, singleor double -pole, threeor four-way two-position devices rated 20 amperes at 277 volts, 60 hertz alternating current (ac) only.

All toggle switches shall be products of the same manufacturer.

2.5 RECEPTACLES

Receptacles shall be commercial grade, 20A, 125 VAC, 2-pole, 3-wire duplex conforming to NEMA WD 6, NEMA 5-20R.

2.6 OUTLETS, OUTLET BOXES, AND PULL BOXES

Outlet boxes for use with conduit systems shall be in accordance with ANSI/NEMA FB 1 and ANSI/NEMA OS 1 and shall be not less than 1-1/2 inches deep. Pull and junction boxes shall be furnished with screw-fastened covers.

2.7 PANELBOARDS

Lighting and appliance branch circuit panelboards shall be the circuit-breaker type in accordance with NEMA PB 1. Circuit breakers shall be bolted to the bus. Plug-in circuit breakers shall not be acceptable. Buses shall be copper of the rating indicated, with main lugs or main circuit breaker as indicated. Panelboards for use on grounded ac systems shall be provided with a full-capacity isolated neutral bus and a separate grounding bus bonded to the panelboard enclosure. Panelboard enclosures shall be NEMA 250, Type 1, in accordance with NEMA PB 1. Enclosure fronts shall have latchable hinged doors.

2.8 CIRCUIT BREAKERS

Circuit-breaker interrupting rating shall be not less than those indicated and in no event less than 22,000 amperes root-mean-square (rms) symmetrical at 208 volts, respectively. Multipole circuit breakers shall be the common-trip type with a single handle. Molded case circuit breakers shall be bolt-on type conforming to UL 489.

2.9 LAMPS AND LIGHTING FIXTURES

Manufacturers and catalog numbers shown are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, will be acceptable. Lamps of the proper type and wattage shall be provided for each fixture.

Ballasts shall be high power factor and be energy efficient. Ballasts shall have a Class P terminal protective device for 120 -volt operation as indicated and shall be rapid-start fluorescent. Ballasts shall be "A" sound rated. Fluorescent lamps shall be standard reduced wattage type.

High intensity discharge (HID) lighting fixtures shall have prewired integral ballasts and cast aluminum housings complete with tempered glass lenses suitable for installation in damp or wet locations. Fixtures and lamps shall be provided.

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall contain not more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Crushed or deformed conduit shall not be installed. Trapped conduit runs shall be avoided where possible. Care shall be taken to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clogged conduit shall be cleared of obstructions or shall be replaced.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

3.1.1 Rigid Steel Conduit

Field-made bends and offsets shall be made with approved hickey or conduit bending machine. Conduit elbows larger than 2-1/2 inches shall be long radius.

Conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, shall be provided with a flush coupling when the floor slab is of sufficient thickness. Otherwise, a floor box shall be provided and set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.1.2 Electrical Metallic Tubing (EMT)

EMT shall be grounded in accordance with NFPA 70, using pressure grounding connectors especially designed for EMT.

3.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall be used to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

Bonding wires shall be used in flexible conduit as specified in NFPA 70, for all circuits. Flexible conduit shall not be considered a ground conductor.

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit.

Liquidtight flexible metallic conduit shall be used in wet and oily locations and to complete the connection to motor-driven equipment.

3.1.4 Intermediate Conduit

Field-made bends and offsets shall be made with approved hickey or conduit bending machine. Intermediate metal conduit shall be used only for indoor installations.

3.1.5 Wireway and Auxiliary Gutter

Straight sections and fittings shall be bolted together to provide a rigid, mechanical connection and electrical continuity. Dead ends of wireways and auxiliary gutters shall be closed. Unused conduit openings shall be plugged.

Wireways for overhead distribution and control circuits shall be supported

at maximum 5-foot intervals.

Auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure shall contain no switches, overcurrent devices, appliances, or apparatus and shall be not more than 30feet long.

3.1.6 Surface Raceways and Assemblies

Surface raceways shall be mounted plumb and level, with the base and cover secured. Minimum circuit run shall be three-wire with one wire designated as ground.

3.1.7 Cable Trays

Cable trays shall be supported from ceiling hangers, equipment bays, or floor or wall supports. Cable trays may be mounted on equipment racks. Support shall be provided when the free end extends beyond 3 feet. Maximum support spacing shall be 6 feet. Trays 10-inches wide or less shall be supported by one hanger. Trays greater than 10-inches wide shall be supported by two hangers. Cable trays shall be bonded at splices.

3.2 WIRING

Feeder and branch circuit conductors shall be color coded as follows:

CONDUCTOR	COLOR-208 VAC
Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Equipment Grounds	Green

Conductors up to and including AWG No. 2shall be manufactured with colored insulating materials. Conductors larger than AWG No. 2 shall have ends identified with color plastic tape in outlet, pull, or junction boxes.

Splices shall be in accordance with the NFPA 70. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification shall match as indicated.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.

3.3 SAFETY SWITCHES

Switches shall be securely fastened to the supporting structure or wall, utilizing a minimum of four 1/4 inch bolts. Sheet metal screws and small machine screws shall not be used for mounting. Switches shall not be mounted in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be 5 feet above floor level, when possible.

3.4 WIRING DEVICES

3.4.1 Wall Switches and Receptacles

Wall switches and receptacles shall be so installed that when device plates are applied, the plates will be aligned vertically to within 1/16 inch.

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.4.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets shall be suitably marked, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Required marking shall consist of a self-adhesive label having 1/4 inch embossed letters.

Device plates for convenience outlets shall be similarly marked indicating the supply panel and circuit number.

3.5 BOXES AND FITTINGS

Pullboxes shall be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Boxes and enclosures shall be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, shall be in accordance with ANSI/ICC A117.1 and as follows:

LOCATION	MOUNTING HEIGHT
Receptacles in offices	18 inches
Receptacles in corridors	18 inches
Receptacles in shops & laboratories	48 inches
Receptacles in rest rooms	48 inches
Switches for light control	48 inches

3.6 LAMPS AND LIGHTING FIXTURES

New lamps of the proper type and wattage shall be installed in each fixture. Fixtures and supports shall be securely fastened to structural members and shall be installed parallel and perpendicular to major axes of structures.

3.7 PANELBOARDS

Panelboards shall be securely mounted so that the top operating handle does not exceed 72-inches above the finished floor. No equipment shall be mounted within 36 inches of the front of the panel.Directory card information shall be complete and legible.

3.8 IDENTIFICATION PLATES AND WARNINGS

Identification plates shall be furnished for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, door bells, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Process control devices and pilot lights shall have identification plates.

Identification plates shall be furnished for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

3.9 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks shall be thoroughly cleaned and painted as specified in Section 09 90 00.00 40 ARCHITECTURAL PAINTING.

3.10 FIELD TESTING

After the installation is complete wire and cable shall be given a continuity and insulation resistance test. Insulation resistance test shall be with a 250 - volt insulation test set. Readings shall be recorded after a minimum of 3 minutes and until the reading is constant for 1 minute. Resistance between phase conductors and ground shall be no less than 25 megohms.

Phase-rotation tests shall be conducted on three-phase circuits using a phase-rotation indicating instrument. Phase rotation of electrical connections to connected equipment shall be A, B, C left to right, or top to bottom facing the equipment.

Final acceptance will depend upon the satisfactory performance of the equipment under test. No conductor or circuit shall be energized until the installation has been approved by the Contracting Officer. Final test data shall be provided to the Contracting Officer. Data shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Data - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION 26 05 73.00 40

OVERCURRENT PROTECTIVE DEVICES
07/07

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM A 167	(2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 48/A 48M	(2003) Standard Specification for Gray Iron Castings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.09	(1999) IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on aSymmetrical Current Basis

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA AB 3	(2001) Molded Case Circuit Breakers and Their Application
NEMA FU 1	(2002) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2005) Standard for Industrial Control and Systems General Requirements
NEMA ICS 2	(2000; Errata 2002; R 2005; Errata 2006) Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
NEMA ICS 3	(2005) Standard for Industrial Control and Systems: Medium Voltage Controllers Rated 2001 to 7200 Volts AC

NEMA ICS 6	(2006) Standard for Industrial Controls and Systems Enclosures
NEMA SG 2	(1993) Standard for High-Voltage Fuses

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 489	(2004; Rev thru Jun 2006) Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
UL 50	(2003; R 2005) Standard for Enclosures for Electrical Equipment
UL 508	(2005) Standard for Industrial Control Equipment

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

No change in continuous-current rating, interrupting rating, and clearing or melting time of fuses shall be made unless written permission has first been secured from the Contracting Officer.

SD-02 Shop Drawings

Connection Diagrams and Fabrication Drawings shall be submitted for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Installation drawings shall also be submitted for the following items in accordance with the paragraph entitled, "Installation," of this section.

Control Devices
Protective Devices

SD-03 Product Data

Equipment and performance data shall be submitted for the following items including use life, system functional flows, safety features, and mechanical automated details.

Manufacturer's catalog data shall also be submitted for the following items:

Motor Control
Enclosures -G
Circuit Breakers -G
Fuses -G

Control Devices

SD-06 Test Reports

Factory Test Reports shall be submitted for Power, High Voltage, and Oil Circuit Breakers in accordance with IEEE C37.09.

Dielectric Tests

Insulation Power Factor Test

SD-07 Certificates

Certificates shall be submitted for Circuit Tests on similar motor-control or motor-circuit protector (MCP) units under actual conditions may be submitted in lieu of factory tests on the actual units provided.

SD-08 Manufacturer's Instructions

Manufacturer's Instructions shall be submitted for the following items, including special provisions required to install equipment components and system packages. Special notices shall detail, resistance impedances, hazards and safety precautions.

Control Devices
Protective Devices

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals shall be submitted for the following equipment:

Manual Motor Controllers
Magnetic Motor Controllers
Combination Motor Controllers

Circuit Breakers

Protective Relays
Indicating Instruments

1.3 GENERAL REQUIREMENTS

Section 26 05 00.00 98 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Connection Diagrams shall be submitted showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Fabrication Drawings shall be submitted for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

PART 2 PRODUCTS

2.1 MOTOR CONTROL

Motor controllers shall conform to NEMA ICS 1, NEMA ICS 2, and UL 508. Controllers shall have thermal overload protection in each phase.

2.1.1 Magnetic Motor Controllers

2.1.1.1 Full-Voltage Controllers

Magnetic motor controllers for the control and protection of single- and three-phase, 60-hertz, squirrel-cage induction motors shall be full-voltage, full magnetic devices in accordance with NEMA ICS 1, NEMA ICS 2, and UL 508.

Operating coil assembly shall operate satisfactorily between 85 and 110 percent of rated coil voltage. Motor control circuits shall be 120 volts, 60 hertz.

Controller shall be provided with two normally open and two normally closed auxiliary contacts rated per NEMA ICS 1 and NEMA ICS 2 in addition to the sealing-in contact for control circuits.

Solderless pressure wire terminal connectors shall be provided for line-and load-connections to controllers.

Overcurrent protection shall include three manual reset thermal overload devices, one in each pole of the controller. Thermal overload relays shall be bimetallic nonadjustable type with continuous current ratings and service-limit current ratings and shall have a plus or minus 15 percent adjustment to compensate for ambient operating conditions.

An externally operable manual-reset button shall be provided to re-establish control power to the holding coil of the electromagnet. After the controller has tripped from overload, resetting the motor-overload device shall not restart the motor.

Enclosure shall be in accordance with NEMA 250, Type I.

2.2 ENCLOSURES

2.2.1 Equipment Enclosures

Enclosures for equipment shall be in accordance with NEMA 250.

Equipment installed inside, clean, dry locations shall be contained in NEMA Type 1, general-purpose sheet-steel enclosures.

Equipment installed in industrial locations shall be contained in NEMA Type 12 industrial use, sheet-steel enclosures constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Sheet-steel enclosures shall be fabricated from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.

Steel enclosures shall be fabricated from corrosion-resistant, chromium-nickel steel sheet conforming to ASTM A 167 Type 300 series with

ASM No. 4 general-purpose polished finish. Box dimensions and thickness of sheet steel shall be in accordance with UL 50.

Cast-iron enclosures shall be gray-iron castings conforming to ASTM A 48/A 48M with tensile-strength classification recognized as suitable for the application. Cast-metal enclosures shall be not less than 1/8-inch thick at every point, of greater thickness at reinforcing ribs and door edges, and not less than 1/4-inch thick at tapped holes for conduits.

2.3 CIRCUIT BREAKERS

Circuit breakers shall conform to UL 489, NEMA AB 1, and NEMA AB 3.

2.3.1 Molded-Case Circuit Breakers

Circuit breakers shall be molded case, manually operated, trip-free, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Circuit breakers shall be completely enclosed in a molded case, with the calibrated sensing element factory-sealed to prevent tampering.

Thermal-magnetic tripping elements shall be located in each pole of the circuit breaker and shall provide inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection. Instantaneous magnetic tripping element shall be adjustable and accessible from the front of the breaker on frame sizes larger than 100 amperes.

Breaker size shall be as required for the continuous current rating of the circuit. Breaker class shall be as required.

Interrupting capacity of the panel and lighting branch circuit breakers shall be sufficient to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Circuit breaker interrupting capacities shall be a minimum of 10,000 amperes and shall conform to NEMA AB 3.

Multipole circuit breakers shall be of the common-trip type having a single operating handle and shall a have two-position on/off indication. Circuit breakers shall have temperature compensation for operation in an ambient temperature of 104 degrees F. Circuit breakers shall have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective type tripping (time delay, magnetic, thermal, or ground fault).

Breaker body shall be of phenolic composition. Breakers shall be capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required.

Circuit breakers used for motor-circuit disconnects shall meet the applicable requirements of NFPA 70 and shall be of the motor-circuit protector type.

Circuit breakers used for service disconnection shall be the enclosed circuit-breaker type with external handle for manual operation. Enclosures shall be sheet metal with a hinged cover suitable for surface mounting.

2.4 FUSES

A complete set of fuses for all switches and switchgear shall be provided.

Fuses shall have a voltage rating not less than the circuit voltage.

Fuses rated 30 amperes, 125 volts or less shall be the nonrenewable cartridge type. Fuses rated above 30 amperes 600 volts or less shall be the renewable cartridge type with time-delay dual elements, except where otherwise indicated. Fuses shall conform to NEMA FU 1.

Special fuses such as extra-high interrupting-capacity fuses, fuses for welding machines, and capacitor fuses shall be installed where required. Plug fuses are not permitted.

Power fuses on ac systems above 600 volts shall be in accordance with NEMA SG 2.

Fuses shall be labeled showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, fuse information shall be clearly listed on equipment drawings.

Fuse holders field-mounted in a cabinet or box shall be porcelain. Field installation of fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber shall not be used.

2.5 CONTROL DEVICES

2.5.1 Control-Circuit Transformers

Control-circuit transformers shall be provided within the enclosure of magnetic contactors and motor controllers when the line voltage is in excess of 120 volts. Transformer shall be encapsulated dry type, single-phase, 60-hertz, with a 120-volt isolated secondary winding.

Rated primary voltage of the transformer shall be not less than the rated voltage of the controller. Rated secondary current of the transformer shall be not less than continuous-duty current of the control circuit.

Voltage regulation of the transformer shall be such that, with rated primary voltage and frequency, the secondary voltage shall not be less than 95 percent nor more than 105 percent of rated secondary voltage.

Source of supply for control-circuit transformers shall be the load side of the main disconnecting device. Secondary winding of the transformer and control-circuit wiring shall be protected against overloads and short circuits with fuses selected in accordance with NEMA ICS 6. Secondary winding of the control-circuit transformer shall be grounded in accordance with NEMA ICS 6.

2.5.2 Pushbuttons and Switches

2.5.2.1 Pushbuttons

Pushbuttons for low-voltage ac full-voltage magnetic controllers shall be heavy-duty oiltight NEMA 250, Type 12, momentary-contact devices rated 600 volts, with pilot light, and with the number of buttons and the marking of identification plates as shown. Color code for pushbuttons shall be in accordance with NEMA ICS 6.

Pushbuttons shall be designed with normally open, circuit-closing contacts; normally closed circuit-opening contacts; and two-circuit normally open and normally closed circuit-closing and -opening contacts. Pushbutton-contact

ratings shall be in accordance with NEMA ICS 1 and NEMA ICS 2 with contact designation A600.

Pushbuttons in remote control stations shall be identified with identification plates affixed to front cover in a prominent location. Identification plate shall carry the identification of the system being controlled.

2.5.2.2 Selector Switches

Selector switches for low-voltage control circuits shall be heavy-duty oiltight maintained-contact devices with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Selector switches in remote control stations shall be identified with engraved identification plates affixed to front cover in a prominent location. Identification plate shall carry the identification of the system being controlled.

2.6 FINISH

Metallic materials shall be protected against corrosion. Equipment shall have the standard finish by the manufacturer when used for most indoor installations.

PART 3 EXECUTION

3.1 INSTALLATION

Control devices and protective devices not factory installed in equipment shall be installed in accordance with the manufacturer's recommendations and shall be field adjusted and operation tested. Installations shall conform to NFPA 70, NEMA ICS 1, NEMA ICS 2, and NEMA ICS 3 requirements for installation of control and protective devices.

3.2 FIELD TESTING

Control and protective devices not factory installed in equipment shall be demonstrated to operate as indicated.

Instrumentation, potential, and current transformers shall be ratio'd and tap settings verified.

Control and protective devices shall not be energized until recorded test data have been approved by the Contracting Officer. Final test reports shall be provided to the Contracting Officer. Reports shall have a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

SECTION 26 24 16.00 40

PANELBOARDS
07/07

PART 1 GENERAL

1.1 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.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(2002) Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
NEMA PB 1	(2006) Standard for Panelboards

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev B; Am 1) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 67	(1993; Rev thru Apr 2006) Standard for Panelboards

1.2 GENERAL REQUIREMENTS

Section 26 05 00.0098 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Detail Drawings shall be submitted for the panelboards consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents. Drawings shall include details of bus layout.

Outline Drawings for panelboards shall indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

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

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings and Outline Drawings shall be submitted for panelboards in accordance with paragraph entitled, "General Requirements," of this section. -G

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Panelboards -G
Directory Card and Holder -G

SD-04 Samples

Keys shall then be properly tagged and delivered to the Contracting Officer.

SD-06 Test Reports -G

Test reports shall be submitted for the following tests in accordance with the paragraph entitled, "Site Testing," of this section. Panelboards shall not be energized until the recorded test data have been submitted to and approved by the Contracting Officer.

Continuity Tests
Insulation Tests
Phase Rotation Test

SD-07 Certificates

Statements shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for Panelboards including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

PART 2 PRODUCTS

2.1 PANELBOARDS

Power-distribution panelboards and lighting and appliance branch-circuit panelboards shall be totally enclosed in a steel cabinet, dead-front circuit breaker type with copper buses, surface- or flush-mounted as indicated. Panelboards shall conform to NEMA PB 1 and NEMA AB 1. Branch circuit panels shall have buses fabricated for bolt-on type circuit breakers.

An outer door or cover, hinged on one side, shall be provided on surface-mounted panelboards to provide gutter space access. A center door shall be provided for circuit breaker/switch access only.

Voltage and current rating, number of phases, and number of wires shall be as indicated. Four-wire distribution panelboards and lighting and appliance branch-circuit panelboards shall be provided with an isolated full-capacity neutral bus. Panelboards shall be rated for 120/208-volt, three-phase , 60-hertz current.

Three-phase, 4-wire distribution lighting and branch circuit panelboards shall be provided with an isolated full-capacity bus providing spaces for single-pole circuit breakers/switches and spaces indicated as spare.

Panelboards shall be provided with a separate grounding bus bonded to the enclosure. Grounding bus shall be a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Each panelboard, as a complete unit, shall have a short-circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or as indicated.

Panelboards and main lugs or main breaker shall have current ratings as shown on the panelboard schedule.

Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Three-phase, four-wire busing shall be such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.

Mechanical lugs furnished with panelboards shall be cast copper or copper alloys of sizes suitable for the conductors indicated to be connected thereto.

Panelboard box shall be galvanized rust-resistant code-gage sheet steel without knockouts. Entire panelboard front shall be hinged on one side with a piano hinge for the full height and shall also have captive screws opposite the hinged side. Where panelboards are installed flush with the walls, the installation details shall be such that the hinged front can be opened without damage to the adjacent wall surfaces. Color of the finished coat of trim and front shall match the adjacent walls except that when the box is installed in electrical closets or equipment rooms, the gray finish as specified will be acceptable.

Panelboard enclosures shall be NEMA 250, Type 1. Enclosures shall be provided with hinged fronts and corrosion-resistant steel pin-tumbler cylinder locks. Locks shall be keyed alike, and two keys shall be provided for each enclosure.

Panelboards shall be finished with baked enamel. Finish color shall be No. 61 gray conforming to FED-STD-595.

2.2 CIRCUIT BREAKERS

Circuit breakers shall be the molded-case type as specified in Section 26 05 73.00 40 OVERCURRENT PROTECTIVE DEVICES. Frame and trip ratings shall be as indicated.

Interrupting rating of circuit breakers shall be as indicated. If not shown, the interrupting rating for circuit breakers in 120/208 -volt panelboards shall be not less than 22,000 amperes rms symmetrical.,

Circuit breakers shall be bolt-on type. Plug-in type shall not be acceptable.

Connections to the bus shall be bolt-on type.

When multiple wires per phase are specified, the circuit breakers shall be furnished with connectors made to accommodate multiple wires.

Circuit breaker spaces called out on the drawings shall be complete with mounting hardware to permit ready installation of the circuit breakers.

2.3 DIRECTORY CARD AND HOLDER

A directory card shall be mounted on the inside of hinged fronts and doors 0.030-inch thick minimum plastic in a metal frame, with spaces for circuit numbers, outlets controlled, and room numbers. Where hinged fronts or doors are not required, the directory card shall be provided 0.030-inch thick minimum plastic in a metal frame mounted on the left-hand side of the front trim. Directory card shall identify each branch circuit with its respective and numbered circuit breaker.

2.4 FACTORY TESTING

Complete panelboards shall be tested in accordance with UL 67.

2.5 PRECAUTIONARY LABEL

To ensure persons are aware of immediate or potential hazard in the application, installation, use, or maintenance of panelboards, each panelboard shall be conspicuously marked on the trim or dead front shield with the text (or equivalent) **DANGER** symbol. If the panel is supplied with a door, the label shall be visible when the door is in the open position.

PART 3 EXECUTION

3.1 INSTALLATION

Panelboards shall be installed as indicated and in accordance with the manufacturer's instructions. Panels shall be fully aligned and mounted so that the height of the top operating handle will not exceed 72-inches above the finished floor.

Directory-card information shall be typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.

3.2 SITE TESTING

Each panelboard enclosure key shall be shown to operate the enclosure locks in the presence of the Contracting Officer.

Panelboards shall be given continuity and insulation tests after the

installation has been completed and before the panelboard is energized.

Test equipment, labor, and personnel shall be provided by the Contractor as required to perform the tests as specified. Continuity tests shall be conducted using a dc device with bell.

Insulation tests on panelboards rated 480 volts or less shall be conducted using a 500-volt minimum insulation-resistance test set. Readings shall be recorded after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Phase rotation tests shall be conducted on three-phase circuits using a phase rotation indicating instrument. Phase rotation shall be A, B, C left to right, or top to bottom facing the panelboard.

Test data shall be recorded and shall include the location and identification of panelboards and megohm readings versus time.

-- End of Section --

SECTION 26 27 26.00 40

WIRING DEVICES
07/07

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM D 2301	(1999; R 2004) Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2003) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA C80.1	(2005) Standard for Electrical Rigid Steel Conduit (ERSC)
NEMA C80.3	(2005) Standard for Electrical Metallic Tubing (EMT)
NEMA C80.5	(2005) Standard for Electrical Rigid Aluminum Conduit (ERAC)
NEMA FB 1	(2003) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
NEMA FB 11	(2000) Standard for Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations
NEMA KS 1	(2001) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA WD 1	(1999; R 2005) Standard for General Requirements for Wiring Devices
NEMA WD 6	(2002) Standard for Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005) Standard for Flexible Metal Conduit
UL 1242	(2006; Rev thru Jun 2006) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 1581	(2001; Rev thru Aug 2006) Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 20	(2004) Standard for General-Use Snap Switches
UL 486C	(2004; Rev thru Aug 2006) Standard for Splicing Wire Connectors
UL 50	(2003; R 2005) Standard for Enclosures for Electrical Equipment
UL 514A	(2005) Standard for Metallic Outlet Boxes
UL 514B	(2004; Rev thru Apr 2006) Standard for Conduit, Tubing and Cable Fittings
UL 6	(2004e13) Standard for Electrical Rigid Metal Conduit-Steel
UL 797	(2004) Standard for Electrical Metallic Tubing -- Steel
UL 870	(1995; Rev thru Jul 2003) Wireways, Auxiliary Gutters, and Associated Fittings

1.2 GENERAL REQUIREMENTS

Section 26 05 00.00 98 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Material, Equipment, and Fixture Lists for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Conduit, Raceways and Fittings
Wire and Cable
Safety Switches
Flush Wiring Devices
Boxes and Fittings

SD-02 Shop Drawings

Submit the following types of drawings to check for contract conformity:

Fabrication Drawings
Assembly Drawings

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Conduit, Raceways and Fittings -G
Wire and Cable -G
Safety Switches -G
Flush Wiring Devices -G
Boxes and Fittings -G

SD-06 Test Reports -G

Submit Test Reports for standard wiring systems in accordance with the paragraph entitled, "Field Testing," of this section. Minimum test reports required are as follows:

Insulation-Resistance Test
Continuity Test
Phase-Rotation Tests

SD-07 Certificates

Submit Certificates of Compliance for the following items showing conformance with the referenced standards contained in this section.

Conduit, Raceways and Fittings
Wire and Cable
Safety Switches
Flush Wiring Devices
Boxes and Fittings

1.4 FABRICATION AND ASSEMBLY DRAWINGS

Submit Fabrication Drawings for the standard wiring systems consisting of fabrication and Assembly Drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements for the contract documents.

PART 2 PRODUCTS

2.1 CONDUIT, RACEWAYS AND FITTINGS

Provide conduit with 3/4 inch diameter minimum, except where specifically shown smaller on the contract drawings, and except for exposed switch leg runs.

Conduit, connectors, and fittings must be approved for the installation of electrical conductors.

2.1.1 Intermediate Metal Conduit

Intermediate metal conduit, including couplings, elbows, bends, and nipples, for use as a raceway for wire and cables in an electrical system must conform to the requirements of UL 1242 as amended for thin or thick-wall types and must also conform to NFPA 70. Interior and exterior surfaces of the conduit must be protected with a metallic zinc coating.

2.1.2 Rigid Steel Conduit

Rigid steel,or aluminum conduit, including couplings, elbows, bends, and nipples, must conform to the requirements of UL 6 andNEMA C80.1NEMA C80.5 Steel fittings must be galvanized by the hot-dip process.

Fittings for rigid steel,or aluminum conduit must be threaded and must conform to NEMA FB 1.

Gaskets must be solid for fittings sized 1-1/2 inches and less. Conduit fittings with blank covers must have gaskets except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers must have captive screws and be accessible after the work has been completed.

2.1.3 Electrical Metallic Tubing (EMT)

EMT must be rigid metallic conduit of the thinwall type in straight lengths, elbows, or bends and must conform to NEMA C80.3 and the requirements of UL 797.

Couplings and connectors must be hex-nut expansion-gland type, cadmium -plated. Crimp, spring, or setscrew type fittings are not acceptable. Where EMT enters outlet boxes, cabinets, or other enclosures, connectors must be the insulated-throat type, with a locknut. Fittings must meet the requirements of NEMA FB 1.

2.1.4 Flexible Metallic Conduit

Flexible metallic conduit must meet the requirements of UL 1.

Liquidtight flexible metallic conduit must 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 must meet the requirements of UL 514B, Type I box connector, electrical, Type III coupling, electrical conduit, flexible steel, or Type IV adapter, electrical conduit.

Fittings for liquidtight flexible metallic conduit must meet the requirements of UL 514B, Type I box connector, electrical, Class 3 liquidtight flexible metallic conduit connectors.

2.1.5 Wireways and Auxiliary Gutters

Wireways and auxiliary gutters for use in exposed, dry locations must be a prefabricated channel-shaped sheet metal trough with hinged or removable

covers, associated fittings, and supports for housing, and protecting electrical wires and cables in accordance with UL 870.

Straight sections of trough, elbows, tees, crosses, closing plates, connectors, and hanging brackets must be constructed from sheet steel of commercial quality not less than 16-gage. Sheet metal component parts must be cleaned, phosphatized, and coated with a corrosion-resistant gray paint.

Straight sections of wireways and auxiliary gutters must be solid or have knockouts as indicated in both sides and bottom, 3 inches on center.

Straight sections must be not more than 5-feet long, with covers held closed with screws.

2.1.6 Surface Metal Raceways

Surface metal raceways must conform to the requirements of NFPA 70. Minimum size must equal or exceed the capacity of 1/2 inch trade size conduit.

2.1.7 Surface Multiple-Outlet Assemblies

Surface multiple-outlet assemblies must conform to the requirements of NFPA 70 and must be provided with receptacles conforming to NEMA WD 1, NEMA FB 11 and NEMA WD 6, Figure 5-15R.

2.2 WIRE AND CABLE

Insulated current-carrying wire and grounding conductors must be copper and must conform to NFPA 70 and UL 1581. Wire bundles with cable ties must be secured to the enclosure with sheet-metal screws. Self-sticking adhesive attachments are not acceptable.

2.2.1 Building Wire

Building wire for use in conduits, raceways, and wireways must be single-conductor, 600-volt, heat- and moisture-resistant insulated wire suitable for use in wet or dry locations.

Conductors AWG No. 10 and smaller must be solid round copper wire. Conductors AWG No. 8 and larger must be standard concentric stranded copper wire. Conductors must be not less than AWG No. 12, except that AWG No. 14 must be stranded copper wire and must be used for control wiring.

Building wire must be Type THWN with insulation of PVC and nylon jacket, with a minimum temperature rating of 75 degrees C.

2.2.2 Lighting-Fixture Wiring

Lighting-fixture wire for use in fluorescent fixture wiring channels must be flexible seven-strand or solid copper wire conforming to NFPA 70.

2.2.3 Splices and Connectors

Splices in building wire AWG No. 8 and smaller and multiple conductor cables must be made with insulated Scotchlock, or equal, connectors or with indentor crimp-type connectors and compression tools to ensure a satisfactory mechanical and electrical joint.

Splices in building wire AWG No. 6 and larger and single-conductor cables must be made with indentor crimp-type connectors and compression tools or with bolted clamp-type connectors to ensure a satisfactory mechanical and electrical joint.

Joints must be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor. Splices in rubber-insulated neoprene-jacketed wire and cables must be watertight.

Vinyl-plastic electrical insulating tape must meet the requirements of ASTM D 2301. Where pressure-sensitive tape is used, the surface must be cleaned free of dust, sand, or other foreign material and a primer recommended by the tape manufacturer must be applied prior to taping.

Where indicated and for building wire AWG No. 8 and larger, terminations must utilize screw-set pressure terminal lugs.

Where indicated, building wire AWG No. 10 and smaller must be terminated in pre-insulated crimp ring lugs on terminal blocks.

Solid wiring must be terminated with terminal blocks specifically designed for solid wire. Crimp type must not be used on solid wire for termination.

Stranded wire must use crimp type lugs for termination on terminal blocks.

2.3 SAFETY SWITCHES

Switches must comply with NEMA KS 1.

Safety switches must be the heavy-duty type with voltage, current rating, number of poles, and fusing as indicated. Switch construction must be such that, with the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device must be coinproof and must be so constructed that an external tool (screwdriver) must be used to open the cover. Provisions must be made to lock the handle in the "OFF" position, but the switch handle must not be capable of being locked in the ON position.

Switches must be the quick-make, quick-break type. Terminal lugs must be approved for use with copper conductors.

2.4 FLUSH WIRING DEVICES

2.4.1 Wall Switches

Snap switches installed for the control of incandescent, mercury, and fluorescent lighting fixtures must be heavy-duty, general-purpose, noninterchangeable flush devices conforming to UL 20 and NEMA WD 1, as indicated.

Snap switches must be the toggle type: single-pole, double-pole three-wayor four-way two-position devices rated 20 amperes at 277 volts, 60 hertz, ac only, meeting the requirements of UL 20.

All snap switches must be made by the same manufacturer.

Where two or more snap switches are to be installed at the same location, they must be mounted in one-piece ganged switch boxes, with a gang cover plate.

Combination snap switch and single or duplex receptacles must be mounted in two-gang switch boxes, with a combination two-gang cover plate.

Combination snap switch and flush pilot light must be interchangeable devices mounted in a one-gang switch box with a one-gang, two-opening cover plate. Pilot-light cover opening must be fitted with a rectangular-shaped ruby-red plastic jewel in a metal frame.

2.4.2 Receptacles

Receptacles must be 20-ampere, 125-volt ac, 2-pole, 3-wire, duplex grounded, conforming to NEMA FB 11, NEMA WD 1 and to the 5-20R configuration in NEMA WD 6.

Bodies of 20-ampere receptacles must be nylon compound supported by a mounting yoke having plaster ears. Contact arrangement must be such that contact is made on two sides of an inserted blade. Each receptacle must be back -wired with two screws per terminal, must be provided with a third grounding pole, and must be capable of receiving 2-wire, 3-pole parallel-blade caps. Third grounding pole must be connected to a metal mounting yoke and must be provided with a green-colored screw for grounding.

Power outlets for connection to 208 volt,single and three -phase, ac circuits must consist of single locking receptacles in industrial cast-metal enclosures with cast-aluminum bodies, angle adapters, and receptacle housings with spring-loaded hinged lift covers, conforming to NEMA 250 for the indicated voltage and current rating. Springs and hinge pins must be corrosion-resistant steel. Screws and spring covers must be chromium -plated brass. Rubber gaskets must provide a positive seal against the entrance of dust, lint, fibers, and oil or coolant seepage.

Locking receptacles must conform to NEMA WD 6. One plug must be furnished with each locking receptacle.

Receptacles must meet the requirements for retention of plugs, overload, temperature, and assembly security in accordance with NEMA WD 1.

2.4.3 Weatherproof Outlets

Convenience outlets installed in outdoor damp or wet locations for connection to 120-volt ac single-phase circuits must consist of duplex Ground Fault Circuit Isolation (GFCI) receptacles enclosed in weatherproof outlet boxes, with gasketed cast-aluminum plates and spring-loaded hinged lift covers. Springs and hinge pins must be corrosion-resistant steel. Screws and spring covers must be chromium -plated brass. Rubber or neoprene gaskets must provide a positive seal against the weather. Covers to be in-use protection type.

2.4.4 Device Plates

Wall plates for flush snap switches and receptacles must be the appropriate type and size and must match the wiring devices for which they are intended. Dimensions for openings in wall plates must be in accordance with NEMA WD 1.

2.5 BOXES AND FITTINGS

Boxes must have sufficient volume to accommodate the number of conductors

entering the box in accordance with the requirements of NFPA 70 and UL 514A. Boxes that are exposed to the weather or that are in normally wet locations must be cast-metal with threaded hubs. Surface-mounted boxes on interior walls must be cast-metal. Boxes in other areas must be cadmium-plated or zinc-coated sheet metal.

2.5.1 Sheet Metal Boxes and Outlets

Outlet, switch, and junction boxes flush-mounted in walls or ceilings must be square -shaped gang boxes as appropriate, with extension rings and covers.

Ceiling outlet boxes, from which surface- and pendant-mounted lighting fixtures are supported, must be not less than 4 inches square, with plaster rings 1-1/2 inches deep and must be capable of withstanding a vertical downward force of 200 pounds for 5 minutes. All boxes in spaces above suspended ceilings must be installed in accessible locations. Boxes in otherwise inaccessible locations must be accessible from ceiling space access panels. Ceiling-mounted outlet boxes for lighting fixtures, fittings, and wiring devices must be symmetrical, except as otherwise indicated, and must not interfere with the work of other trades.

Wall outlet boxes for two -gang flush wiring devices must be not less than 4 inches square and 1-1/2 inches deep. Wall outlet boxes for multiple-gang flush wiring devices must be not less than 4-1/2 inches wide and 2-1/2 inches deep. Wall-mounted outlet boxes for lighting fixtures and flush devices must be capable of withstanding a vertical downward force of 50 pounds for a period of 5 minutes.

Boxes must be formed from carbon-steel sheets of commercial quality, not less than 14-gage. Boxes must be one-piece construction, zinc- or cadmium-plated in accordance with UL 514A. Boxes and box extension rings must be provided with knockouts. Boxes must be designed for mounting flush wiring devices.

Exposed surface junction boxes must be installed only in equipment rooms and other utility areas.

Surface-mounted boxes must be outside flange type with a matching solid flat cover. Flush-mounted boxes in walls and floors must be the outside flange type with a matching recessed solid walkway cover. Box bodies and covers must be galvanized by the hot-dip process in accordance with ASTM A 123/A 123M, Class A.

2.5.2 Pull and Junction Boxes

Pull and junction boxes must be fabricated from carbon steel and must conform to UL 50. Box dimensions and conduit connections must conform to NFPA 70.

Boxes must be welded construction with flat removable covers fastened to the box with machine screws. Seams and joints at corners or back edges of the box must be closed and reinforced with flanges formed of the same material from which the box is constructed or by other means such as continuous welding which provides a construction equivalent to integral flange construction.

Boxes intended for outdoor use must becast with threaded hubs and neoprene-gasketed covers.

Boxes intended for use in dry locations must be sheet steel hot-dipped galvanized after fabrication conforming to UL 514A.

PART 3 EXECUTION

3.1 INSTALLATION

Power, lighting, control emergency light and power, and special-service systems and all related components must be installed in accordance with NFPA 70, and must be enclosed in separate conduit or separate conduit systems.

Any run of EMT, intermediate, or rigid conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting must contain not more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting. Field bends must be made in accordance with the manufacturer's recommendations, which normally require use of a one-size-larger bender than would be required for uncoated conduit. Installed conduit and fittings must be free of dirt and trash and must not be deformed or crushed. Empty conduit must have a pull rope stalled.

Conduit must be installed with a minimum of 3 inches of free air space separation from mechanical piping.

Conduit in finished areas must be installed concealed. Conduit passing through masonry or concrete walls must be installed in sleeves.

Conduit must be securely clamped and supported at least every 10 feet vertically and 8 feet horizontally. Galvanized pipe straps must be fastened to structure with bolts, screws, and anchors. Wooden masonry plugs must not be used.

Conduit and boxes must not be supported from T-bar ceiling wires.

All recessed outlet boxes in non-combustible walls or ceilings must be installed flush, such that the outlet box is set back less than 1/16 inch or protrudes less than 1/16 inch from the face of the ceiling or wall.

Conduit connections to boxes and fittings must be supported not more than 36 inches from the connection point. Conduit bends must be supported not more than 36 inches from each change in direction. Conduit must be installed in neat symmetrical lines parallel to the centerlines of the building construction and the building outline. Multiple runs must be parallel and grouped whenever possible on common supports.

Conduit and raceway runs in or under concrete, in damp, corrosive, or outdoor locations, in hazardous areas, where subject to mechanical damage, or intended for conductors rated over 600 volts, must be rigid steel conduit. Conduit joints in corrosive areas must be painted with corrosion -inhibiting compounds.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

Ends of conduit extending from the interior to the exterior of the building and portions of interior conduit exposed to widely varying temperatures

must be sealed to prevent the passage of air within the conduit. Conduit must be sloped to drain and must be provided with drainage fittings at the lower end of the run. Curved portion of conduit bends must not be visible above the finished floor. Underground service entrance and feeder conduit entering or leaving the building above the ground floor must be terminated in a pull box.

Expansion fittings with flexible ground strap must be provided in conduit runs crossing building expansion joints.

Underground portions of conduit runs must be painted with bitumastic or must be provided with a factory-applied coating of PVC not less than 0.20 inch thick. Underground conduit encased in concrete does not require a protective coating of PVC. When the factory-applied coating is chosen by the Contractor, any nicks, cuts, or other abrasions must be wrapped with a single layer of 0.010 inch thick pressure-sensitive PVC tape, half-lapped to obtain a minimum thickness of 0.20 inch. Couplings must be wrapped with pressure-sensitive tape, as described above, over the coupling and for 2 inches on each side of the coupling. When precoated couplings designed for the purpose are used, taping may be omitted provided the manufacturer's adhesive is used between the coating on the coupling and the coating on the conduit. Depth of buried conduit must be in accordance with NFPA 70 or as indicated on the contract drawings.

Exposed ends of conduit without conductors must be sealed with watertight caps or plugs.

Bushings must be provided on the open ends of conduit containing conductors. Insulated bushings must be provided for conduits containing conductors AWG No. 4 or larger with an insulating ring an integral part of the bushing.

Flexible metallic conduit must be used to connect recessed fixtures from outlet boxes in ceilings, metallic transformers, and other approved assemblies. Sections of flexible steel conduit must be not more than 6 feet long and must be installed only in exposed or accessible locations. Interior surfaces of conduit must be free from burrs and sharp edges which might cause abrasion of wire and cable coverings. Ends of flexible steel conduit must be provided with grounding bushings and approved fittings.

Bonding wires must be used in flexible conduit for all circuits. Flexible conduit must not be considered a ground conductor.

Liquidtight flexible metallic conduits must be used in wet and oily locations and to complete the connection to motor-driven equipment.

Electrical connections to vibration-isolated equipment must be made with flexible metallic conduit in a manner that will not impair the function of the equipment.

Wire or cable must not be installed in conduit until the conduit system is completed; the inner surfaces of conduit must be clean and dry.

A nylonpull rope with a tensile strength not less than 130 pounds must be installed in empty conduit.

3.1.1 Installation of Rigid Metal Conduit

Ends of conduit must be cut square, reamed and threaded, and joints must be

brought butt-to-butt in the couplings. Joints must be mechanically tight. Conduit must be protected against damage and the entrance of water or foreign material during construction.

Ninety-degree bends of conduit with a diameter larger than 1 inch must be made with factory-made elbows. Conduit elbows larger than 2-1/2 inches must be long radius. Field-made bends and offsets must be made with an approved hickey or conduit-bending machine. Changes in directions of runs must be made with symmetrical bends or cast-metal fittings.

At connections to sheet metal enclosures and boxes, a sufficient number of threads must project through to permit the bushing to be drawn tight against the end of the conduit, after which the locknut must be pulled up sufficiently tight to draw the bushing into firm electrical contact with the box. Conduit must be fastened to sheet metal boxes and cabinets with two locknuts where required by NFPA 70 where insulating bushings are used, where bushings cannot be brought into firm contact with the box, and where indicated.

Conduit joints must be made with tapered threads set firmly. Each length of conduit cut in the field must be reamed before installation. Where conduit is threaded in the field, each threaded end must consist of at least five full threads. Corrosion-inhibitive compound must be used on conduit threads in exterior areas.

Conduit stubbed-up through concrete floors for connections to free-standing equipment except motor-control centers, cubicles, and other such items of equipment must be provided with a flush coupling if the floor slab is of sufficient thickness; if not, a floor box must be provided and set flush with the finished floor. Conduits installed for future use must be terminated with a coupling and plug set flush with the floor.

3.1.2 Installation of EMT

EMT must be cut square and reamed to remove burrs and rough surfaces.

Field-made bends and offsets must be avoided where possible but, where necessary, must be made with an approved hickey or conduit-bending machine. Changes in direction of runs must be made with symmetrical bends or approved metal fittings.

3.1.3 Installation of Wireways and Auxiliary Gutters

Straight sections and fittings must be bolted together to provide a rigid mechanical connection and electrical continuity. Dead ends of wireways and auxiliary gutters must be closed. Unused conduit openings must be plugged.

Wireways for overhead distribution and control circuits must be supported at maximum 5-foot intervals.

Auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure must not contain switches, overcurrent devices, appliances, or apparatus and must be not more than 30 feetlong.

3.1.4 Installation of Flexible Metallic Conduit

Flexible metallic conduit must be installed only in exposed, accessible locations in accordance with NFPA 70. A grounding green conductor must be installed in all runs. Connections to motors and vibrating equipment must

be made with flexible metallic conduit.

3.2 INSTALLATION OF WIRING

Raceways must be completely installed, with interiors protected from the weather, before proceeding with the installation of wires and cables. Conductors of special-service systems and emergency light and power systems must not occupy the same enclosure with light and power conductors or the same enclosure with each other. Conductors must be continuous with splices and connections made in outlet, junction, or pull boxes only. All control wiring must be continuous between components and/or terminal boards.

Phase conductors and the neutral conductor of each branch or feeder circuit must be contained in a single enclosure or paralleled in separate enclosures to avoid overheating the raceway by electromagnetic induction. Conductors and conduit in parallel must be the same length and size, must have conductors of the same type of insulation, must be terminated at both ends in a manner to ensure equal division of the total current among conductors, and must have a separate neutral conductor in each conduit.

Sharing of a common neutral between single phase circuits, connected to different phases, must not be permitted.

Conductors installed in heavy-wall rigid steel conduit and EMT must have allowable current-carrying capacity and ampere ratings in accordance with NFPA 70. Larger-sized conductors must be used to compensate for derating factors when more than three current-carrying conductors are installed in raceways and when conductors are installed in wet locations.

Conductors 600 volts and below must be color coded in accordance with the following:

CONDUCTOR	120/208 COLOR
Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Equipment Grounds	Green

Conductors up to and including AWG No. 2 must be manufactured with colored insulating materials. Conductors larger than AWG No. 2 must have ends identified with colored plastic tape in outlet, pull, or junction boxes. Control circuit conductors must be identified at each connection point.

Connectors and splices must conform to UL 486C and must be made in approved enclosures utilizing solderless pressure connectors and adequate insulation with vinyl-plastic electrical insulating tape. Conductors and materials used in a splice, tap, or connection must be thoroughly cleaned prior to makeup to ensure good electrical and mechanical connections. Conductor identification must be provided within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification must match that shown on approved shop drawings. Hand lettering or marking is not acceptable. Control-circuit terminals of equipment must be properly identified by

color-coded insulated conductors, number-coded plastic self-sticking printed markers, or permanently attached metal-foil markers. Cable fittings must conform to UL 514B; insulating tape must conform to ASTM D 2301.

Where several feeders pass through a common pullbox, the feeders must be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.

Grounding must be provided in accordance with NFPA 70. Noncurrent-carrying parts of electrical equipment must be bonded and grounded together.

3.3 SAFETY SWITCHES

Switches must be securely fastened to the supporting structure or wall utilizing a minimum of four 1/4 inch bolts. Sheet metal screws and small machine screws must not be used for mounting. Switches must not be mounted in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height must be 5 feet above floor level, when possible.

3.4 WIRING DEVICES

3.4.1 Wall Switches and Receptacles

Wall switches and receptacles must be so installed that when device plates are applied, the plates will be aligned vertically to within 1/16 inch.

Ground terminal of each flush-mounted receptacle must be bonded to the outlet box with an approved green bonding jumper.

3.4.2 Device Plates

Device plates for switches that are not within sight of the loads controlled must be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 20 -ampere, 125-volt, single-phase, duplex, convenience outlets must be suitably engraved, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle; for example: RP1-12, 208 VOLTS, 60 HERTZ, 3-PHASE, 30 AMPERES. If engraving is not practical, an engraved laminated phenolic identification plate may be applied.

Device plates must be identified on the inside by circuit number and panelboard.

3.5 BOXES AND FITTINGS

Pullboxes must be furnished and installed where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right-angle bends must have a pullbox installed at a convenient intermediate location.

Boxes and enclosures must be securely mounted to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Bonding jumpers must be used around concentric or eccentric knockouts.

Approximate mounting height of wall-mounted outlet and switch boxes, measured between the bottom of the box and the finished floor, must be as follows:

LOCATION	MOUNTING HEIGHT
Receptacles in offices	18 inches
Switches for light control	48 inches
Thermostats	66 inches

3.6 IDENTIFICATION PLATES

Mark all equipment with externally powered wiring with a laminated plastic nameplate having 3/16 inch high white letters on a red background as follows:

DANGER - EXTERNAL VOLTAGE SOURCE

3.7 FIELD TESTING

Submit Test Reports in accordance with referenced standards in this section.

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

Contractor must provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices must be used to isolate the circuits under test.

Perform Insulation-Resistance Test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential must be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values must not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes 8AWG and smaller insulation resistance testing is not required.

Perform Continuity Test to insure correct cable connection (i.e correct phase conductor, grounded conductor, and grounding conductor wiring) end-to end. Any damages to existing or new electrical equipment resulting from contractor mis-wiring will be repaired and re-verified at contractor's expense. All repairs must be approved by the CO prior to acceptance of the repair.

Conduct Phase-Rotation Tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. Do not energize any conductor until the final test

reports are reviewed and approved by the CO.

-- End of Section --

SECTION 26 50 00.98.98

FLUORESCENT LUMINAIRES
04/06

PART 1 GENERAL

1.1 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 C78.1	(1991; C78.1a-1992) Dimensional and Electrical Characteristics of Fluorescent Lamps - Rapid Start Types
ANSI C82.1	(2004) Ballasts for Fluorescent Lamps
ANSI C82.2	(2002) Fluorescent Lamp Ballasts - Methods of Measurement

FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 18	RF Lighting Devices

UNDERWRITERS LABORATORIES (UL)

UL 1570	(1995; 4th Ed; Rev thru May 25, 1990) Fluorescent Lighting Fixtures
UL 935	(2001; 10th Ed) Fluorescent-Lamp Ballasts

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 98, "GENERAL ELECTRICAL PROVISIONS," applies to work specified in this section.

Outline Drawings shall be submitted for the fluorescent fixtures indicating overall physical features, dimensions, ratings, service requirements, and weights of equipment.

Test Reports shall show compliance with the requirements of this specification as follows:

Lighting-Distribution Curves for each type of fixture shall be prepared utilizing the fixture manufacturer's own facilities or those of an independent nationally recognized laboratory, in accordance with the standard procedure developed by the Illuminating Engineering Society.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication drawings shall be submitted for the following items:

Fluorescent Lighting Fixtures
Fluorescent Lamp Ballast
Fluorescent Lamps

Outline Drawings shall be submitted for fluorescent fixtures in accordance with paragraph entitled, "General Reqirements," of this section.

SD-03 Product Data

Equipment and performance data shall be submitted for the following including life, test, system functional flows, safety features, and mechanical automated details.

Fluorescent Lighting Fixtures -G
Fluorescent Lamp Ballast -G
Fluorescent Lamps -G

Manufacturer's catalog data shall be submitted for the following items:

Fluorescent Lighting Fixtures -G
Fluorescent Lamp Ballast -G
Fluorescent Lamps -G

SD-06 Test Reports

Test Reports shall be submitted for the following in accordance with paragraph entitled, "General Requirements," of this section.

Lighting-Distribution Curves

SD-07 Certificates

Certificates shall be submitted for the following showing conformance with the referenced standards contained in this section.

Fluorescent Lighting Fixtures
Fluorescent Lamp Ballast
Fluorescent Lamps

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Fluorescent lighting fixtures shall conform to UL 1570 and as specified.

Lighting fixtures shall be furnished completely assembled with wiring and mounting devices and ready for installation at the locations indicated. Recessed fixtures in suspended ceilings shall be designed and equipped for installation in the type of ceiling in which the fixture is to be installed. Fixtures shall be designed to be supported independent of the ceiling and shall be equipped with the lamps indicated.

2.2 COMMERCIAL FIXTURES

Commercial fluorescent lighting fixtures shall conform to UL 1570 and include recessed, surface-mounted, and pendant-mounted luminaires as indicated and herein specified.

Lighting fixtures shall include wiring channel, end plates, end caps, side panels, top reflectors, bottom closures, lampholders, lamps, ballasts, suspension stems, wiring, and other necessary materials and devices.

Ballasts and wiring shall be completely enclosed in the wiring channel and shall be easily accessible. Ballast shall be replaceable without removing the fixture from its mounting. Lamps shall be replaceable without the use of tools and without removal of other lamps and equipment.

Wiring channel, end plates, and other sheet steel enclosure components shall be cold-rolled carbon-steel sheet of commercial quality not less than 20 gage.

When two or more fixtures are joined together in continuous rows, the wiring channel shall form an open and continuous wireway.

2.2.1 Surface-Mounted Fixtures

Surface-mounted fixtures shall be designed to be fastened to wall or ceiling flush-mounted outlet boxes. When two or more fixtures are joined together in continuous rows, the wiring channel shall form an open and continuous wireway.

2.2.2 Pendant-Mounted Fixtures

Pendant-mounted fixtures shall be equipped with stems, swivel, ball-and-socket self-aligning hangers, ceiling canopies, and fixture-leveling devices. Stems shall be not less than 1/2 inch in diameter, made from seamless corrosion-resistant steel tubing. Stem length, material, and finish shall be as indicated.

2.3 INDUSTRIAL FIXTURES

Industrial fluorescent lighting fixtures shall conform to UL 1570 and shall be as indicated.

Lower edge of the reflector shall be formed into a flange or bead to provide stiffness and shall be completely covered by the finish. Each reflector shall be removable and securely maintained in position with latch fastening devices. Reflector shall form the bottom of the wiring-channel enclosure.

Direct-lighting fixture reflectors shall be so shaped that the ratio of the candlepower at 55 degrees nadir to the candlepower at nadir shall be not less than 55 percent. Upward component of light shall be a minimum of 8 percent and a maximum of 20 percent of the total light output.

Semidirect lighting-fixture reflectors shall be so shaped that the ratio of the candlepower at 45 degrees nadir to the candlepower at nadir shall be not less than 60 percent. Upward component of light shall be a minimum of 20 percent and a maximum of 30 percent of the total light output.

Lighting-fixture unit, when viewed at any angle from the minimum shielding

angle to the horizontal plane, shall have a brightness no greater than 40 percent of the brightness of the bare lamp.

Pendant-mounted fixtures shall be equipped with straps, brackets, conduit stems, ball-and-socket self-aligning hangers, ceiling canopies, slide-clamp fixture hangers, and leveling devices. Stems shall be not less than 1/2 inch in diameter, seamless brass, steel, or aluminum tubing. Stem length and finish shall be as indicated. When two or more fixtures are joined together, the wiring channel shall form an open and continuous wireway.

Chain-supported fixtures shall not be used.

2.4 FLUORESCENT LAMP BALLAST

Fluorescent lamp ballasts shall be Class P in accordance with ANSI C82.1, ANSI C82.2, and UL 935.

Ballasts shall be designed for single- or two-lamp operation with line power factor not less than 90 percent. Two-lamp ballasts shall operate the two lamps out of phase with each other. Lamp cathodes shall be continuously heated during lamp operation.

Fluorescent lighting fixtures with lamps 30 watts or more shall be equipped with instant-start ballasts. Auxiliary lamp starters shall not be permitted.

Ballasts shall be voltage rated for operation on 120-volt, single-phase, 60-hertz lighting distribution systems as indicated.

Ballasts shall be designed for a maximum ambient temperature of 105 degrees F.

Ballasts for indoor lamps shall be in accordance with UL 935.

Ballasts for outdoor lamps shall have a minimum starting temperature of minus 0 degrees F.

2.4.1 Electronic Ballasts

Ballasts shall not contain polychlorinated biphenyls (PCB's).

Ballasts shall operate with a 90 to 110 percent input voltage variation at an input frequency of 60 Hz. Light output shall remain constant for line voltage fluctuations of plus or minus 3 percent. Ballasts shall be rapid start type.

Ballasts shall have a minimum power factor of 0.95.

Ballasts shall comply with Class A (20-24 DB) sound rating.

Ballasts shall comply with Electromagnetic Interference (EMI) and Radio Interference (RFI) limits set by the FCC Part 18, CFR, Chapter 18, Part C.

Ballasts shall have less than 10 percent Total Harmonic Distortion.

Ballasts for rapid start lamps T-8 shall be capable of operating remaining lamps if one or more companion lamps fail or are removed.

Ballast size and mounting configuration shall be consistent with standard

electromagnetic ballast for same application.

2.5 FLUORESCENT LAMPS

Lamps shall conform to ANSI C78.1 and shall be the energy-efficient type with a minimum starting temperature of 60 degrees F.

2.5.1 Lamp

The 32-watt, extra-high efficiency fluorescent lamp shall have a minimum efficiency of 91 lumens per watt and shall be designed to operate on a two -lamp, electronic ballast.

Lamps shall have bulb designation T-8 with a nominal length of 48 inches, a base configuration of medium bipin contact.

Lamps shall have an average rated life at 3 hours per start of 20,000 hours.

Bulb color shall be 3500K. Lamp dimensions shall be in accordance with ANSI C78.1.

Acceptable Fluorescent 48 inches (T8) lamps are:

GE type F32T8/SPX35, 32W, 2950 Lumens, 3500K, Trimline Series
Sylvania type FO32/835/XPS/ECO, 32W, 3100 Lumens, 3500K, Octron Series

Acceptable Fluorescent U6 (T8) lamps are:

GE type F32T8/SPX35/U/6,, 31W, 2800 Lumens, 3500K
Sylvania type FBO32/835/XP/ECO, 32W, 2900 Lumens, 3500K

2.6 FLUORESCENT FIXTURE LENS

All 24" X 48", 24" X 24", and 12" X 48" lensed fluorescent light fuixture shall have a diffuser made of clear color stailized "K-12" (0.125") low brightness acrylic material except in areas using video terminals.

PART 3 EXECUTION

3.1 INSTALLATION

Fluorescent fixtures shall be installed in accordance with UL 1570.

A fixture shall be installed at each outlet indicated, and lamps of the proper type and wattage shall be installed in each fixture.

New lamps shall be installed immediately prior to completion of the project.

Fixtures shall be installed parallel and perpendicular to major axes of structures and shall be plumb and aligned to a tolerance of 1/2 inch in 10 feet.

Supports for recessed fixtures shall have a minimum capacity of 150 pounds, and all parts of the support shall be arranged to prevent them from vibrating free.

Surface-mounted fixtures shall be attached securely to structural members

or to metal supports that span structural members. Fixtures shall be fastened near each end and, when over 4-feet long, shall also be fastened at the center. When surface-mounted fixtures are not UL approved for direct mounting on combustible ceilings, suitable spacers shall be installed.

Fixtures located in equipment rooms shall be so installed that they clear all obstructions such as duct, piping, bracing, and supports.

3.2 FIELD TESTING

Fluorescent lighting fixtures shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

-- End of Section --

SECTION 26 52 00.98

EMERGENCY LIGHTING
04/07

PART 1 GENERAL

1.1 REFERENCES

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2009) Code for Safety to Life from Fire in Buildings and Structures
NFPA 70	(2008) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 924	(2006) UL Standard for Safety Emergency Lighting and Power Equipment

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 98, "General Electrical Provisions," applies to work specified in this section.

Material, Equipment, and Fixture Lists shall be submitted showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. The following shall be submitted in accordance with Section 01 33 00. SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted in accordance with paragraph entitled, "General Requirements," of this section.

SD-02 Shop Drawings

Installation drawings shall be submitted for the Emergency Lighting Egress Units indicating locations of installed fixtures.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Emergency Lighting Egress Units G

Accessories G

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Emergency lighting units shall conform to UL 924 and NFPA 101.

Emergency lighting units shall be furnished completely assembled with wiring and mounting devices and ready for installation at the locations indicated. Fixtures shall be equipped with lamps. Fixtures shall be Emergi-Lite, Series JS,JSE18-2-AD or approved equal.

2.2 EMERGENCY LIGHTING EGRESS UNITS

Emergency lighting units shall be complete self-contained units with batteries, battery charger, one or more local or remote lamp heads with lamps, low voltage battery disconnect, battery lockout, brownout protection, advanced diagnostics, indicator lights, and test switch as indicated. The units shall come with a full warranty of 3-years.

Batteries shall be rated not less than 6 volts.

Battery charger shall include a dry-type full-wave rectifier and solid state circuitry to promote long reliable battery life and unit operation. Batteries shall be kept at full capacity by a pulse charge that allows them to cycle continuously. The battery charger shall also automatically recharge the battery to a fully charged state within 24 hours after continuous discharge of 1-1/2 hours through the connected lampload.

Batteries shall have capacity and rating to supply the lamp load with maintained 87.5-percent power, minimum, for 1.5 hours, or the battery-lamp combination shall maintain 60-percent, minimum, illumination for a period of at least 1.5 hours. Batteries shall be maintenance-free sealed long life lead type. The batteries shall come with a full warranty of 5 years and a life expectancy of 12 years.

Unit enclosure shall be fabricated from sheet steel not less than 20 gage. Cover shall provide access to the battery and battery-charger compartments and shall have a full-length piano hinge and a latching device. Component parts within the enclosure shall be protected from dust, moisture, and oxidizing fumes from the battery. Interior and exterior surfaces of enclosure shall be coated with an off-white baked-enamel finish.

Lampheads shall be mounted on the top of the unit enclosure, except where otherwise indicated, and shall be fully adjustable in the horizontal and vertical planes. The lamphead mounting assembly shall be all thermoplastic construction and off-white in color.

Lamps shall be the wedge base high intensity incandescent type T-5, rated not less than 9 watts at the specified dc voltage.

Advanced diagnostics shall continuously monitor every critical function of the unit. Operational status shall be indicated by colored LED lamps and a high-pitched audible alarm. Seven LED lamps and one momentary-contact pushbutton Test switch shall be mounted on the cover of the unit enclosure.

Battery Failure	Red LED illuminates when battery is shorted or battery voltage drops below acceptable

	value.
Battery Disconnect	Red LED illuminates when battery circuit is opened.
Charger Failure	Red LED illuminates when charger is not functioning properly.
Lamp Failure	Red LED illuminates when lamp is bad or lamp circuit is faulty.
Service Alarm	Red LED illuminates when there is a fault and unit requires service.
AC On	Green LED illuminates when AC power is present.
Charger On	Amber LED illuminates when charger is supplying current to the battery.
Test Switch	Switch transfers unit from normal AC supply to battery supply and tests operation of equipment under simulated AC power failure. Switch also silences audible alarm. (LED lamps flash until the fault is corrected.)

An on-board microprocessor shall provide an automatic unit test. The automatic unit test shall place the unit into a simulated power failure condition each month, providing a long duration visible test and an exercise of the battery. The automatic unit test shall be field programmable.

The brownout protection feature shall automatically connect the lamload to the battery supply when the ac supply falls to 80 percent of normal voltage, the level at which most fluorescent and HID fixtures extinguish.

The battery/lockout feature shall prevent the battery from discharging when the unit is installed to a non-energized circuit. The battery shall be electronically locked out until the unit is energized with AC power.

The low voltage battery disconnect feature shall prevent deep discharge damage to the battery by disconnecting the lighting load at 87.5 percent of the nominal battery voltage.

Emergency lighting units shall be suitable for operation on the 120 or 277 volt ac supply circuit to which they are to be electrically connected.

PART 3 EXECUTION

3.1 INSTALLATION

Emergency lighting unit shall be permanently fixed in place and shall have wiring to each unit installed in accordance with NFPA 70. The branch circuit feeding the unit equipment shall be the same branch circuit as that serving the normal lighting in the area and shall be connected ahead of area switches. The emergency lighting unit power source, both panel number and breaker number, shall be permenently marked on the inside of the unit. Emergency lighting fixtures that are remotely connected to the emergency lighting unit shall have circuit wiring kept independent of all other wiring and equipment and shall not enter the same conduit, cable, box, or

cabinet with other wiring.

Mounting heights of emergency lighting units and remote lamps shall be a minimum of 7-feet above the finished floor.

3.2 FIELD TESTING

Emergency lighting units shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

-- End of Section --

SECTION 26 53 00.00 98

EXIT LIGHTING
04/06

PART 1 GENERAL

1.1 REFERENCES

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2009) Code for Safety to Life from Fire in Buildings and Structures

UNDERWRITERS LABORATORIES (UL)

UL 924	(2006) UL Standard for Safety Emergency Lighting and Power Equipment

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 98, "General Electrical Provisions," applies to work specified in this section.

Material, Equipment, and Fixture Lists shall be submitted for the following showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the following in accordance with paragraph entitled, "General Requirements," of this section.

Exit Lighting Units G

Accessories G

SD-02 Shop Drawings

Installation drawings shall be submitted for Exit Lighting Units showing their physical location on the construction plan.

Outline drawings shall be submitted for Exit Lighting Units indicating overall physical features, dimensions, ratings, service requirements, and weights of equipment.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Exit Lighting Units G

Accessories G

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Emergency exit lighting fixtures shall conform to UL 924, NFPA 101, and as specified.

Exit lighting fixtures shall be furnished completely assembled with mounting devices and ready for installation at the locations indicated. Ceiling-mounted fixtures shall be designed to be supported independent of the ceiling. Fixtures shall be Isolite, Model 2040, or approved equal.

2.2 SELF LUMINOUS EXIT SIGNS

All units shall be internally illuminated non-electric (light source is independent of electrical power and is generated by the action of tritium gas on a phosphorescent material).

All signs shall be licensed by the United States Nuclear Regulatory Commission. Integrity and performance shall be guaranteed for 20 years of normal use.

2.2.1 Enclosure

The assembled tamper resistant enclosure shall be of 1/8 inch high impact ABS plastic.

Each sign shall bear a permanently attached plastic nameplate bearing the Manufacturer's Name, Address, catalog number, Date of Manufacture, and date to be replaced (in addition to information required by listed authorities).

2.2.2 Face

Each face of the sign shall be a non-colored translucent panel covered by an opaque 1/32 inch red aluminum stencil bearing the word "EXIT" in 6 by 3/4 inch letters and including a universal directional arrow which indicates the direction of the exit (left, right or both ways).

2.2.3 Illumination

Illumination of the sign shall be by means of sealed glass tubes, internally phosphor coated and filled with tritium gas. Tubes shall be securely bonded to the enclosure and cushioned against mechanical shock. .

2.2.4 Mounting Accessories

Each sign shall be supplied with tamperproof hardware for wall mounting, end mounting, or pendant mounting for single face and double face units.

PART 3 EXECUTION

3.1 INSTALLATION

Fixtures shall be mounted at the locations identified on the contract drawings.

3.2 FIELD TESTING

Exit lighting shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

-- End of Section --

SECTION 31 00 00

EARTHWORK
08/08

PART 1 GENERAL

1.1 MEASUREMENT PROCEDURES

1.1.1 Excavation

The unit of measurement for excavation and borrow will be the cubic yard, computed by the average end area method from cross sections taken before and after the excavation and borrow operations, including the excavation for ditches, gutters, and channel changes, when the material is acceptably utilized or disposed of as herein specified. The measurements will include authorized excavation of rock (except for piping trenches that is covered below), authorized excavation of unsatisfactory subgrade soil, and the volume of loose, scattered rocks and boulders collected within the limits of the work; allowance will be made on the same basis for selected backfill ordered as replacement. The measurement will not include the volume of subgrade material or other material that is scarified or plowed and reused in-place, and will not include the volume excavated without authorization or the volume of any material used for purposes other than directed. The volume of overburden stripped from borrow pits and the volume of excavation for ditches to drain borrow pits, unless used as borrow material, will not be measured for payment. The measurement will not include the volume of any excavation performed prior to the taking of elevations and measurements of the undisturbed grade.

1.1.2 Piping Trench Excavation

Measure trench excavation by the number of linear feet along the centerline of the trench and excavate to the depths and widths specified for the particular size of pipe. Replace unstable trench bottoms with a selected granular material. Include the additional width at manholes and similar structures, the furnishing, placing and removal of sheeting and bracing, pumping and bailing, and all incidentals necessary to complete the work required by this section.

1.1.3 Rock Excavation for Trenches

Measure and pay for rock excavation by the number of cubic yards of acceptably excavated rock material. Measure the material in place, but base volume on a maximum 30 inch width for pipes 12 inch in diameter or less, and a maximum width of 16 inch greater than the outside diameter of the pipe for pipes over 12 inch in diameter. Provide the measurement to include all authorized overdepth rock excavation as determined by the Contracting Officer. For manholes and other appurtenances, compute volumes of rock excavation on the basis of 1 foot outside of the wall lines of the structures.

1.1.4 Topsoil Requirements

Separate excavation, hauling, and spreading or piling of topsoil and related miscellaneous operations will be considered subsidiary obligations of the Contractor, covered under the contract unit price for excavation.

1.1.5 Overhaul Requirements

Allow the unit of measurement for overhaul to be the station-yard. The overhaul distance will be the distance in stations between the center of volume of the overhaul material in its original position and the center of volume after placing, minus the free-haul distance in stations. The haul distance will be measured along the shortest route determined by the Contracting Officer as feasible and satisfactory. Do no measure or waste unsatisfactory materials for overhaul where the length of haul for borrow is within the free-haul limits.

1.1.6 Select Granular Material

Measure select granular material in place as the actual cubic yards replacing wet or unstable material in trench bottoms within the limits shown . Provide unit prices which include furnishing and placing the granular material, excavation and disposal of unsatisfactory material, and additional requirements for sheeting and bracing, pumping, bailing, cleaning, and other incidentals necessary to complete the work.

1.2 PAYMENT PROCEDURES

Payment will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work.

1.2.1 Classified Excavation

Classified excavation will be paid for at the contract unit prices per cubic yard for common or rock excavation.

1.2.2 Piping Trench Excavation

Payment for trench excavation will constitute full payment for excavation and backfilling, 0.2 meter overdepth except in rock or unstable trench bottoms.

1.2.3 Rock Excavation for Trenches

Payment for rock excavation will be made in addition to the price bid for the trench excavation, and will include all necessary drilling and blasting and all incidentals necessary to excavate and dispose of the rock. Select granular material, used as backfill replacing rock excavation, will not be paid for separately, but will be included in the unit price for rock excavation.

1.2.4 Unclassified Excavation

Unclassified excavation will be paid for at the contract unit price per cubic yard for unclassified excavation.

1.2.5 Classified Borrow

Classified borrow will be paid for at the contract unit prices per cubic yard for common or rock borrow.

1.2.6 Unclassified Borrow

Unclassified borrow will be paid for at the contract unit price per cubic

yard for unclassified borrow.

1.2.7 Authorized Overhaul

The number of station-yards of overhaul to be paid for will be the product of number of cubic yards of overhaul material measured in the original position, multiplied by the overhaul distance measured in stations of 100 feet and will be paid for at the contract unit price per station-yard for overhaul in excess of the free-haul limit as designated in paragraph DEFINITIONS.

1.2.8 Sheeting and Bracing

Sheeting and bracing, when shown or authorized by the Contracting Officer to be left in place, will be paid for as follows: .

1.2.8.1 Timber Sheeting

Timber sheeting will be paid for as the number of board feet of lumber below finish grade measured in place prior to backfilling. Include in the measurement sheeting wasted when cut off between the finished grade and 1 foot below the finished grade.

1.2.8.2 Steel Sheeting and Soldier Piles

Steel sheeting, soldier piles, and steel bracing will be paid for according to the number of pounds of steel calculated. Calculate the steel by multiplying the measured in-place length in feet below finish grade by the unit weight of the section in pounds per foot. Obtain unit weight of rolled steel sections from recognized steel manuals. Included in the measurement sheeting wasted when cut off between the finished grade and a distance of up to 3 feet below the finished grade.

1.3 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

d. Ground water elevation is 3 feet below existing surface elevation.

e. Material character is indicated by the boring logs.

f. .

1.4 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T 180	(2001; R 2004) Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and an 457-mm (18-in) Drop
AASHTO T 224	(2001; R 2004) Correction for Coarse Particles in the Soil Compaction Test

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2006; Errata 2006) Structural Welding Code - Steel

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA C2	(2003) Lumber, Timber, Bridge Ties and Mine Ties - Preservative Treatment by Pressure Processes
AWPA P5	(2005) Standard for Waterborne Preservatives

ASTM INTERNATIONAL (ASTM)

ASTM A 139/A 139M	(2004) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A 252	(1998; R 2007) Standard Specification for Welded and Seamless Steel Pipe Piles
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 33	(2007) Standard Specification for Concrete Aggregates
ASTM D 1140	(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 1883	(2007) CBR (California Bearing Ratio) of Laboratory-Compacted Soils

ASTM D 2487	(2006) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2937	(2004) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D 698	(2007e1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes
EPA SW-846.3-3	(2007, Fourth Edition, Update IV-A and IV-B) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

1.5 DEFINITIONS

1.5.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, . Satisfactory materials for grading comprise stones less than 8 inches, except for fill material for pavements and railroads which comprise stones less than 3 inches in any dimension.

1.5.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. Notify the Contracting Officer when encountering any contaminated materials.

1.5.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D 4318, ASTM C 136, ASTM D 422, and ASTM D 1140.

1.5.4 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated as a percent of laboratory maximum density. Since ASTM D 1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, express the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve as a percentage of the maximum density in accordance with AASHTO T 180 and corrected with AASHTO T 224. To maintain the same percentage of coarse material, use the "remove and replace" procedure as described in NOTE 8 of Paragraph 7.2 in AASHTO T 180.

1.5.5 Overhaul

Overhaul is the authorized transportation of satisfactory excavation or borrow materials in excess of the free-haul limit of 2 stations. Overhaul is the product of the quantity of materials hauled beyond the free-haul limit, and the distance such materials are hauled beyond the free-haul limit, expressed in station yards.

1.5.6 Topsoil

Material suitable for topsoils obtained from offsite areas is defined as: Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

1.5.7 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 12 inch in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.5.8 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding [1/2] [_____] cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.5.9 Unstable Material

Unstable material are too wet to properly support the utility pipe, conduit, or appurtenant structure.

1.5.10 Select Granular Material

1.5.10.1 General Requirements

Select granular material consist of materials classified as SW, or by ASTM D 2487 where indicated. The liquid limit of such material must not exceed 35 percent when tested in accordance with ASTM D 4318. The plasticity index must not be greater than 12 percent when tested in accordance with ASTM D 4318, and not more than 35 percent by weight may be finer than No. 200 sieve when tested in accordance with ASTM D 1140.

1.5.10.2 California Bearing Ratio Values

Bearing Ratio: At 0.1 inch penetration, provide a bearing ratio of 12 percent at 95 percent ASTM D 1557 maximum density as determined in accordance with ASTM D 1883 for a laboratory soaking period of not less than 4 days. Conform the combined material to the following sieve analysis:

Sieve Size	Percent Passing by Weight
2 1/2 inch	100
No. 4	40 - 85
No. 10	20 - 80
No. 40	10 - 60
No. 200	5 - 25

1.5.11 Initial Backfill Material

Initial backfill consists of select granular material or satisfactory materials free from rocks 12 inches or larger in any dimension or free from rocks of such size as recommended by the pipe manufacturer, whichever is smaller. When the pipe is coated or wrapped for corrosion protection, free the initial backfill material of stones larger than 12 inches in any dimension or as recommended by the pipe manufacturer, whichever is smaller.

1.5.12 Expansive Soils

Expansive soils are defined as soils that have a plasticity index equal to or greater than 12 when tested in accordance with ASTM D 4318.

1.5.13 Nonfrost Susceptible (NFS) Material

Nonfrost susceptible material are a uniformly graded washed sand with a maximum particle size of 12 inch and less than 5 percent passing the No. 200 size sieve, and with not more than 3 percent by weight finer than 0.02 mm grain size.

1.5.14 Pile Supported Structure

As used herein, a structure where both the foundation and floor slab are pile supported.

1.6 SYSTEM DESCRIPTION

Subsurface soil boring logs are appended to the SPECIAL CONTRACT REQUIREMENTS. The subsoil investigation report and samples of materials taken from subsurface investigations may be examined at NASA offices. These data represent the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.6.1 Classification of Excavation

Finish the specified excavation on a classified basis, in accordance with the following designations and classifications.

1.6.1.1 Common Excavation

Include common excavation with the satisfactory removal and disposal of all materials not classified as rock excavation.

1.6.1.2 Rock Excavation

Include rock excavation with blasting, excavating, grading, disposing of material classified as rock, and the satisfactory removal and disposal of boulders 1/2 cubic yard or more in volume; solid rock; rock material that is in ledges, bedded deposits, and unstratified masses, which cannot be removed without systematic drilling and blasting; firmly cemented conglomerate deposits possessing the characteristics of solid rock impossible to remove without systematic drilling and blasting; and hard materials (see Definitions). Include the removal of any concrete or masonry structures, except pavements, exceeding 1/2 cubic yard in volume that may be encountered in the work in this classification. If at any time during excavation, including excavation from borrow areas, the Contractor encounters material that may be classified as rock excavation, uncover such material and notify the Contracting Officer. Do not proceed with the excavation of this material until the Contracting Officer has classified the materials as common excavation or rock excavation and has taken cross sections as required. Failure on the part of the Contractor to uncover such material, notify the Contracting Officer, and allow ample time for classification and cross sectioning of the undisturbed surface of such material will cause the forfeiture of the Contractor's right of claim to any classification or volume of material to be paid for other than that allowed by the Contracting Officer for the areas of work in which such deposits occur.

1.6.2 Blasting

Blasting will not be permitted.

1.6.3 Dewatering Work Plan

Submit procedures for accomplishing dewatering work.

1.7 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shoring; G

Submit 15 days prior to starting work.

SD-03 Product Data

Utilization of Excavated Materials; G
Rock Excavation
Opening of any Excavation or Borrow Pit
Shoulder Construction

Procedure and location for disposal of unused satisfactory material. Proposed source of borrow material. Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

SD-06 Test Reports

Testing
Borrow Site Testing

Within 24 hours of conclusion of physical tests, 15 copies of test results, including calibration curves and results of calibration tests. Results of testing at the borrow site.

SD-07 Certificates

Testing

Qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities.

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill shall contain a maximum of 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and a maximum of 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall pass the TCPL test. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020. Perform TCLP in accordance with EPA SW-846.3-3 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Do not bring material onsite until tests have been approved by the Contracting Officer.

2.2 BURIED WARNING AND IDENTIFICATION TAPE

Provide polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Provide permanent color and printing, unaffected by moisture or soil.

Warning Tape Color Codes

Red:	Electric

Warning Tape Color Codes

Yellow:	Gas, Oil; Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air

2.2.1 Warning Tape for Metallic Piping

Provide acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.003 inch and a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2.2.2 Detectable Warning Tape for Non-Metallic Piping

Provide polyethylene plastic tape conforming to the width, color, and printing requirements specified above, with a minimum thickness of 0.004 inch, and a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Manufacture tape with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.3 DETECTION WIRE FOR NON-METALLIC PIPING

Insulate a single strand, solid copper detection wire with a minimum of 12 AWG.

2.4 MATERIAL FOR RIP-RAP

Provide Bedding material and rock conforming to DOT for construction indicated.

2.4.1 Bedding Material

Provide bedding material consisting of sand, gravel, or crushed rock, well graded, or poorly graded with a maximum particle size of 2 inch. Compose material of tough, durable particles. Allow fines passing the No. 200 standard sieve with a plasticity index less than six.

2.4.2 Grout

Provide durable grout composed of cement, water, an air-entraining admixture, and sand mixed in proportions of one part portland cement to two parts of sand, sufficient water to produce a workable mixture, and an amount of admixture which will entrain sufficient air, as determined by the Contracting Officer. Mix grout in a concrete mixer. Allow a sufficient mixing time to produce a mixture having a consistency permitting gravity flow into the interstices of the rip-rap with limited spading and brooming.

2.4.3 Rock

Provide rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Use rock fragments free from cracks, seams, and other defects that would increase

the risk of deterioration from natural causes. Provide fragments sized so that no individual fragment exceeds a weight of [150] [_____] pounds and that no more than 10 percent of the mixture, by weight, consists of fragments weighing 2 pounds or less each. Provide rock with a minimum specific gravity of 2.50 . Do not permit the inclusion of more than trace 1 percent quantities of dirt, sand, clay, and rock fines.

2.5 CAPILLARY WATER BARRIER

Provide capillary water barrier of clean, poorly graded crushed rock, crushed gravel, or uncrushed gravel placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to the area immediately below. Conform to ASTM C 33 for fine aggregate grading with a maximum of 3 percent by weight passing ASTM D 1140, No. 200 sieve, 1-1/2 inch and no more than 2 percent by weight passing the No. 4 size sieve .

2.6 PIPE CASING

2.6.1 Casing Pipe

ASTM A 139/A 139M, Grade B, or ASTM A 252, Grade 2, smooth wall pipe. Match casing size to the outside diameter and wall thickness as indicated on Drawing Sheet No. TBD. Protective coating is not required on casing pipe.

2.6.2 Wood Supports

Locally available, rough, structural grade. Provide wood with nonleaching water-borne pressure preservative (ACA or CCA) and treatment conforming to AWPA P5 and AWPA C2, respectively. Secure wood supports to carrier pipe with stainless steel or zinc-coated steel bands.

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

Where indicated or directed, strip topsoil to a depth of [4] [_____] inch. Spread topsoil on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inch in diameter, and other materials that would interfere with planting and maintenance operations. Remove from the site any surplus of topsoil from excavations and gradings.

3.2 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material ordered as replacement in excavation. Dispose surplus satisfactory excavated material not required for fill or embankment in areas approved

for surplus material storage or designated waste areas. Dispose unsatisfactory excavated material in designated waste or spoil areas. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

3.2.1 Ditches, Gutters, and Channel Changes

Finish excavation of ditches, gutters, and channel changes by cutting accurately to the cross sections, grades, and elevations shown on Drawing Sheet No. tbd. Do not excavate ditches and gutters below grades shown. Backfill the excessive open ditch or gutter excavation with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Dispose excavated material as shown or as directed, except in no case allow material be deposited a maximum 4 feet from edge of a ditch. Maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

3.2.2 Drainage Structures

Make excavations to the lines, grades, and elevations shown, or as directed. Provide trenches and foundation pits of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Clean rock or other hard foundation material of loose debris and cut to a firm, level, stepped, or serrated surface. Remove loose disintegrated rock and thin strata. Do not disturb the bottom of the excavation when concrete or masonry is to be placed in an excavated area. Do not excavate to the final grade level until just before the concrete or masonry is to be placed. Where pile foundations are to be used, stop the excavation of each pit at an elevation 1 foot above the base of the footing, as specified, before piles are driven. After the pile driving has been completed, remove loose and displaced material and complete excavation, leaving a smooth, solid, undisturbed surface to receive the concrete or masonry.

3.2.3 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.2.4 Dewatering

Control groundwater flowing toward or into excavations to prevent sloughing of excavation slopes and walls, boils, uplift and heave in the excavation and to eliminate interference with orderly progress of construction. Do

not permit French drains, sumps, ditches or trenches within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Take control measures by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, maintain the water level continuously, at least 5 feet below the working level. Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system.

3.2.5 Trench Excavation Requirements

Excavate the trench as recommended by the manufacturer of the pipe to be installed. Slope trench walls below the top of the pipe, or make vertical, and of such width as recommended in the manufacturer's printed installation manual. Provide vertical trench walls where no manufacturer's printed installation manual is available. Shore trench walls more than 3 feet high, cut back to a stable slope, or provide with equivalent means of protection for employees who may be exposed to moving ground or cave in. Shore vertical trench walls more than 3 feet high. Excavate trench walls which are cut back to at least the angle of repose of the soil. Give special attention to slopes which may be adversely affected by weather or moisture content. Do not exceed the trench width below the pipe top of 24 inches plus pipe outside diameter (O.D.) for pipes of less than 24 inch inside diameter, and do not exceed 36 inch plus pipe outside diameter for sizes larger than 24 inch inside diameter. Where recommended trench widths are exceeded, provide redesign, stronger pipe, or special installation procedures by the Contractor. The Contractor is responsible for the cost of redesign, stronger pipe, or special installation procedures without any additional cost to the Government.

3.2.5.1 Bottom Preparation

Grade the bottoms of trenches accurately to provide uniform bearing and support for the bottom quadrant of each section of the pipe. Excavate bell holes to the necessary size at each joint or coupling to eliminate point bearing. Remove stones of 24 inch or greater in any dimension, or as recommended by the pipe manufacturer, whichever is smaller, to avoid point bearing.

3.2.5.2 Removal of Unyielding Material

Where overdepth is not indicated and unyielding material is encountered in the bottom of the trench, remove such material 50 inch below the required grade and replaced with suitable materials as provided in paragraph BACKFILLING AND COMPACTION.

3.2.5.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, remove such material to the depth directed and replace it to the proper grade with select granular material as provided in paragraph BACKFILLING AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the Contractor is responsible for excavating the resulting material and replacing it without additional cost to the Government.

3.2.5.4 Excavation for Appurtenances

Provide excavation for manholes, catch-basins, inlets, or similar structures sufficient to leave at least 12 inch clear between the outer structure surfaces and the face of the excavation or support members Clean rock of loose debris and cut to a firm surface either level, stepped, or serrated, as shown or as directed. Remove loose disintegrated rock and thin strata. Specify removal of unstable material. When concrete or masonry is to be placed in an excavated area, take special care not to disturb the bottom of the excavation. Do not excavate to the final grade level until just before the concrete or masonry is to be placed.

3.2.5.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, provide excavation by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Contracting Officer, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections.

3.2.6 Underground Utilities

The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Perform work adjacent to non-Government utilities as indicated in accordance with procedures outlined by utility company. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

3.2.7 Structural Excavation

Ensure that footing subgrades have been inspected and approved by the Contracting Officer prior to concrete placement. Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the Contracting Officer. Backfill and compact over excavations and changes in grade due to pile driving operations to 95 percent of ASTM D 698 maximum density.

3.3 SELECTION OF BORROW MATERIAL

Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Obtain borrow material from the borrow areas from approved private sources. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval. Consider necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon related operations to the borrow excavation.

3.4 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

Notify the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, excavate borrow pits and other excavation areas providing adequate drainage. Transport overburden and other spoil material to designated spoil areas or otherwise dispose of as directed. Provide neatly trimmed

and drained borrow pits after the excavation is completed. Ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.5 SHORING

3.5.1 General Requirements

Submit a Shoring and Sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a registered professional engineer, describing the methods for shoring and sheeting of excavations. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheeting as excavations are backfilled, in a manner to prevent caving.

3.5.2 Geotechnical Engineer

Hire a Professional Geotechnical Engineer to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for updating the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and submit an updated plan if necessary. Submit a monthly written report, informing the Contractor and Contracting Officer of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Contracting Officer is responsible for arranging meetings with the Geotechnical Engineer at any time throughout the contract duration.

3.6 GRADING AREAS

Where indicated, divide work into grading areas within which satisfactory excavated material will be placed in embankments, fills, and required backfills. Do not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing. Place and grade stockpiles of satisfactory and unsatisfactory as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.7 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Do not excavate to final grade until just before concrete is to be placed. For pile foundations, stop the excavation at an elevation of from 6 to 12 inch above the bottom of the footing before driving piles. After pile driving has been completed, complete the remainder of the excavation to the elevations shown. Only use excavation methods that will leave the foundation rock in a solid and unshattered condition. Roughen the level surfaces, and cut the sloped surfaces, as indicated, into rough steps or benches to provide a satisfactory bond. Protect shales from slaking and all surfaces from erosion resulting from ponding or water flow.

3.8 GROUND SURFACE PREPARATION

3.8.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer, in surfaces to receive fill or in excavated areas. Scarify the surface to a depth of 6 inch before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inch, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inch and compact it as specified for the adjacent fill.

3.8.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.9 UTILIZATION OF EXCAVATED MATERIALS

Dispose unsatisfactory materials removing from excavations into designated waste disposal or spoil areas. Use satisfactory material removed from excavations, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. Do not waste any satisfactory excavated material without specific written authorization. Dispose of satisfactory material, authorized to be wasted, in designated areas approved for surplus material storage or designated waste areas as directed. Clear and grub newly designated waste areas on Government-controlled land before disposal of waste material thereon. Stockpile and use coarse rock from excavations for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. Do not dispose excavated material to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

3.10 BURIED TAPE AND DETECTION WIRE

3.10.1 Buried Warning and Identification Tape

Provide buried utility lines with utility identification tape. Bury tape 12 inch below finished grade; under pavements and slabs, bury tape 6 inch below top of subgrade.

3.10.2 Buried Detection Wire

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inch above the top of pipe. Extend the wire continuously and unbroken, from manhole to manhole. Terminate the ends of the wire inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. Furnish insulated wire over

it's entire length. Install wires at manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, terminate the wire in the valve pit at the pump station end of the pipe.

3.11 BACKFILLING AND COMPACTION

Place backfill adjacent to any and all types of structures, and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials, to prevent wedging action or eccentric loading upon or against the structure. Prepare ground surface on which backfill is to be placed as specified in paragraph GROUND SURFACE PREPARATION. Provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs GROUND SURFACE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.11.1 Trench Backfill

Backfill trenches to the grade shown. Do not backfill the trench until all specified tests are performed.

3.11.1.1 Replacement of Unstable Material

Replace unstable material removed from the bottom of the trench or excavation with select granular material placed in layers not exceeding 6 inch loose thickness.

3.11.1.2 Bedding and Initial Backfill

Provide bedding of the type and thickness shown. Place initial backfill material and compact it with approved tampers to a height of at least one foot above the utility pipe or conduit. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Compact backfill to top of pipe to 95 percent of ASTM D 698 maximum density. Provide plastic piping with bedding to spring line of pipe. Provide materials as follows:

a. Class I: Angular, 0.25 to 1.5 inch, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

b. Class II: Coarse sands and gravels with maximum particle size of 1.5 inch, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D 2487.

c. Clean, coarse-grained sand classified as clean in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL, gradation 12 of the DOT or SW by ASTM D 2487 for as indicated.

d. Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as directed in accordance with Section 31 23 00.00 20 EXCAVATION AND FILL, or having a classification of GP

in accordance with ASTM D 2487 for as indicated.

3.11.1.3 Final Backfill

Fill the remainder of the trench, except for special materials for roadways, railroads and airfields, with satisfactory material. Place backfill material and compact as follows:

a. Roadways, Railroads, and Airfields: Place backfill up to the required elevation as specified. Do not permit water flooding or jetting methods of compaction.

b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Deposit backfill in layers of a maximum of 12 inch loose thickness, and compact it to 85 percent maximum density for cohesive soils and 90 percent maximum density for cohesionless soils. Do not permit compaction by water flooding or jetting. Apply this requirement to all other areas not specifically designated above.

3.11.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 14 days, place backfill in such a manner that the structure is not be damaged by the shock of falling earth. Deposit the backfill material, compact it as specified for final backfill, and bring up the backfill evenly on all sides of the structure to prevent eccentric loading and excessive stress.

3.12 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

3.12.1 Gas Distribution

Excavate trenches to a depth that will provide a minimum 18 inch of cover in rock excavation and a minimum 24 inch of cover in other excavation.

3.12.2 Water Lines

Excavate trenches to a depth that provides a minimum cover of 3 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe.

3.12.3 Heat Distribution System

Free initial backfill material of stones larger than 1/4 inch in any dimension.

3.12.4 Electrical Distribution System

Provide a minimum cover of 24 inch from the finished grade to direct burial cable and conduit or duct line, unless otherwise indicated.

3.12.5 Sewage Absorption Trenches or Pits

3.12.5.1 Porous Fill

Provide backfill material consisting of clean crushed rock or gravel having

a gradation such that 100 percent passes the 2 inch sieve and zero percent passes the 1/2 inch sieve.

3.12.5.2 Cover

Filter fabric as indicated.

3.12.6 Pipeline Casing

Provide new smooth wall steel pipeline casing under . Provide each new pipeline casing, where indicated and to the lengths and dimensions shown, complete and suitable for use with the new piped utility as indicated.

3.12.6.1 Bore Holes

Mechanically bore holes and case through the soil with a cutting head on a continuous auger mounted inside the casing pipe. Weld lengths of pipe together in accordance with AWS D1.1/D1.1M. Do not use water or other fluids in connection with the boring operation.

3.12.6.2 Cleaning

Clean inside of the pipeline casing of dirt, weld splatters, and other foreign matter which would interfere with insertion of the piped utilities by attaching a pipe cleaning plug to the boring rig and passing it through the pipe.

3.12.6.3 End Seals

After installation of piped utilities in pipeline casing, provide watertight end seals at each end of pipeline casing between pipeline casing and piping utilities. Provide watertight segmented elastomeric end seals.

3.12.7 Rip-Rap Construction

Construct rip-rap with grout in the areas indicated. Trim and dress indicated areas to conform to cross sections, lines and grades shown within a tolerance of 0.1 foot.

3.12.7.1 Bedding Placement

Spread filter fabric bedding material uniformly to a thickness of at least [3] [_____] inch on prepared subgrade as indicated. Compaction of bedding is not required. Finish bedding to present even surface free from mounds and windrows.

3.12.7.2 Stone Placement

Place rock for rip-rap on prepared bedding material to produce a well graded mass with the minimum practicable percentage of voids in conformance with lines and grades indicated. Distribute larger rock fragments, with dimensions extending the full depth of the rip-rap throughout the entire mass and eliminate "pockets" of small rock fragments. Rearrange individual pieces by mechanical equipment or by hand as necessary to obtain the distribution of fragment sizes specified above. For grouted rip-rap, hand-place surface rock with open joints to facilitate grouting and do not fill smaller spaces between surface rock with finer material. Provide at least one "weep hole" through grouted rip-rap for every 50 square feet of finished surface. Provide weep holes with columns of bedding material, 4

inch in diameter, extending up to the rip-rap surface without grout.

3.12.7.3 Grouting

Prior to grouting, wet rip-rap surfaces. Grout rip-rap in successive longitudinal strips, approximately 10 feet in width, commencing at the lowest strip and working up the slope. Distribute grout to place of final deposit and work into place between stones with brooms, spades, trowels, or vibrating equipment. Take precautions to prevent grout from penetrating bedding layer. Protect and cure surface for a minimum of 7 days.

3.13 EMBANKMENTS

3.13.1 Earth Embankments

Construct earth embankments from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. Place the material in successive horizontal layers of loose material not more than [12][_____] inch in depth. Spread each layer uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, plow, disk, or otherwise brake up each layer; moisten or aerate as necessary; thoroughly mix; and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements are identical with those requirements specified in paragraph SUBGRADE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.13.2 Rock Embankments

Construct rock embankments from material classified as rock excavation, as defined above, placed in successive horizontal layers of loose material not more than 12 inch in depth. Do not use pieces of rock larger than 24 inch in the greatest dimension. Spread each layer of material uniformly, completely saturate, and compact to a minimum density of 30 pcf. Adequately bond each successive layer of material to the material on which it is placed. Finish compaction with vibratory compactors weighing at least 1 tons, heavy rubber-tired rollers weighing at least 1 tons, or steel-wheeled rollers weighing at least 1 tons. Do not use rock excavation as fill material for the construction of pavements.

3.14 SUBGRADE PREPARATION

3.14.1 Proof Rolling

Finish proof rolling on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade of the top with six passes of a 15 ton, pneumatic-tired roller. Operate the roller in a systematic manner to ensure the number of passes over all areas, and at speeds between 2-1/2 to 3-1/2 mph. When proof rolling, provide one-half of the passes made with the roller in a direction perpendicular to the other passes. Notify the Contracting Officer a minimum of 3 days prior to proof rolling. Perform proof rolling in the presence of the Contracting Officer. Undercut rutting or pumping of material as directed by the Contracting Officer and replace with fill and

backfill material.

3.14.2 Construction

3.14.3 Compaction

3.14.3.1 Subgrade for Pavements

Compact subgrade for pavements to at least 12 percentage laboratory maximum density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, thoroughly blend, reshape, and compact the top 13 inch of subgrade.

3.14.3.2 Subgrade for Shoulders

Compact subgrade for shoulders to at least 3 percentage laboratory maximum density for the full depth of the shoulder.

3.14.3.3 Subgrade for Airfield Pavements

Compact top 24 inch below finished pavement or top 12 inch of subgrades, whichever is greater, to 100 percent of ASTM D 1557; compact fill and backfill material to 100 percent of ASTM D 1557.

3.15 SHOULDER CONSTRUCTION

Construct shoulders of satisfactory excavated or borrow material or as otherwise shown or specified. Construct shoulders immediately after adjacent paving is complete. In the case of rigid pavements, do not construct shoulders until permission of the Contracting Officer has been obtained. Compact the entire shoulder area to at least the percentage of maximum density as specified in paragraph SUBGRADE PREPARATION above, for specific ranges of depth below the surface of the shoulder. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Finish shoulder construction in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. Align the completed shoulders true to grade and shaped to drain in conformity with the cross section shown.

3.16 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades specified in paragraph SUBGRADE PREPARATION. Finish gutters and ditches in a manner that will result in effective drainage. Finish the surface of areas to be turfed from settlement or washing to a smoothness suitable for the application of turfing materials. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.16.1 Subgrade and Embankments

During construction, keep embankments and excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do no disturb the finished subgrade by traffic or other operation. Protect and maintain the finsihed subgrade in a satisfactory condition until ballast, subbase, base, or pavement is placed. Do not permit the storage or stockpiling of materials on the finished subgrade. Do not lay subbase, base course, ballast, or pavement until the subgrade has been checked and approved, and in no case place subbase, base, surfacing, pavement, or ballast on a muddy, spongy, or frozen subgrade.

3.16.2 Capillary Water Barrier

Place a capillary water barrier under concrete floor and area-way slabs grade directly on the subgrade and compact with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.16.3 Grading Around Structures

Construct areas within 5 feet outside of each building and structure line true-to-grade, shape to drain, and maintain free of trash and debris until final inspection has been completed and the work has been accepted.

3.17 PLACING TOPSOIL

On areas to receive topsoil, prepare the compacted subgrade soil to a 2 inch depth for bonding of topsoil with subsoil. Spread topsoil evenly to a thickness of 60 inch and grade to the elevations and slopes shown. Do not spread topsoil when frozen or excessively wet or dry. Obtain material required for topsoil in excess of that produced by excavation within the grading limits from offsite areas .

3.18 TESTING

Perform testing by a Corps validated commercial testing laboratory or the Contractor's validated testing facility. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer. Determine field in-place density in accordance with ASTM D 1556 . ASTM D 2937, use the Drive Cylinder Method only for soft, fine-grained, cohesive soils. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a registered professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.18.1 Fill and Backfill Material Gradation

One test per 12 cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM D 1140.

3.18.2 In-Place Densities

a. One test per 1 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by other than hand-operated machines.

b. One test per 1 square feet, or fraction thereof, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per 1 linear feet, or fraction thereof, of each lift of embankment or backfill for roads .

d. One test per 1 linear feet, or fraction thereof, of each lift of embankment or backfill for railroads.

3.18.3 Check Tests on In-Place Densities

If ASTM D 6938 is used, check in-place densities by ASTM D 1556 as follows:

a. One check test per lift for each 1 square feet, or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines.

b. One check test per lift for each 1 square feet, of fill or backfill areas compacted by hand-operated machines.

c. One check test per lift for each 1 linear feet, or fraction thereof, of embankment or backfill for roads .

d. One check test per lift for each 1 linear feet, or fraction thereof, of embankment or backfill for railroads.

3.18.4 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer.

3.18.5 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 12 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.18.6 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph SUBGRADE PREPARATION during construction of the subgrades.

3.18.7 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to the finished grade surface, inspect the pipe to determine whether significant displacement has occurred. Conduct this inspection in the presence of the Contracting Officer. Inspect pipe sizes larger than 36 inch, while inspecting smaller diameter pipe by shining a light or laser between manholes or manhole locations, or by the use of television cameras

passed through the pipe. If, in the judgement of the Contracting Officer, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, replace or repair the defects as directed at no additional cost to the Government.

3.19 DISPOSITION OF SURPLUS MATERIAL

Provide surplus material or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber as wasted in Government disposal area indicated.

-- End of Section --

SECTION 31 10 00

CLEARING FOR CIVIL WORKS
08/08

PART 1 GENERAL

1.1 UNIT PRICES

1.1.1 Clearing (Structure)

1.1.1.1 Payment

Payment will be made for costs associated with furnishing plant, labor, materials and equipments, and performing all operations necessary for clearing (structures) as specified.

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.2 DEFINITIONS

1.2.1 Structures

The term "structures" includes buildings or portions thereof, walls, silos, storm or root cellars, cisterns, wells, windmills, pit silos, water towers, etc. Structures shall be removed or filled to the ground surface.

1.3 PROJECT/SITE CONDITIONS

1.3.1 Aesthetics and Pollution Control

1.3.1.1 Ground Areas

All ground areas in the zone of normal pool level fluctuations which are disturbed by clearing operations and which would become subject to erosion will be protected or restored.

1.3.2 Existing Conditions

1.3.2.1 Boundaries

The area to be cleared under this contract is divided into two (2) zones having the general limits as defined below and as indicated on the drawings and , which form a part of this contract.

a. Zone 1 - Included in this zone is that portion of the reservoir area bounded by the 600 foot msl contour line.

b. Zone 2 - Included in this zone is that portion of the reservoir area above the 1 foot msl contour line and below the 1 foot msl contour line.

1.3.2.2 Structures

Burn combustible materials obtained from removal of structures in accordance with paragraph DISPOSAL OF MATERIAL or dispose of them off the

reservoir area. Where filling of structures is required, fill to within 18 inches of the ground surface and made with noncombustible materials such as masonry rubble, and other debris. When all available debris has been used in filling, all remaining unfilled portions, together with the above 18 inches shall be completely filled to the ground surface with earth, borrowed as directed by the Contracting Officer. The top surfaces of fills shall be neat in appearance and smooth enough not to constitute a hazard to persons or livestock.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 CLEARING REQUIREMENTS

3.2 DISPOSAL OF MATERIAL

3.2.1 General

The material cleared from the areas shall be completely removed by transporting from the Government property or burned within the cleared areas unless otherwise approved by the Contracting Officer. All timber from which saw logs, posts, ties or cordwood can be produced will become the property of the Contractor and in the interest of conservation it is required that the Contractor make a reasonable effort to dispose of material for these purposes. The Contractor may cut timber into convenient lengths at the site but approval must be secured prior to the operation of saw mills within the Government lands. In no case shall cleared material be thrown into or left in the creeks or river. After the felling operation has been completed, the timber to be burned must be decked for burning within 14 days. All felled timber shall be completely removed. However, it is intended that all existing down timber in zones one (1) and two (2) will remain in place except solid, floatable material that is larger than 4 inches in diameter (regardless of length) and/or over 8 feet in length (regardless of diameter) shall be disposed of in the manner prescribed for cleared material. Clean-up of floatable debris shall be accomplished by any practical means. The cutting of branches and debris remaining after clean-up, to reduce their length in order to avoid removal, will not be permitted.

3.2.2 Burning

a. The material cleared may be burned within the contract area, and at any time within the contract period provided such burning does not interfere with inhabitants of the area by drastic changes in their accustomed environment, such as addition to air pollution or danger of fire. However, the specific time, location and manner of burning shall be subject to approval from the viewpoints of air pollution, governing fire laws and safety.

b. In the interest of conservation, the Contractor may, as an option, make available to the general public without charge, the material scheduled for burning. No burning operations shall be conducted within 100 feet of any standing timber or flammable growth. The burning operations shall be subject to all public law governing such operations and the Contractor will be responsible for any damage to life and/or property resulting from fires that are started by its employees or as a result of its operations.

c. Furnish at the site adequate fire fighting equipment, such as back tanks, flaps, shovels, rakes, etc., to properly equip his personnel for fighting fires. Fires shall be guarded at all times and shall be under constant surveillance until they have burned out or have been extinguished.

d. All burning shall be so thorough that the materials will be reduced to ashes, except that occasional charred pieces of logs or branches not exceeding 4 inches in diameter and/or 8 feet in length will be permitted to remain. Upon approval, charred material will be buried after it is determined that it could not be disposed of by methods used in the normal burning operation. All material disposed of in such manner shall be at approved locations and shall be covered within a minimum of 18 inches of earth.

3.2.3 Burial

In certain cases, such as along drainage channels in remote areas, cleared material may be disposed of by burial in areas designated for disposal of excess excavation or spoil. When this option is used, care will be taken to insure that all such cleared material will be buried under not less than 18 inches of earth. Approval will be obtained for each area selected for debris disposal for burial prior to beginning such operations. Areas to be used for permanent roadways, levees or embankments will not be used for disposal of material from clearing operations. Areas for disposal of cleared materials by burial will not be located within 300 feet of public road crossings or of project areas to be regularly visited by the public.

3.2.4 Removal from Site

Except as otherwise provided, the Contractor will be permitted to remove felled and trimmed timber from the site of the work. The Contractor will be allowed to stockpile salvaged timber near contour line 630 at approved locations. The Government will assume no responsibility for the protection and safekeeping of such material. All stockpiled timber must be removed from Government lands before final acceptance of the work will be made.

3.3 DEBRIS

Burn combustible debris in accordance with paragraph DISPOSAL OF MATERIAL. Noncombustible debris in excess of that disposed of as set forth in paragraph STRUCTURES shall be disposed of at such locations below elevation 630 as may be designated by the Contracting Officer. Debris shall include trash of all kinds.

3.4 MARKETABLE MATERIALS

Any of the cleared materials which the Contractor considers marketable shall become its property and shall be removed from the reservoir area.

3.5 LOCATIONS

The locations of structures and debris to be cleared are tabulated below.

n|a

-- End of Section --

SECTION 31 23 00.00 20

EXCAVATION AND FILL
04/06

PART 1 GENERAL

1.1 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.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C600	(2005) Installation of Ductile-Iron Water Mains and Their Appurtenances

ASTM INTERNATIONAL (ASTM)

ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 33	(2007) Standard Specification for Concrete Aggregates
ASTM D 1140	(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 1883	(2007) CBR (California Bearing Ratio) of Laboratory-Compacted Soils
ASTM D 2216	(2005) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2321	(2005) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2487	(2006) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(2005) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(2005) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3786	(2006e1) Hydraulic Bursting Strength of

	Textile Fabrics-Diaphragm Bursting Strength Tester Method
ASTM D 4318	(2005) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4355	(2007) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	(1999a; R 2004e1) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D 4759	(2002; R 2007) Determining the Specification Conformance of Geosynthetics
ASTM D 4833	(2007) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 698	(2007e1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2003) Safety -- Safety and Health Requirements

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 530/F-93/004	(1993; Rev O; Updates I, II, IIA, IIB, and III) Test Methods for Evaluating Solid Waste (Vol IA, IB, IC, and II) (SW-846)
EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-1909	(Basic Notice 1; Canc. Notice 2) Fertilizer

1.2 DEFINITIONS

1.2.1 Capillary Water Barrier

A layer of clean, poorly graded crushed rock, stone, or natural sand or gravel having a high porosity which is placed beneath a building slab with or without a vapor barrier to cut off the capillary flow of pore water to

the area immediately below a slab.

1.2.2 Degree of Compaction

Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 698, for general soil types, abbreviated as percent laboratory maximum density.

1.2.3 Hard Materials

Weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.2.4 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding [1/2] [1] [_____] cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.2.5 Pile Supported Structure

As used herein, a structure where both the foundation and floor slab are pile supported.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval.for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shoring and Sheeting Plan

Dewatering work plan

Blasting work plan

Submit 15 days prior to starting work.

SD-06 Test Reports

Borrow Site Testing; G

Fill and backfill test

Select material test

Porous fill test for capillary water barrier

Density tests

Moisture Content Tests

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

1.4 DELIVERY, STORAGE, AND HANDLING

Perform in a manner to prevent contamination or segregation of materials.

1.5 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of construction.

d. Material character is indicated by the boring logs.

e. Blasting will not be permitted. Remove material in an approved manner.

1.6 REQUIREMENTS FOR OFF SITE SOIL

Soils brought in from off site for use as backfill shall be tested for TPH, BTEX and full TCLP including ignitability, corrosivity and reactivity. Backfill shall contain less than 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and less than 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall not fail the TCPL test. TPH concentrations shall be determined by using EPA 600/4-79/020 Method 418.1. BTEX concentrations shall be determined by using EPA 530/F-93/004 Method 5030/8020. TCLP shall be performed in accordance with EPA 530/F-93/004 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Material shall not be brought on site until tests have been approved by the Contracting Officer.

1.7 QUALITY ASSURANCE

1.7.1 Dewatering Work Plan

Submit procedures for accomplishing dewatering work.

1.7.2 Utilities

Movement of construction machinery and equipment over pipes and utilities during construction shall be at the Contractor's risk. Perform work adjacent to non-Government utilities as indicated in accordance with procedures outlined by utility company. For work immediately adjacent to

or for excavations exposing a utility or other buried obstruction, excavate by hand. Start hand excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured. Support uncovered lines or other existing work affected by the contract excavation until approval for backfill is granted by the Contracting Officer. Report damage to utility lines or subsurface construction immediately to the Contracting Officer.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

2.1.1 Satisfactory Materials

Any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, free of debris, roots, wood, scrap material, vegetation, refuse, soft unsound particles, and frozen, deleterious, or objectionable materials. Unless specified otherwise, the maximum particle diameter shall be one-half the lift thickness at the intended location.

2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials. Unsatisfactory materials also include man-made fills, trash, refuse, or backfills from previous construction. Unsatisfactory material also includes material classified as satisfactory which contains root and other organic matter, frozen material, and stones larger than 150 inches. The Contracting Officer shall be notified of any contaminated materials.

2.1.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D 2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, and SM shall be identified as cohesionless only when the fines are nonplastic (plasticity index equals zero). Materials classified as GM and SM will be identified as cohesive only when the fines have a plasticity index greater than zero.

2.1.4 Expansive Soils

Soils that have a plasticity index equal to or greater than 25 when tested in accordance with ASTM D 4318.

2.1.5 Nonfrost Susceptible (NFS) Material

A uniformly graded washed sand with a maximum particle size of 0.05 inch and less than 5 percent passing the No. 200 size sieve, and with not more than 3 percent by weight finer than 0.02 mm grain size.

2.1.6 Common Fill

Approved, unclassified soil material with the characteristics required to compact to the soil density specified for the intended location.

2.1.7 Backfill and Fill Material

ASTM D 2487, classification GW, GP, GM, GC, SW, SP, SM, SC with a maximum ASTM D 4318 liquid limit of 35, maximum ASTM D 4318 plasticity index of 12,

and a maximum of 25 percent by weight passing ASTM D 1140, No. 200 sieve.

2.1.8 Select Material

Provide materials classified as GW, or by ASTM D 2487 where indicated.

Bearing Ratio: At 0.1 inch penetration, the bearing ratio shall be 12 percent at 95 percent ASTM D 1557 maximum density as determined in accordance with ASTM D 1883 for a laboratory soaking period of not less than 4 days. The combined material shall conform to the following sieve analysis:

Sieve Size	Percent Passing by Weight
2 1/2 inches	100
No. 4	40 - 85
No. 10	20 - 80
No. 40	10 - 60
No. 200	5 - 25

2.1.9 Topsoil

Provide as specified in Section 32 92 19SEEDING.

Natural, friable soil representative of productive, well-drained soils in the area, free of subsoil, stumps, rocks larger than one inch diameter, brush, weeds, toxic substances, and other material detrimental to plant growth. Amend topsoil pH range to obtain a pH of 5.5 to 7.

2.2 POROUS FILL FOR CAPILLARY WATER BARRIER

ASTM C 33 fine aggregate grading with a maximum of 3 percent by weight passing ASTM D 1140, No. 200 sieve, 1-1/2 inches and no more than 2 percent by weight passing the No. 4 size sieve and conforming to the general soil material requirements specified in paragraph entitled "Satisfactory Materials."

2.3 UTILITY BEDDING MATERIAL

Except as specified otherwise in the individual piping section, provide bedding for buried piping in accordance with AWWA C600, Type 4, except as specified herein. Backfill to top of pipe shall be compacted to 95 percent of ASTM D 698 maximum density. Plastic piping shall have bedding to spring line of pipe. Provide ASTM D 2321 materials as follows:

a. Class I: Angular, 0.25 to 1.5 inches, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

b. Class II: Coarse sands and gravels with maximum particle size of 1.5 inches, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D 2487.

2.3.1 Sand

Clean, coarse-grained sand classified as sand in accordance with the DOT State Standard or SW by ASTM D 2487 for bedding.

2.3.2 Gravel

Clean, coarsely graded natural gravel, crushed stone or a combination thereof identified as gravel in accordance with the DOT State Standard or having a classification of GW in accordance with ASTM D 2487 for bedding. Maximum particle size shall not exceed [3] [_____] inches.

2.4 [Enter Appropriate Subpart Title Here]

2.5 FILTER FABRIC

Provide a pervious sheet of polyester, nylon, glass or polypropylene , ultraviolet resistant filaments woven, spun bonded, fused, or otherwise manufactured into a nonraveling fabric with uniform thickness and strength. Fabric shall have the following manufacturer certified minimum average roll properties as determined by ASTM D 4759:

	Class A	Class B
a. Grab tensile strength (ASTM D 4632) machine and transversed direction	min. [180]	[80] lbs.
b. Grab elongation (ASTM D 4632) machine and transverse direction	min. [15]	[15] percent
c. Puncture resistance (ASTM D 4833)	min. [80]	[25] lbs.
d. Mullen burst strength (ASTM D 3786)	min. [290]	[130] psi.
e. Trapezoidal Tear (ASTM D 4533)	min. [50]	[25] lbs.
[f. Apparent Opening Size (ASTM D 4751)	[_____]	[_____]]
[f. Apparent Opening Size (ASTM D 4751)	See Criteria Below	

(1) Soil with 50 percent or less particles by weight passing US No. 200 Sieve, AOS less than 0.6 mm (greater than #30 US Std. Sieve)

(2) Soil with more than 50 percent particles by weight passing US No. 200 Sieve, AOS less than 0.297 mm (greater than #50 US Std. Sieve)]

g. Permeability (ASTM D 4491)	[k fabric greater than k Soil]
[h. Ultraviolet Degradation (ASTM D 4355)	70 percent Strength retained at 150 hours]

2.6 MATERIAL FOR RIP-RAP

Bedding material and rock conforming to DOT State Standard for construction indicated.

2.6.1 Bedding Material

Consisting of sand, gravel, or crushed rock, well graded, or poorly graded with a maximum particle size of 2 inches. Material shall be composed of tough, durable particles. Fines passing the No. 200 standard sieve shall have a plasticity index less than six.

2.6.2 Grout

Composed of cement, water, an air-entraining admixture, and sand mixed in proportions of one part portland cement to two parts of sand, sufficient water to produce a workable mixture, and an amount of admixture which will entrain sufficient air to produce durable grout, as determined by the Contracting Officer. Mix grout in a concrete mixer. Mixing time shall be sufficient to produce a mixture having a consistency permitting gravity flow into the interstices of the rip-rap with limited spading and brooming.

2.6.3 Rock

Rock fragments sufficiently durable to ensure permanence in the structure and the environment in which it is to be used. Rock fragments shall be free from cracks, seams, and other defects that would increase the risk of deterioration from natural causes. The size of the fragments shall be such that no individual fragment exceeds a weight of [150] [_____] pounds and that no more than 10 percent of the mixture, by weight, consists of fragments weighing 2 pounds or less each. Specific gravity of the rock shall be a minimum of 2.50 . The inclusion of more than trace 1 percent quantities of dirt, sand, clay, and rock fines will not be permitted.

2.7 BURIED WARNING AND IDENTIFICATION TAPE

Polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch minimum width, color coded as specified below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil.

Warning Tape Color Codes

Yellow:	Electric
Yellow:	Gas, Oil; Dangerous Materials
Orange:	Telephone and Other Communications
Blue:	Water Systems
Green:	Sewer Systems
White:	Steam Systems
Gray:	Compressed Air

2.7.1 Warning Tape for Metallic Piping

Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise, and 1250 psi crosswise, with a maximum 350 percent elongation.

2.7.2 Detectable Warning Tape for Non-Metallic Piping

Polyethylene plastic tape conforming to the width, color, and printing requirements specified above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. Tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when tape is buried up to 3 feet deep. Encase metallic element of the tape in a

protective jacket or provide with other means of corrosion protection.

2.8 DETECTION WIRE FOR NON-METALLIC PIPING

Detection wire shall be insulated single strand, solid copper with a minimum of 12 AWG.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Shoring and Sheeting

Provide shoring bracing where indicated. In addition to Section 25 A and B of EM 385-1-1 and other requirements set forth in this contract, include provisions in the shoring and sheeting plan that will accomplish the following:

a. Prevent undermining of pavements, foundations and slabs.

b. Prevent slippage or movement in banks or slopes adjacent to the excavation.

c. Allow for the abandonment of shoring and sheeting materials in place in critical areas as the work is completed. In these areas, backfill the excavation to within 3 feet of the finished grade and remove the remaining exposed portion of the shoring before completing the backfill.

3.1.2 Drainage and Dewatering

Provide for the collection and disposal of surface and subsurface water encountered during construction.

3.1.2.1 Drainage

So that construction operations progress successfully, completely drain construction site during periods of construction to keep soil materials sufficiently dry. The Contractor shall establish/construct storm drainage features (ponds/basins) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and/or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils, prevent erosion and undermining of foundations. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site, the area immediately surrounding the site, and the area affecting operations at the site shall be continually and effectively drained.

3.1.2.2 Dewatering

Groundwater flowing toward or into excavations shall be controlled to prevent sloughing of excavation slopes and walls, boils, uplift and heave

in the excavation and to eliminate interference with orderly progress of construction. French drains, sumps, ditches or trenches will not be permitted within 3 feet of the foundation of any structure, except with specific written approval, and after specific contractual provisions for restoration of the foundation area have been made. Control measures shall be taken by the time the excavation reaches the water level in order to maintain the integrity of the in situ material. While the excavation is open, the water level shall be maintained continuously, at least 1 feet below the working level.

Measure and record performance of dewatering system at same time each day by use of observation wells or piezometers installed in conjunction with the dewatering system.

3.1.3 Underground Utilities

Location of the existing utilities indicated is approximate. The Contractor shall physically verify the location and elevation of the existing utilities indicated prior to starting construction. The Contractor shall scan the construction site with electromagnetic and sonic equipment and mark the surface of the ground where existing underground utilities are discovered.

3.1.4 Machinery and Equipment

Movement of construction machinery and equipment over pipes during construction shall be at the Contractor's risk. Repair, or remove and provide new pipe for existing or newly installed pipe that has been displaced or damaged.

3.2 SURFACE PREPARATION

3.2.1 Clearing and Grubbing

Unless indicated otherwise, remove trees, stumps, logs, shrubs, brush and vegetation and other items that would interfere with construction operations within the within lines 5 feet outside of each building and structure line . Remove stumps entirely. Grub out matted roots and roots over 2 inches in diameter to at least 18 inches below existing surface.

3.2.2 Stripping

Strip suitable soil from the site where excavation or grading is indicated and stockpile separately from other excavated material. Material unsuitable for use as topsoil shall be stockpiled and used for backfilling. Locate topsoil so that the material can be used readily for the finished grading. Where sufficient existing topsoil conforming to the material requirements is not available on site, provide borrow materials suitable for use as topsoil. Protect topsoil and keep in segregated piles until needed.

3.2.3 Unsuitable Material

Remove vegetation, debris, decayed vegetable matter, sod, mulch, and rubbish underneath paved areas or concrete slabs.

3.3 EXCAVATION

Excavate to contours, elevation, and dimensions indicated. Reuse excavated

materials that meet the specified requirements for the material type required at the intended location. Keep excavations free from water. Excavate soil disturbed or weakened by Contractor's operations, soils softened or made unsuitable for subsequent construction due to exposure to weather. Excavations below indicated depths will not be permitted except to remove unsatisfactory material. Unsatisfactory material encountered below the grades shown shall be removed as directed. Refill with satisfactory material and compact to 95 percent of ASTM D 698 maximum density. Unless specified otherwise, refill excavations cut below indicated depth with satisfactory material and compact to 95 percent of ASTM D 1557 maximum density. Satisfactory material removed below the depths indicated, without specific direction of the Contracting Officer, shall be replaced with satisfactory materials to the indicated excavation grade; except as specified for spread footings. Determination of elevations and measurements of approved overdepth excavation of unsatisfactory material below grades indicated shall be done under the direction of the Contracting Officer.

3.3.1 Structures With Spread Footings

Ensure that footing subgrades have been inspected and approved by the Contracting Officer prior to concrete placement. Fill over excavations with concrete during foundation placement.

3.3.2 Pile Cap Excavation and Backfilling

Excavate to bottom of pile cap prior to placing or driving piles, unless authorized otherwise by the Contracting Officer. Backfill and compact overexcavations and changes in grade due to pile driving operations to 95 percent of ASTM D 698 maximum density.

3.3.3 Pipe Trenches

Excavate to the dimension indicated. Grade bottom of trenches to provide uniform support for each section of pipe after pipe bedding placement. Tamp if necessary to provide a firm pipe bed. Recesses shall be excavated to accommodate bells and joints so that pipe will be uniformly supported for the entire length. Rock, where encountered, shall be excavated to a depth of at least 6 inches below the bottom of the pipe.

3.3.4 Hard Material and Rock Excavation

Remove hard material and rock to elevations indicated in a manner that will leave foundation material in an unshattered and solid condition. Roughen level surfaces and cut sloped surfaces into benches for bond with concrete. Protect shale from conditions causing decomposition along joints or cleavage planes and other types of erosion. Removal of hard material and rock beyond lines and grades indicated will not be grounds for a claim for additional payment unless previously authorized by the Contracting Officer. Excavation of the material claimed as rock shall not be performed until the material has been cross sectioned by the Contractor and approved by the Contracting Officer. Common excavation shall consist of all excavation not classified as rock excavation.

3.3.5 Excavated Materials

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required or shall be separately stockpiled if it cannot be readily placed. Satisfactory material

in excess of that required for the permanent work and all unsatisfactory material shall be disposed of as specified in Paragraph "DISPOSITION OF SURPLUS MATERIAL."

3.3.6 Final Grade of Surfaces to Support Concrete

Excavation to final grade shall not be made until just before concrete is to be placed. For pile foundations, the excavation shall be stopped at an elevation 6 to 12 inches above the bottom of the footing before driving piles. After pile driving has been completed, the remainder of the excavation shall be completed to the elevations shown. Only excavation methods that will leave the foundation rock in a solid and unshattered condition shall be used. Approximately level surfaces shall be roughened, and sloped surfaces shall be cut as indicated into rough steps or benches to provide a satisfactory bond. Shales shall be protected from slaking and all surfaces shall be protected from erosion resulting from ponding or flow of water.

3.4 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials as directed by the Contracting Officer. The surface shall be scarified to a depth of 6 inches before the fill is started. Sloped surfaces steeper than 1 vertical to 4 horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When subgrades are less than the specified density, the ground surface shall be broken up to a minimum depth of 6 inches, pulverized, and compacted to the specified density. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches and compacted as specified for the adjacent fill. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Material shall be moistened or aerated as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Minimum subgrade density shall be as specified herein.

3.4.1 Proof Rolling

Proof rolling shall be done on an exposed subgrade free of surface water (wet conditions resulting from rainfall) which would promote degradation of an otherwise acceptable subgrade. After stripping, proof roll the existing subgrade of the building with six passes of a15 ton, pneumatic-tired roller. Operate the truck in a systematic manner to ensure the number of passes over all areas, and at speeds between 2 1/2 to 3 1/2 miles per hour. When proof rolling under buildings, the building subgrade shall be considered to extend 5 feet beyond the building lines, and one-half of the passes made with the roller shall be in a direction perpendicular to the other passes. Notify the Contracting Officer a minimum of 3 days prior to proof rolling. Proof rolling shall be performed in the presence of the Contracting Officer. Rutting or pumping of material shall be undercut as directed by the Contracting Officer and replaced with fill and backfill material. Bids shall be based on replacing approximately 1 square yards, with an average depth of 12 inches at various locations.

3.5 SUBGRADE FILTER FABRIC

Place synthetic fiber filter fabric as indicated directly on prepared subgrade free of vegetation, stumps, rocks larger than diameter and other debris which may puncture or otherwise damage the fabric. Repair damaged fabric by placing an additional layer of fabric to cover the damaged area a minimum of overlap in all directions. Overlap fabric at joints a minimum of 3 feet. Obtain approval of filter fabric installation before placing fill or backfill. Place fill or backfill on fabric in the direction of overlaps and compact as specified herein. Follow manufacturer's recommended installation procedures.

3.6 FILLING AND BACKFILLING

Fill and backfill to contours, elevations, and dimensions indicated. Compact each lift before placing overlaying lift.

3.6.1 Common Fill Placement

Provide for general site Place in [6] [_____] inch lifts. Compact areas not accessible to rollers or compactors with mechanical hand tampers. Aerate material excessively moistened by rain to a satisfactory moisture content. Finish to a smooth surface by blading, rolling with a smooth roller, or both.

3.6.2 Backfill and Fill Material Placement

Provide for paved areas and under concrete slabs, except where select material is provided. Place in [6] [_____] inch lifts. Do not place over wet or frozen areas. Place backfill material adjacent to structures as the structural elements are completed and accepted. Backfill against concrete only when approved. Place and compact material to avoid loading upon or against the structure.

3.6.3 Select Material Placement

Provide under porous fill of structures not pile supported. Place in [6] [_____] inch lifts. Do not place over wet or frozen areas. Backfill adjacent to structures shall be placed as structural elements are completed and accepted. Backfill against concrete only when approved. Place and compact material to avoid loading upon or against structure.

3.6.4 Backfill and Fill Material Placement Over Pipes and at Walls

Backfilling shall not begin until construction below finish grade has been approved, underground utilities systems have been inspected, tested and approved, forms removed, and the excavation cleaned of trash and debris. Backfill shall be brought to indicated finish grade and shall include backfill for outside grease interceptors and underground fuel tanks. Where pipe is coated or wrapped for protection against corrosion, the backfill material up to an elevation 2 feet above sewer lines and 1 foot above other utility lines shall be free from stones larger than 1 inch in any dimension. Heavy equipment for spreading and compacting backfill shall not be operated closer to foundation or retaining walls than a distance equal to the height of backfill above the top of footing; the area remaining shall be compacted in layers not more than 4 inches in compacted thickness with power-driven hand tampers suitable for the material being compacted. Backfill shall be placed carefully around pipes or tanks to avoid damage to coatings, wrappings, or tanks. 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.

3.6.5 Porous Fill Placement

Provide under floor and area-way slabs on a compacted subgrade. Place in [4] [_____] inch lifts with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.6.6 Trench Backfilling

Backfill as rapidly as construction, testing, and acceptance of work permits. Place and compact backfill under structures and paved areas in [6] [_____] inch lifts to top of trench and in [6] [_____] inch lifts to one foot over pipe outside structures and paved areas.

3.7 BORROW

Where satisfactory materials are not available in sufficient quantity from required excavations, approved borrow materials shall be obtained as specified herein.

3.8 BURIED WARNING AND IDENTIFICATION TAPE

Provide buried utility lines with utility identification tape. Bury tape 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.

3.9 BURIED DETECTION WIRE

Bury detection wire directly above non-metallic piping at a distance not to exceed 12 inches above the top of pipe. The wire shall extend continuously and unbroken, from manhole to manhole. The ends of the wire shall terminate inside the manholes at each end of the pipe, with a minimum of 3 feet of wire, coiled, remaining accessible in each manhole. The wire shall remain insulated over it's entire length. The wire shall enter manholes between the top of the corbel and the frame, and extend up through the chimney seal between the frame and the chimney seal. For force mains, the wire shall terminate in the valve pit at the pump station end of the pipe.

3.10 COMPACTION

Determine in-place density of existing subgrade; if required density exists, no compaction of existing subgrade will be required.

3.10.1 General Site

Compact underneath areas designated for vegetation and areas outside the 5 foot line of the paved area or structure to 90 percent of ASTM D 698 .

3.10.2 Structures, Spread Footings, and Concrete Slabs

Compact top 12 inches of subgrades to 95 percent of ASTM D 698 . Compact fill and backfill material to 95percent of ASTM D 1557.

3.10.3 Adjacent Area

Compact areas within 5 feet of structures to 90 percent of ASTM D 698 .

3.10.4 Paved Areas

Compact top 12 inches of subgrades to 95 percent of ASTM D 1557. Compact fill and backfill materials to 95 percent of ASTM D 698 .

3.11 SPECIAL EARTHWORK REQUIREMENTS FOR SUBSURFACE DRAINS

Excavate to dimensions indicated. Provide a bedding surface of no more than one inch of sandgravel and place on compacted native soilas indicated. Backfill around and over the pipes after pipe installation has been approved. Place special granular filter material in 6 inch lifts and compact with mechanical, vibrating plate tampers or rammers until no further consolidation can be achieved. Compact backfill overlying the special granular filter material as specified for adjacent or overlying work.

3.11.1 Granular Backfill Without Filter Fabric

3.11.1.1 Perforated or Slotted Wall Pipe

Place granular material as pipe is laid and extend fit for a minimum of one pipe diameter on each side of and 18 inches above the top of the pipe. Place a layer of kraft paper on top of granular filter before continuing with the backfill.

3.11.2 Granular Backfill Using Filter Fabric

3.11.2.1 Perforated or Slotted Wall Pipes

Wrap one layer of filter fabric around pipe in such a manner that longitudinal overlaps are in unperforated or unslotted quadrants of the pipe. Overlap fabric a minimum of 2 inches. Secure fabric to pipe so that backfill material does not infiltrate through overlaps. Place granular material and extend it for one pipe diameter, minimum of 6 inches on each side of and 18 inches above top of pipe. Place a layer of filter fabric on top of granular filter before continuing with backfill.

3.12 FINISH OPERATIONS

3.12.1 Grading

Finish grades as indicated within one-tenth of one foot. Grade areas to drain water away from structures. Maintain areas free of trash and debris. For existing grades that will remain but which were disturbed by Contractor's operations, grade as directed.

3.12.2 Topsoil and Seed

Provide as specified in Section 32 92 19 SEEDING.

Scarify existing subgrade. Provide 4 inches of topsoil for newly graded finish earth surfaces and areas disturbed by the Contractor. Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to seeding, planting, or proper grading. Additional topsoil will not be required if work is performed in compliance with stripping and stockpiling requirements. Seed shall match existing vegetation. Provide seed at 5 pounds per 1000 square feet. Provide CID A-A-1909, Type I, Class 2, 10-10-10 analysis fertilizer at 25 pounds per 1000 square feet. Provide commercial agricultural limestone of

94-80-14 analysis at 70 pounds per 1000 square feet. Provide mulch and water to establish an acceptable stand of grass.

3.12.3 Protection of Surfaces

Protect newly backfilled, graded, and topsoiled areas from traffic, erosion, and settlements that may occur. Repair or reestablish damaged grades, elevations, or slopes.

3.13 DISPOSITION OF SURPLUS MATERIAL

Remove from Government property] surplus or other soil material not required or suitable for filling or backfilling, and brush, refuse, stumps, roots, and timber.

3.14 FIELD QUALITY CONTROL

3.14.1 Sampling

Take the number and size of samples required to perform the following tests.

3.14.2 Testing

Perform one of each of the following tests for each material used. Provide additional tests for each source change.

3.14.2.1 Fill and Backfill Material Testing

Test fill and backfill material in accordance with ASTM C 136 for conformance to ASTM D 2487 gradation limits; ASTM D 1140 for material finer than the No. 200 sieve; ASTM D 4318 for liquid limit and for plastic limit; ASTM D 698 or ASTM D 1557 for moisture density relations, as applicable.

3.14.2.2 Select Material Testing

Test select material in accordance with ASTM C 136 for conformance to ASTM D 2487 gradation limits; ASTM D 1140 for material finer than the No. 200 sieve; ASTM D 698 or ASTM D 1557 for moisture density relations, as applicable.

3.14.2.3 Porous Fill Testing

Test porous fill in accordance with ASTM C 136 for conformance to gradation specified in ASTM C 33.

3.14.2.4 Density Tests

Test density in accordance with ASTM D 1556, or ASTM D 2922 and ASTM D 3017. When ASTM D 2922 and ASTM D 3017 density tests are used, verify density test results by performing an ASTM D 1556 density test at a location already ASTM D 2922 and ASTM D 3017 tested as specified herein. Perform an ASTM D 1556 density test at the start of the job, and for every 10 ASTM D 2922 and ASTM D 3017 density tests thereafter. Test each lift at randomly selected locations every [2000] [_____] square feet of existing grade in fills for structures and concrete slabs, and every [2500] [_____] square feet for other fill areas and every [2000] [_____] square feet of subgrade in cut. Include density test results in daily report.

a. Bedding and backfill in trenches: One test per [50] [_____]

linear feet in each lift.

3.14.2.5 Moisture Content Tests

In the stockpile, excavation or borrow areas, a minimum of two tests per day per type of material or source of materials being placed is required during stable weather conditions. During unstable weather, tests shall be made as dictated by local conditions and approved moisture content shall be tested in accordance with ASTM D 2216. Include moisture content test results in daily report.

] -- End of Section --

SECTION 31 32 11

SOIL SURFACE EROSION CONTROL

08/08

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

1.1.1 Standard and Geosynthetic Binder

Measure the standard and geosynthetic binder by the square yard of surface area covered. No measurement for payment will be made for fine grading, trenching or other miscellaneous materials necessary for placement of the binder.

1.1.2 Mulch and Compost

Measure mulch and compost by the square yard of surface area covered. No measurement for payment will be made for binder, dye or other miscellaneous materials or equipment necessary for placement of the mulch or compost.

1.1.3 Hydraulic Mulch

Measure hydraulic mulch by the square yard of surface area covered. Measurement for payment will include binder, dye or both. No measurement for payment will be made for other miscellaneous materials or equipment necessary for placement of the hydraulic mulch.

1.1.4 Geotextile Fabric

Measure geotextile fabrics by the square yard of surface area covered. No measurement for payment will be made for fine grading, trenching or other miscellaneous materials necessary for placement of the fabric.

1.1.5 Erosion Control Blankets

Measure erosion control blankets by the square yard of surface area covered. No measurement for payment will be made for fine grading, trenching or other miscellaneous materials necessary for placement of the erosion control blankets.

1.1.6 Synthetic Grid/Sheet Systems

Measure synthetic grid/sheet system by the square yard of surface area covered. No measurement for payment will be made for fine grading, trenching, geotextile, seams, grout, rock, topsoil or other miscellaneous materials necessary for placement of the articulating cellular concrete block system.

1.1.7 Cellular Concrete Block Systems

Measure articulating cellular concrete block system by the square yard of surface area covered. No measurement for payment will be made for fine grading, trenching, geotextile, seams, grout, rock, topsoil or other miscellaneous materials necessary for placement of the articulating

cellular concrete block system.

1.2 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.

ASTM INTERNATIONAL (ASTM)

ASTM C 140	(2007a) Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C 39/C 39M	(2005e1) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42/C 42M	(2004) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM D 1248	(2005) Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D 1560	(2005e1) Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus
ASTM D 1777	(1996; R 2007) Thickness of Textile Materials
ASTM D 2028	(1997; R 2004) Cutback Asphalt (Rapid-Curing Type)
ASTM D 2844	(2007) Resistance R-Value and Expansion Pressure of Compacted Soils
ASTM D 3776	(2007) Mass Per Unit Area (Weight) of Fabric
ASTM D 3787	(2007) Bursting Strength of Textiles - Constant-Rate-of-Traverse (CRT), Ball Burst Test
ASTM D 3884	(2007) Abrasion Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)
ASTM D 4355	(2007) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	(1999a; R 2004e1) Water Permeability of Geotextiles by Permittivity
ASTM D 4533	(2004) Trapezoid Tearing Strength of Geotextiles

ASTM D 4595	(2005) Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4632	(1991; R 2003) Grab Breaking Load and Elongation of Geotextiles
ASTM D 4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D 4833	(2007) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D 4972	(2001; R 2007) pH of Soils
ASTM D 5034	(1995; R 2001) Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM D 5035	(2006) Breaking Force and Elongation of Textile Fabrics (Strip Method)
ASTM D 5268	(2007) Topsoil Used for Landscaping Purposes
ASTM D 5852	(2000; R 2007) Standard Test Method for Erodibility Determination of Soil in the Field or in the Laboratory by the Jet Index Method
ASTM D 648	(2007) Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position
ASTM D 6629	(2001; R 2007) Selection of Methods for Estimating Soil Loss by Erosion
ASTM D 698	(2007e1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))
ASTM D 977	(2005) Emulsified Asphalt

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R 1998) Federal Seed Act

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED	(2002; R 2005) Leadership in Energy and Environmental Design(tm) Green Building Rating System for New Construction (LEED-NC)

1.3 SYSTEM DESCRIPTION

The work consists of furnishing and installing temporary and permanent soil surface erosion control materials to prevent the pollution of air, water,

and land, including fine grading, blanketing, stapling, mulching, vegetative measures, structural measures, and miscellaneous related work, within project limits and in areas outside the project limits where the soil surface is disturbed from work under this contract at the designated locations. This work includes all necessary materials, labor, supervision and equipment for installation of a complete system. Coordinate this section with the requirements of Section 31 00 00 EARTHWORK . Complete backfilling the openings in synthetic grid systems and articulating cellular concrete block systems a maximum 7 days after placement to protect the material from ultraviolet radiation.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Work sequence schedule; G
Erosion control plan; G; (LEED)

SD-02 Shop Drawings

Layout;
Obstructions Below Ground;
Erosion Control;

Scale drawings defining areas to receive recommended materials as required by federal, state or local regulations.

Seed Establishment Period

Calendar time period for the seed establishment period. When there is more than one seed establishment period, the boundaries of the seeded area covered for each period shall be described.

Maintenance Record

Record of maintenance work performed, of measurements and findings for product failure, recommendations for repair, and products replaced.

SD-03 Product Data

Local/Regional Materials; (LEED)

Documentation indicating distance between manufacturing facility and the project site. Indicate distance of raw material origin from the project site. Indicate relative dollar value of local/regional materials to total dollar value of products included in project.

Geosynthetic Binders;
Recycled Plastic; (LEED)
Wood Cellulose Fiber; (LEED)
Paper Fiber; (LEED)

Mulch Control Netting and Filter Fabric; (LEED)
Hydraulic Mulch; ; (LEED)
Erosion Control Blankets Type XI; (LEED)
Geotextile Fabrics; ; (LEED)
Aggregate; (LEED)
Synthetic Grid Systems;
Articulating Cellular Concrete Block Systems;

Manufacturer's literature including physical characteristics, application and installation instructions. Documentation indicating percentage of post-industrial and post-consumer recycled content per unit of product. Indicate relative dollar value of recycled content products to total dollar value of products included in project.

Equipment

A listing of equipment to be used for the application of erosion control materials.

Finished Grade
Erosion Control Blankets

Condition of finish grade status prior to installation; location of underground utilities and facilities.

SD-04 Samples

Materials

a. Geosynthetic and synthetic binding material; 1 quart.

b. Standard mulch; 2 pounds.

c. Hydraulic mulch; 2 pounds.

d. Geotextile fabrics; 6 inch square.

e. Erosion control blankets; 6 inch square.

f. Synthetic grid systems; One sample grid.

g. Articulating cellular concrete block systems; 100 square feet area.

h. Two color charts displaying the colors and finishes for the articulating cellular block system.

SD-06 Test Reports

Geosynthetic Binders
Hydraulic Mulch
Geotextile Fabrics
Erosion Control Blankets
Synthetic Grid Systems
Articulating Cellular Concrete Block Systems

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and

interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

Sand
Gravel

Sieve test results. Sand shall be uniformly graded.

SD-07 Certificates

Fill Material
Mulch
Hydraulic Mulch
Geotextile Fabrics

Prior to delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following.

For items listed in this section:

a. Certification of recycled content or,

b. Statement of recycled content.

c. Certification of origin including the name, address and telephone number of manufacturer.

Geosynthetic Binders
Synthetic Soil Binders

Certification for binders showing EPA registered uses, toxicity levels, and application hazards.

Installer's Qualification

The installer's company name and address; training and experience and or certification.

Recycled Plastic

Individual component and assembled unit structural integrity test; creep tolerance; deflection tolerance; and vertical load test results. Life-cycle durability.

Seed

Classification, botanical name, common name, percent pure live seed, minimum percent germination and hard seed, maximum percent weed seed content, and date tested.

Asphalt Adhesive
Tackifier

Composition.

Wood By-Products

Composition, source, and particle size. Products shall be free from toxic chemicals or hazardous material.

Wood Cellulose Fiber

Certification stating that wood components were obtained from managed forests.

SD-10 Operation and Maintenance Data

Maintenance Instructions

Instruction for year-round care of installed material. The Contractor shall include manufacturer supplied spare parts.

SD-11 Closeout Submittals

Local/Regional Materials; (LEED)

LEED documentation relative to local/regional materials credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

Recycled Plastic; (LEED)

Wood Cellulose Fiber; (LEED)

Paper Fiber; (LEED)

Mulch Control Netting and Filter Fabric; (LEED)

Hydraulic Mulch; G (LEED)

Erosion Control Blankets Type XI; (LEED)

Geotextile Fabrics; G (LEED)

Aggregate; (LEED)

LEED documentation relative to recycled content credit in accordance with LEED Reference Guide. Include in LEED Documentation Notebook.

1.5 QUALITY ASSURANCE

1.5.1 Installer's Qualification

The installer shall be certified by the manufacturer for training and experience installing the material.

1.5.2 Erosion Potential

Assess potential effects of soil management practices on soil loss in accordance with ASTM D 6629. Assess erodibility of soil with dominant soil structure less than 2.8 to 3.1 inches in accordance with ASTM D 5852.

1.5.3 Substitutions

Substitutions will not be allowed without written request and approval from the Contracting Officer.

1.5.4 SUSTAINABLE DESIGN REQUIREMENTS

1.5.4.1 Local/Regional Materials

Use materials or products extracted, harvested, or recovered, as well as manufactured, within a [500][_____] mile radius from the project site, if available from a minimum of three sources.

1.5.4.2 Biobased Materials

Use biobased materials when feasible and as specified.

1.6 DELIVERY, STORAGE, AND HANDLING

Store materials in designated areas and as recommended by the manufacturer protected from the elements, direct exposure, and damage. Do not drop containers from trucks. Material shall be free of defects that would void required performance or warranty. Deliver geosynthetic binders and synthetic soil binders in the manufacturer's original sealed containers and stored in a secure area.

a. Furnish erosion control blankets and geotextile fabric in rolls with suitable wrapping to protect against moisture and extended ultraviolet exposure prior to placement. Label erosion control blanket and geotextile fabric rolls to provide identification sufficient for inventory and quality control purposes.

b. All synthetic grids, synthetic sheets, and articulating cellular concrete block grids shall be sound and free of defects that would interfere with the proper placing of the block or impair the strength or permanence of the construction. Minor cracks in synthetic grids and concrete cellular block, incidental to the usual methods of manufacture, or resulting from standard methods of handling in shipment and delivery, will not be deemed grounds for rejection.

c. Inspect seed upon arrival at the jobsite for conformity to species and quality. Seed that is wet, moldy, or bears a test date five months or older, shall be rejected.

1.7 SCHEDULING

Submit a construction work sequence schedule, with the state or local government approved erosion control plan a minimum of 30 days prior to start of construction. The work schedule shall coordinate the timing of land disturbing activities with the provision of erosion control measures to reduce on-site erosion and off-site sedimentation. Coordinate installation of temporary erosion control features with the construction of permanent erosion control features to assure effective and continuous control of erosion, pollution, and sediment deposition. Include a vegetative plan with planting and seeding dates and fertilizer, lime, and mulching rates. Distribute copies of the work schedule and erosion control plan to site subcontractors. Address the following in the erosion control plan:

a. Statement of erosion control and stormwater control objectives.

b. Description of temporary and permanent erosion control, stormwater control, and air pollution control measures to be implemented on site.

c. Description of the type and frequency of maintenance activities required for the chosen erosion control methods.

d. Comparison of proposed post-development stormwater runoff conditions with predevelopment conditions.

1.8 WARRANTY

Erosion control material shall have a warranty for use and durable condition for project specific installations. Temporary erosion control materials shall carry a minimum eighteen month warranty. Permanent erosion control materials shall carry a minimum three year warranty.

PART 2 PRODUCTS

2.1 RECYCLED PLASTIC

Recycled plastic shall contain a minimum 85 percent of recycled post-consumer product. Recycled material shall be constructed or manufactured with a maximum 1/4 inch deflection or creep in any member, according to ASTM D 648 and ASTM D 1248. The components shall be molded of ultraviolet (UV) and color stabilized polyethylene. The material shall consist of a minimum 75 percent plastic profile of high-density polyethylene, low-density polyethylene, and polypropylene raw material. The material shall be non-toxic and have no discernible contaminates such as paper, foil, or wood. The material shall contain a maximum 3 percent air voids and shall be free of splinters, chips, peels, buckling, and cracks. Material shall be resistant to deformation from solar heat gain.

2.2 BINDERS

2.2.1 Synthetic Soil Binders

Calcium chloride, or other standard manufacturer's spray on adhesives designed for dust suppression.

2.2.2 Geosynthetic Binders

Geosynthetic binders shall be manufactured in accordance with ASTM D 1560, ASTM D 2844; and shall be referred to as products manufactured for use as modified emulsions for the purpose of erosion control and soil stabilization. Emulsions shall be manufactured from all natural materials and provide a hard durable finish.

2.3 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region.

2.3.1 Straw

Straw shall be stalks from oats, wheat, rye, barley, or rice, furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment.

2.3.2 Hay

Hay shall be native hay, sudan-grass hay, broomsedge hay, or other herbaceous mowings, furnished in an air-dry condition suitable for placing with commercial mulch-blowing equipment.

2.3.3 Wood Cellulose Fiber

Wood cellulose fiber shall be 100 percent recycled material and shall not contain any growth or germination-inhibiting factors and shall be dyed with non-toxic, biodegradable dye an appropriate color to facilitate placement during application. Composition on air-dry weight basis: a minimum 9 to a maximum 15 percent moisture, and between a minimum 4.5 to a maximum 6.0 pH. See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. This item may contain post-consumer or post-industrial recycled content.

2.3.4 Paper Fiber

Paper fiber mulch shall be 100 percent post-consumer recycled news print that is shredded for the purpose of mulching seed. See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements.

2.3.5 Shredded Bark

Locally shredded material shall be treated to retard the growth of mold and fungi.

2.3.6 Wood By-Products

Wood locally chipped or ground bark shall be treated to retard the growth of mold and fungi. Gradation: A maximum 2 inch wide by 4 inch long.

2.3.7 Coir

Coir shall be manufactured from 100 percent coconut fiber cured in fresh water for a minimum of 6 months.

2.3.8 Asphalt Adhesive

Asphalt adhesive shall conform to the following: Emulsified asphalt, conforming to ASTM D 977, Grade SS-1; and cutback asphalt, conforming to ASTM D 2028, Designation RC-70.

2.3.9 Mulch Control Netting and Filter Fabric

Mulch control netting and filter fabric may be constructed of lightweight recycled plastic, cotton, or paper or organic fiber. The recycled plastic shall be a woven or nonwoven polypropylene, nylon, or polyester containing stabilizers and/or inhibitors to make the fabric resistant to deterioration from UV, and with the following properties:

a. Minimum grab tensile strength (TF 25 #1/ASTM D 4632), 180 pounds.

b. Minimum Puncture (TF 25 #4/ASTM D 3787), 75 psi in the weakest direction.

c. Apparent opening sieve size of a minimum 40 and maximum 80 (U.S.

Sieve Size).

d. Minimum Trapezoidal tear strength (TF 25 #2/ASTM D 4533), 50 pounds.

2.3.10 Hydraulic Mulch

Hydraulic mulch shall be made of 100 percent recycled material. Wood shall be naturally air-dried to a moisture content of 10.0 percent, plus or minus 3.0 percent. A minimum of 50 percent of the fibers shall be equal to or greater than 0.15 inch in length and a minimum of 75 percent of the fibers shall be retained on a 28 mesh screen. No reprocessed paper fibers shall be included in the hydraulic mulch. Hydraulic mulch shall have the following mixture characteristics:

CHARACTERISTIC (typical)	VALUE
pH	5.4 ± 0.1
Organic Matter (oven dried basis),	percent 99.3 within ± 0.2
Inorganic Ash (oven dried basis),	percent 0.7 within ± 0.2
Water Holding Capacity,	percent 1,401

2.3.11 Tackifier

Tackifier shall be a blended polyacrylimide material with non-ionic galactomannan of Gramineae endosperm in powder and crystalline form with molecular weights over 250,000. Tackifier shall be pre-packaged in the hydraulic mulch at the rate of 12 ounces per lb of wood fiber.

2.3.12 Dye

Dye shall be a water-activated, green color. Pre-package dye in water dissolvable packets in the hydraulic mulch.

2.4 GEOTEXTILE FABRICS

Geotextile fabrics shall be woven of polyester filaments formed into a stable network so that the filaments retain their relative position to each other. See Section 01 33 29 LEED(tm) DOCUMENTATION for cumulative total recycled content requirements. Geotextile fabric may contain post-consumer or post-industrial recycled content. Sewn seams shall have strength equal to or greater than the geotextile itself. Install fabric to withstand maximum velocity flows as recommended by the manufacturer. The geotextile shall conform to the following minimum average roll values:

Property	Performance	Test Method
Weight		ASTM D 3776
Thickness		ASTM D 1777
Permeability		ASTM D 4491
Abrasion Resistance,	58 percent X	
Type (percent strength retained)	81 percent	ASTM D 3884
Tensile Grab Strength	1,467 N X 1, 933 N	ASTM D 4632
Grab Elongation	15percent X 20percent	ASTM D 4632
Burst Strength	5,510 kN/m^2	ASTM D 3787
Puncture Strength	733 N	ASTM D 4833
Trapezoid Tear	533 N X 533 N	ASTM D 4533

Property	Performance	Test Method
Apparent Opening Size	40 US Std Sieve	ASTM D 4751
UV Resistance @ 500 hrs	90 percent	ASTM D 4355

2.5 EROSION CONTROL BLANKETS

2.5.1 Erosion Control Blankets Type I

Use Type I blankets for erosion control and vegetation establishment on roadside embankments, abutments, berms, shoulders, and median swales where natural vegetation will provide long term stabilization. Erosion control blankets shall be a machine-produced mat of 100% straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top side with a photodegradable polypropylene netting having an approximate 1/2 by 1/2 inch mesh and be sewn together on a maximum 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately 0.50 lb/yd^2 weight
Netting	One side only, lightweight photodegradable with approximately 1.64 lb/1,000 ft^2 weight.
Thread	Degradable

Note 1: Photodegradable life a minimum of 2 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 3:1 gradient.

2.5.2 Erosion Control Blankets Type II

Erosion control blankets shall be a machine-produced mat of 100 percent straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top side with a polypropylene netting having an approximate 1/2 by 1/2 inch mesh with photodegradable accelerators to provide breakdown of the netting within approximately 45 days, depending upon geographic location and elevation. Sew the blanket together on a maximum 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately 0.50 lb/yd^2 weight.
Netting	One side only, photodegradable with photo accelerators and approximately 1.64 lb/1,000 ft^2 weight.
Thread	Degradable

NOTE: Photodegradable life a minimum of 10 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 3:1

Material Content
gradient.

2.5.3 Erosion Control Blankets Type III

Type III blankets shall be used for erosion control and vegetation establishment on roadside embankments, abutments, berms, shoulders, and median swales where natural vegetation will provide long term stabilization. Erosion control blanket shall be a machine-produced mat consisting of 70 percent straw and 30 percent coconut fiber. The blanket shall be of consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat. Cover the blanket on the top side with heavyweight photodegradable polypropylene netting having UV additives to delay breakdown and an approximate 5/8 by 5/8 inch mesh, and on the bottom side with a lightweight photodegradable polypropylene netting with an approximate 1/2 by 1/2 inch mesh. Sew the blanket together on 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	70 percent by approximately 0.35 lb/yd^2.
Coconut Fiber	30 percent by approximately 0.15 lb/yd^2 weight.
Netting	Top side heavyweight photodegradable with UV additives and approximately 3 lb/1,000 ft^2 weight Bottom side lightweight photodegradable with approximately 1.64 lb/1,000 ft^2 weight.

NOTE: Photodegradable life a minimum of 10 months with a minimum 90 percent light penetration. Apply to slopes with a gradient less than 1.5:1.

2.5.4 Erosion Control Blankets Type IV

Erosion control blanket shall be a machine-produced mat of 100 percent straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top and bottom sides with lightweight photodegradable polypropylene netting having an approximate 1/2 by 1/2 inch mesh. Sew the blanket together on 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately 0.5 lb/yd^2 weight.
Netting	Both sides lightweight photodegradable with approximately 1.64 lb/1,000 ft^2

Material Content
weight.

Thread Degradable

NOTE: Photodegradable life a minimum of 2 months with a minimum 90 percent light penetration. Apply to slopes with a gradient of less than 1.5:1.

2.5.5 Erosion Control Blankets Type V

Erosion control blanket shall be a machine-produced mat of 100 percent straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top side with polypropylene netting having an approximate 1/2 by 1/2 inch mesh with photodegradable accelerators to provide breakdown of the netting within approximately 45 days, depending upon geographic location and elevation. Cover the bottom with a polypropylene netting having an approximate 1/2 by 1/2 inch mesh with photo accelerators. Sew the blanket together on 1.5 inch centers with degradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately 0.5 lb/yd^2 weight.
Netting	Top side lightweight photodegradable with photo accelerators with approximately 1.64 lb/1,000 ft^2 weight.
Thread	Bottom side lightweight photodegradable with photo accelerators and approximately 1.64 lb/1,000 ft^2 weight.

NOTE: Photodegradable life a minimum of 10 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 2:1 gradient.

2.5.6 Erosion Control Blankets Type VI

Erosion control blanket shall be a machine-produced 100 percent biodegradable mat with a 100 percent straw fiber matrix. The blanket shall be of consistent thickness with the straw fiber evenly distributed over the entire area of the mat. Cover the blanket on the top side with a 100 percent biodegradable woven natural organic fiber netting. The netting shall consist of machine directional strands formed from two intertwined yarns with cross directional strands interwoven through the twisted machine strands (commonly referred to as a Leno weave) to form an approximate 1/2 by 1/2 inch mesh. Sew the blanket together with biodegradable thread on 1.5 inch centers. The erosion control blanket shall have the following properties:

Material Content

Matrix	100 percent straw fiber with approximately 0.50 lb/yd^2 weight

Material Content

Netting	One side only, Leno woven 100% biodegradable natural organic fiber
Weight	approximately 9.3 lb/1,000 ft.
Thread	Biodegradable

NOTE: Photodegradable life a minimum of 10 months with a minimum 90 Percent light penetration. Apply to slopes up to a maximum 2:1 gradient.

2.5.7 Erosion Control Blankets Type VII

Erosion control blanket shall be a machine-produced 100 percent biodegradable mat with an herbaceous straw fiber matrix. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top and bottom sides with 100 percent biodegradable woven natural fiber netting. The netting shall consist of machine directional strands formed from two intertwined yarns with cross directional strands interwoven through the twisted machine strands (commonly referred to as a Leno weave) to form an approximate 1/2 by 1/2 inch mesh. Sew the blanket together with biodegradable thread on 1.5 inch centers. The blanket shall have the following properties:

Material Content

Straw	100 percent straw fiber with approximately 0.5 lb/yd^2 weight.
Netting	Top and bottom sides,Leno woven 100% biodegradable natural organic fiber with approximately 9.3 lb/1,000ft^2 weight.
Thread	Biodegradable

Note: Photodegradable life a minimum of 18 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 1.5:1 gradient.

2.5.8 Erosion Control Blankets Type VIII

Erosion control blanket shall be a machine-produced 100 percent biodegradable mat with a 70 percent herbaceous straw and 30 percent coconut fiber blend matrix. The blanket shall be of consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the mat. Cover the blanket on the top and bottom sides with 100 percent biodegradable woven natural organic fiber netting. The netting shall consist of machine directional strands formed from two intertwined yarns with cross directional strands interwoven through the twisted machine strands (commonly referred to as a Leno weave) to form an approximate 1/2 by 1/2 inch mesh. Sew the blanket together with biodegradable thread on 1.5 inch centers. Straw/Coconut fiber erosion control blanket shall have the following properties:

Material Content

Matrix	70 percent straw fiber with approximately . 0.35 lb/yd^2 weight. 30 percent coconut fiber cured in fresh water with approximately 0.15 lb/yd^2 weight.
Netting	Both sides woven 100% biodegradable natural organic fiber with approximately 9.3 lbs/1,000 ft^2 weight.
Thread	Biodegradable

NOTE: Photodegradable life a minimum of 24 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 1.5:1 gradient.

2.5.9 Erosion Control Blankets Type IX (Turf Reinforcement Mat)

Permanent erosion control/turf reinforcement mat is constructed of 100 percent coconut fiber stitch bonded between a heavy duty UV stabilized bottom net, and a heavy duty UV stabilized cuspated (crimped) middle netting overlaid with a heavy duty UV stabilized top net. The cuspated netting forms prominent closely spaced ridges across the entire width of the mat. The three nettings are stitched together on 1.5 inch centers with UV stabilized polypropylene thread to form a permanent three dimensional structure. The following list contains further physical properties of the turf erosion control mat.

Property	Test Method	Value	Units
Ground Cover	Image Analysis	93	percent
Thickness	ASTM D 1777		0.63 in
Mass Per Unit Area	ASTM D 3776		0.92 lb/sy
Tensile Strength	ASTM D 5035		480 lb/ft
Elongation	ASTM D 5035		percent
Tensile Strength	ASTM D 5035		960 lb/ft
Elongation	ASTM D 5035	31	percent
Tensile Strength	ASTM D 5034	ASTM D 5035	177 lbs
Elongation	ASTM D 5034	ASTM D 5035	22 percent
Resiliency	ASTM D 1777	greater than 80	percent
UV Stability*	ASTM D 4355		151 lbs
		86	percent
Color(permanent net)		UV Black	
Porosity(permanent net)Calculated		greater than 95	percent
Minimum Filament Measured Diameter (permanent net)			0.03 in

NOTE 1: *ASTM D 5034 ASTM D 5035 Tensile Strength and percent Strength Retention of material after 1000 hours of exposure in Xenon-Arc Weatherometer

NOTE 2: Photodegradable life a minimum of 36 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 1:1

Property	Test Method	Value	Units

gradient.

2.5.10 Erosion Control Blankets Type X (Turf Reinforcement Mat)

Permanent erosion control/turf reinforcement mat shall be constructed of 100 percent UV stabilized high denier polypropylene fiber sewn between a black UV stabilized 1/2 inch mesh polypropylene netting on the top 5 lbs/1000 square ft and a black UV stabilized 5/8 inch mesh polypropylene netting on the bottom 3 lbs/1000 square ft with polypropylene thread. The mat shall be resistant to photo and chemical degradation. The following list contains further physical properties of the turf reinforcement mat.

Property	Test Method	Value	Units
Thickness	ASTM D 1777		0.56 in
Resiliency	100 PSI-3 cycles	94	percent
Mass Per Unit Area	ASTM D 3776		11.2 oz/sq yd
Tensile Strength	ASTM D 4632		35.2 lbs
Elongation	ASTM D 4632	25.5	percent
Tensile Strength	ASTM D 4595		259.2 lbs/ft
Elongation	ASTM D 4595	20.9	percent
Tensile Strength	ASTM D 5035		300 lbs/ft
Elongation	ASTM D 5035	51	percent
Tensile Strength	ASTM D 5034 ASTM D 5035		89 lbs
Elongation	ASTM D 5034 ASTM D 5035	21	percent
UV Stability*	ASTM D 4355		81* lbs
		90*	percent

NOTE 1: *ASTM D 5034 ASTM D 5035 Tensile Strength and percent Strength Retention of material after 1000 hours of exposure in Xenon-Arc Weatherometer.

NOTE 2: Photodegradable life a minimum of 36 months with a minimum 90 percent light penetration. Apply to slopes up to a maximum 1:1 gradient.

2.5.11 Erosion Control Blankets Type XI (Re-vegetation Mat)

Seed-incorporated blanket option shall consist of 2-ply 100 percent recycled, unbleached, cellulose tissue. Uniformly distribute a seed mix upon the bottom ply of cellulose tissue and fully overlaid with a top cellulose ply to provide complete envelopment of the seed layer. Sew the seed-incorporated cellulose medium to the bottom side of the specified erosion control blanket.

Material Content

Top ply 1-ply 100 percent recycled unbleached cellulose tissue with approximately 4.3 lbs/1,000 ft^2 weight.

Seed 0.033 lbs/yd^2 (160 lbs/acre)

0.017 lbs/yd^2 (80 lbs/acre)

Bottom ply 1-ply recycled unbleached cellulose issue with approximately 4.3 lbs/(1,000 ft^2)

Material Content
weight.

NOTE: Photodegradable life a minimum of 36 months with a minimum 90 percent light penetration. Apply to slopes up to a minimum 1:1 gradient.

2.5.12 Erosion Control Blankets Type XII (Compost Mat)

Compost blanket shall consist of a layer of 100 percent biobased stable and mature compost uniformly distributed to a depth of 3/4 to 3 inches along slopes with erosion potential. Compost shall encourage plant growth and seed shall be applied following compost application. The blanket shall have the following properties:

Parameter	Range
Particle size	3/8-1/2 inch sieve and 2-3 inch sieve (ratio = 3:1)
Moisture content	20% - 50%
Soluble salt	3.0 - 6.0 mmhos/cm
Organic matter	40% - 70%
pH	6.0 - 8.0
Nitrogen content	0.5% - 2.0%
Human made inerts	0.0% - 1.0%

2.5.13 Seed

2.5.13.1 Seed Classification

State-certified native seed mix of the latest season's crop shall be provided in original sealed packages bearing the producer's guaranteed analysis for percentages of mixture, purity, germination, hard seed, weed seed content, and inert material. Conform labels to the AMS Seed Act and applicable state seed laws. Submit the Seed Establishment Period information as specified in the Submittals paragraph.

2.5.13.2 Permanent Seed Species and Mixtures

Proportion permanent seed species and mixtures by weight as follows:

Mixture Percent by Weight	Percent Pure Live Seed	Botanical Name	Common Name
12	12	12	12

2.5.13.3 Quality

Weed seed shall be a maximum 1 percent by weight of the total mixture.

2.5.14 Staking

Stakes shall be 100 percent biodegradable manufactured from recycled plastic or wood and shall be designed to safely and effectively secure erosion control blankets for temporary or permanent applications. The biodegradable stake shall be fully degradable by biological activity within a reasonable time frame. The bio-plastic resin used in production of the biodegradable stake shall consist of polylactide, a natural, completely

biodegradable substance derived from renewable agricultural resources. The biodegradable stake must exhibit ample rigidity to enable being driven into hard ground, with sufficient flexibility to resist shattering. Serrate the biodegradable stake on the leg to increase resistance to pull-out from the soil. The biodegradable stake shall have the following dimensions: 2,2,3.

2.5.15 Staples

Staples shall be as recommended by the manufacturer.

2.6 SYNTHETIC GRID AND SHEET SYSTEMS

Synthetic grid and sheet systems shall be formed of recycled plastic in accordance with paragraph RECYCLED PLASTICS and have interlocking components to form a uniform underlayment or strata to receive fill.

2.6.1 Synthetic Grid Systems

Grids shall be made of modular interlocking components. Form blocks as rigid interlocking components or as expandable sheets and manufacture to allow articulation upward and downward while restricting lateral movement. The assembled grid system shall articulate over three-directional vertical curves, both upward and downward. Nominal grid thickness shall be 12 inches, or as indicated. Each pair of grids shall cover approximately 15 square feet. Provide 100 percent coverage of the area with the cells back filled.

2.6.2 Synthetic Sheet System

Synthetic sheet thickness shall be 1 inches, or as indicated.

2.7 SEDIMENT FENCING

Wood or burlap.

2.8 COMPOST FILTER BERMS

Compost berms shall consist of 100 percent biobased trapezoidal-shaped compost piles arranged across slopes. Berms shall have the following properties:

Parameter	Range
Particle size	3/8-1/2 inch sieve and 2-3 inch sieve (ratio = 1:1)
Moisture content	20% - 50%
Soluble salt	4.0 - 6.0 mmhos/cm
Organic matter	40% - 70%
pH	6.0 - 8.0
Nitrogen content	0.5% - 2.0%
Human made inerts	0.0% - 1.0%
Size	1 - 2 feet H x 2.5 - 4 feet W

2.9 AGGREGATE

Recycled crushed concrete shall be free of steel, free-draining and graded between a minimum 3/4 inch and a maximum 1.5 inches. Crushed rock shall be crushed run between a minimum 12 inches and a maximum 12 inches. Gravel shall be river run between a minimum 12 inches and a maximum 12 inches. Submit sieve test results for both gravel and sand.

2.10 ARTICULATING CELLULAR CONCRETE BLOCK SYSTEMS

Blocks shall be made of portland cement concrete, with no reinforcement, and shall be cast using block manufacturing equipment with vibratory compaction processes (dry cast). Blocks shall be made of modular interlocking components. Cast blocks in pairs of "lock" and "key" blocks with each "lock" block having recesses and with each "key" block interlocking knobs. Manufacture blocks to allow articulation upward and downward while restricting lateral movement. The assembled block system shall articulate over three-directional vertical curves, both upward and downward.

a. Nominal block thickness shall be 12 inches, or as indicated.

b. Block weights, per pair of "key" and "lock" blocks, shall be approximately 1 pounds for 12 inch, thick blocks.

c. Compressive strength testing of blocks, per ASTM C 39/C 39M, shall be performed on cylinders cut from random block samples in general conformance with ASTM C 42/C 42M.

d. The average absorption of block samples shall be not greater than 7 percent, with no individual sample greater than 8 percent, in accordance with ASTM C 140.

2.11 WATER

Unless otherwise directed, water is the responsibility of the Contractor. Water shall be collected rainwater or supplied by an existing irrigation system.

PART 3 EXECUTION

3.1 WEATHER CONDITIONS

Perform erosion control operations under favorable weather conditions; when excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped as directed. When special conditions warrant a variance to earthwork operations, submit a revised construction schedule for approval. Do not apply erosion control materials in adverse weather conditions which could affect their performance.

3.1.1 Finished Grade

Verify that finished grades are as indicated on the drawings; complete finish grading and compaction in accordance with Section 31 00 00 EARTHWORK, prior to the commencement of the work. Verify and mark the location of underground utilities and facilities in the area of the work. Repair damage to underground utilities and facilities at the Contractor's expense.

3.1.2 Placement of Erosion Control Blankets

Before placing the erosion control blankets, ensure the subgrade has been graded smooth; has no depressed, void areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter. Verify that mesh does not include invasive species. Vehicles will not be permitted directly on the blankets.

3.1.3 Synthetic Grid

Before placing the grid system, ensure that the subgrade has been properly grubbed of large roots and rocks; compacted; has been graded smooth; has no depressed, void, soft or uncompacted areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter; and has been seeded.

3.1.4 Concrete Cellular Block

Before placing geotextile fabric under cellular block, ensure that the subgrade has been properly compacted; has been graded smooth; has no depressed, void, soft or uncompacted areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter; and has been seeded. Compact subgrade compaction to at least 90 percent of the maximum dry density at optimum moisture content, as determined by ASTM D 698, with a tolerance of plus or minus 1 inch of the design elevation.

3.2 SITE PREPARATION

3.2.1 Soil Test

Test soil in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size and mechanical analysis. Sample collection onsite shall be random over the entire site. The test shall determine the soil particle size as compatible for the specified material.

3.2.2 Layout

Erosion control material locations may be adjusted to meet field conditions. When soil tests result in unacceptable particle sizes, a shop drawing shall be submitted indicating the corrective measures.

3.2.3 Protecting Existing Vegetation

When there are established lawns in the work area, the turf shall be covered and/or protected or replaced after construction operations. Identify existing trees, shrubs, plant beds, and landscape features that are to be preserved on site by appropriate tags and barricade with reusable, high-visibility fencing along the dripline. Mitigate damage to existing trees at no additional cost to the Government. Damage shall be assessed by a state certified arborist or other approved professional using the National Arborist Association's tree valuation guideline.

3.2.4 Obstructions Below Ground

When obstructions below ground affect the work, submit shop drawings showing proposed adjustments to placement of erosion control material for approval.

3.3 INSTALLATION

Immediately stabilize exposed soil using compost, . Stabilize areas for construction access immediately as specified in the paragraph Construction Entrance. Install principal sediment basins and traps before any major site grading takes place. Provide additional sediment traps and sediment fences as grading progresses. Provide inlet and outlet protection at the ends of new drainage systems. Remove temporary erosion control measures at

the end of construction and provide permanent seeding.

3.3.1 Construction Entrance

Provide as indicated on drawings, a minimum of 6 inches thick, at points of vehicular ingress and egress on the construction site. Construction entrances shall be cleared and grubbed, and then excavated a minimum of 3 inches prior to placement of the filter fabric and aggregate. The aggregate shall be placed in a manner that will prevent damage and movement of the fabric. Place fabric in one piece, where possible. Overlap fabric joints a minimum of 12 inches.

3.3.2 Compost Filter Berms

Place compost filter berm uncompacted on bare soil as indicated on drawings, parallel to base of slope, and according to manufacturer recommendations. Place second berm in the same manner at top of slope parallel to first berm. When no longer required, berm material may be left to decompose naturally, or distributed over an adjacent area for use as a soil amendment or ground cover.

3.3.3 Synthetic Binders

Apply synthetic binders heaviest at edges of areas and at crests of ridges and banks to prevent displacement. Apply binders to the remainder of the area evenly at the rate of 12 or as recommended by the manufacturer.

3.3.4 Seeding

When seeding is required prior to installing mulch on synthetic grid systems verify that seeding will be completed in accordance with Sections 31 00 00 EARTHWORK and 32 92 19 SEEDING.

3.3.5 Mulch Installation

install mulch in the areas indicated. Apply mulch evenly at the rate of 1 Square per yard.

3.3.6 Mulch Control Netting

Netting may be stapled over mulch according to manufacturer's recommendations.

3.3.7 Mechanical Anchor

Mechanical anchor shall be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

3.3.8 Asphalt Adhesive Tackifier

Asphalt adhesive tackifier shall be sprayed at a rate between 10 to 13 gallons/1000 square feet. Do no completely exclude sunlight from penetrating to the ground surface.

3.3.9 Non-Asphaltic Tackifier

Apply hydrophilic colloid at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. Apply

a uniform mixture over the area.

3.3.10 Asphalt Adhesive Coated Mulch

Hay or straw mulch may be spread simultaneously with asphalt adhesive applied at a rate between 10 to 13 gallons/1000 square feet, using power mulch equipment equipped with suitable asphalt pump and nozzle. Apply the adhesive-coated mulch evenly over the surface. Do not completely exclude sunlight from penetrating to the ground surface.

3.3.11 Wood Cellulose Fiber, Paper Fiber, and Recycled Paper

Apply wood cellulose fiber, paper fiber, or recycled paper as part of the hydraulic mulch operation.

3.3.12 Hydraulic Mulch Application

3.3.12.1 Unseeded Area

Install hydraulic mulch as indicated and in accordance with manufacturer's recommendations. Mix hydraulic mulch with water at the rate recommended by the manufacturer for the area to be covered. Mixing shall be done in equipment manufactured specifically for hydraulic mulching work, including an agitator in the mixing tank to keep the mulch evenly disbursed.

3.3.12.2 Seeded Area

For drill or broadcast seeded areas, apply hydraulic mulch evenly at the rate of 1 per square yard. For hydraulic seeded areas, apply mulch at the rate of 1 per square yard with the seed and fertilizer, and at the rate of 1 per square yard in a second application of mulch only.

3.3.13 Erosion Control Blankets

a. Install erosion control blankets as indicated and in accordance with manufacturer's recommendations. The extent of erosion control blankets shall be as shown on drawings.

b. Orient erosion control blankets in vertical strips and anchored with staples, as indicated. Abut adjacent strips to allow for installation of a common row of staples. Overlap horizontal joints between erosion control blankets sufficiently to accommodate a common row of staples with the uphill end on top.

c. Where exposed to overland sheet flow, locate a trench at the uphill termination. Staple the erosion control blanket to the bottom of the trench. Backfill and compact the trench as required.

d. Where terminating in a channel containing an installed blanket, the erosion control blanket shall overlap installed blanket sufficiently to accommodate a common row of staples.

3.3.14 Synthetic Sheet System

Anchor synthetic sheet systems in accordance with the manufacturer's recommendation. Place systems on a well graded surface and then backfill, a maximum seven days after placement, to protect the material from ultraviolet radiation. Include contiguous perimeter termination trenches as the installation progresses.

3.3.14.1 Sheet System Revegetation

For areas not requiring re-vegetation, backfill openings to grade with well graded fill material and surface prepared for finish as indicated on the drawings. For areas requiring re-vegetation, backfill openings using well graded fill and topsoil as indicated on the drawings.

3.3.14.2 Sheet System Grids

Each pair of grids shall cover grade without gaps or open spaces between them. Provide 100 percent coverage of the area with the cells backfilled.

3.3.14.3 Sheet System Seeding

Install seed in accordance with Section 32 92 19 SEEDING.

3.3.14.4 Grid System Grids

Anchor synthetic grid systems in accordance with the manufacturer's recommendation. Place interlocking grid systems on well graded surface. Complete the backfilling of openings a maximum 7 days after placement to protect the material from ultraviolet radiation. As the installation progresses, backfilling shall include contiguous perimeter termination trenches.

3.3.15 Grids

3.3.15.1 Grid System Revegetation

For areas not requiring re-vegetation, backfill openings with a minimum 1/2 inch nominal size crushed rock, to a minimum 2 inch depth.

3.3.15.2 Synthetic Grids

Each pair of grids shall cover grade without gaps or open spaces between them. The system shall provide 100 percent coverage of the area with the cells backfilled.

3.3.15.3 Grid System Seeding

Install seed in accordance with Section 32 92 19 SEEDING.

3.3.16 Articulating Cellular Concrete Block System Installation

Underlay block installation with geotextile fabric in accordance with the manufacturer's recommendation. Begin block installation from a straight-line oriented perpendicular to the direction of lay, and proceed toward an open area and not toward a point of fixity. Install blocks with the bottom side down. Continue to lay blocks in straight-lines to maintain the interlock characteristic. To maintain straight-lines, no more than two rows of blocks shall be started at a time. The extent of blocks shall include the perimeter termination trenches and shall be as shown on the drawings. Each pair of "key" and "lock" blocks shall cover a minimum 1 square feet, including uncovered openings between the blocks. Provide a minimum 10 percent coverage of the area with blocks, leaving a minimum 1 percent uncovered area at the ground surface. For installation purposes, the bottom of the block is the side with a flat unformed surface.

3.3.16.1 Concrete Grout

When abutting structures, such as culverts, piers and bridge abutments, furnish and install concrete grout full-depth in the void between the blocks and penetrations. Install grout as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.3.16.2 Toe Protection

Where exposed to hydraulic forces, the perimeter of the block system shall be turned into and buried beneath the adjacent ground level to a minimum 12 inch depth or as directed. Where not exposed to hydraulic forces, place the perimeter of the geotextile in a minimum 12 inch deep trench with the blocks flush with the adjacent surface. Excavate trenches as required for perimeter termination.

3.3.16.3 Backfilling Cellular Block System

Complete backfilling of openings between blocks a maximum of 7 days after placement of the filter, to protect the geotextile from ultraviolet radiation. As the installation progresses, backfilling shall include contiguous perimeter termination trenches.

3.3.16.4 Block System Revegetation

For areas not requiring revegetation, backfill openings with a minimum 1/4 inch nominal size crushed rock to a minimum 2 inch depth or as otherwise specified, regardless of block thickness. For areas requiring revegetation as indicated, backfill openings with topsoil as specified.

3.3.16.5 Seeding, Fertilizing, Mulching

Install seed in accordance with Section 32 92 19 SEEDING.

3.3.17 Sediment Fencing

Install posts at the spacing indicated on drawings and at an angle between 2 degrees and 20 degrees towards the potential silt load area. Sediment fence height shall be approximately 16 inches. Do not attach filter fabric to existing trees. Secure filter fabric to the post and wire fabric using staples, tie wire, or hog rings. Imbed the filter fabric into the ground as indicated on drawings. Splice filter fabric at support pole using a 6 inches overlap and securely seal.

3.4 CLEAN-UP

Dispose of excess material, debris, and waste materials offsite at an approved landfill or recycling center. Clear adjacent paved areas. Immediately upon completion of the installation in an area, protect the area against traffic or other use by erecting barricades and providing signage as required, or as directed.

3.5 WATERING SEED

Start watering immediately after installing erosion control blanket type XI (revegetation mat). Apply water to supplement rainfall at a sufficient rate to ensure moist soil conditions to a minimum 1 inch depth. Prevent run-off and puddling. Do no drive watering trucks over turf areas, unless otherwise directed. Prevent watering of other adjacent areas or plant

material.

3.6 MAINTENANCE RECORD

Furnish a record describing the maintenance work performed, record of measurements and findings for product failure, recommendations for repair, and products replaced.

3.6.1 Maintenance

Maintenance shall include eradicating weeds; protecting embankments and ditches from surface erosion; maintaining the performance of the erosion control materials and mulch; protecting installed areas from traffic.

3.6.2 Maintenance Instructions

Furnish written instructions containing drawings and other necessary information, describing the care of the installed material; including, when and where maintenance should occur, and the procedures for material replacement.

3.6.3 Patching and Replacement

Unless otherwise directed, material shall be placed, seamed or patched as recommended by the manufacturer. Remove material not meeting the required performance as a result of placement, seaming or patching from the site. Replace the unacceptable material at no additional cost to the Government.

3.7 SATISFACTORY STAND OF GRASS PLANTS

When erosion control blanket type XI (revegetation mat) is installed, evaluate the grass plants for species and health when the grass plants are a minimum 1 inch high. A satisfactory stand of grass plants from the revegetation mat area shall be a minimum 10 grass plants per square foot. The total bare spots shall not exceed 2 percent of the total revegetation mat area.

-- End of Section --

SECTION 32 12 17

HOT MIX BITUMINOUS PAVEMENT
04/08

PART 1 GENERAL

1.1 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.

ASPHALT INSTITUTE (AI)

AI MS-02	(6th Edition; 1997) Mix Design Methods for Asphalt

ASTM INTERNATIONAL (ASTM)

ASTM C 117	(2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	(2007) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C 128	(2007a) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C 131	(2006)Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 188	(1995; R 2003) Standard Test Method for Density of Hydraulic Cement
ASTM C 29/C 29M	(2007) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C 88	(2005) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D 1073	(2007) Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	(2007) Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

ASTM D 140	(2001; R 2007) Sampling Bituminous Materials
ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2041	(2003a) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 2172	(2005) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D 242	(2004) Mineral Filler for Bituminous Paving Mixtures
ASTM D 2726	(2005a) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D 4867/D 4867M	(2004) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D 546	(2005) Sieve Analysis of Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	(2000; R 2004) Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 70	(2008) Specific Gravity and Density of Semi-Solid Bituminous Materials (Pycnometer Method)
ASTM D 75	(2003) Standard Practice for Sampling Aggregates
ASTM D 854	(2006e1) Specific Gravity of Soil Solids by Water Pycnometer
ASTM D 946	(1982; R 2005) Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 979	(2001; R 2006e1) Sampling Bituminous Paving Mixtures
ASTM D 995	(1995b; R 2002) Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Bituminous pavement

SD-05 Design Data

Job-mix formula

Submit a job-mix formula, prepared specifically for this project within one year of submittal for roads, for approval by the Government prior to preparing and placing the bituminous mixture. Design mix using procedures contained in Chapter V, Marshall Method of Mix Design, of AI MS-02. Formulas shall indicate physical properties of the mixes as shown by tests made by a commercial laboratory approved by the Contracting Officer, using materials identical to those to be provided on this project. Submit formulas with material samples. Job-mix formula for each mixture shall be in effect until modified in writing by the Contractor and approved by the Contracting Officer. Provide a new job-mix formula for each source change. Submittal shall include all tests indicated in MIX DESIGN section of this specification.

ASPHALT CEMENT BINDER

MIX DESIGN

SD-06 Test Reports

Specific gravity test of asphalt

Coarse aggregate tests

Weight of slag test

Percent of crushed pieces in gravel

Fine aggregate tests

Specific gravity of mineral filler

Bituminous mixture tests

Aggregates tests

Bituminous mix tests

Pavement courses

Submit in accordance with paragraph entitled "Mock-Up Test Section."

1.3 QUALITY ASSURANCE

1.3.1 Safety Requirements

Provide adequate and safe stairways with handrails to the mixer platform, and safe and protected ladders or other means for accessibility to plant operations. Guard equipment and exposed steam or other high temperature lines or cover with a suitable type of insulation.

1.3.2 Required Data

Job-mix formula shall show the following:

a. Source and proportions, percent by weight, of each ingredient of the mixture;

b. Correct gradation, the percentages passing each size sieve listed in the specifications for the mixture to be used, for the aggregate and mineral filler from each separate source and from each different size to be used in the mixture and for the composite mixture;

c. Amount of material passing the No. 200 sieve determined by dry sieving;

d. Number of blows of hammer compaction per side of molded specimen;

e. Temperature viscosity relationship of the asphalt cement;

f. Stability, flow, percent voids in mineral aggregate, percent air voids, unit weight;

g. Asphalt absorption by the aggregate;

h. Effective asphalt content as percent by weight of total mix;

i. Temperature of the mixture immediately upon completion of mixing;

j. Asphalt performance grade viscosity grade ; and

k. Curves for the leveling wearing courses.

1.3.3 Charts

Plot and submit, on a grain size chart, the specified aggregate gradation band, the job-mix gradation and the job-mix tolerance band.

1.3.4 Selection of Optimum Asphalt Content

Base selection on percent of total mix and the average of values at the following points on the curves for each mix:

a. Stability: Peak

b. Unit Weight: Peak

c. Percent Air Voids: Median

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for damage and store with a minimum of handling. Store aggregates in such a manner as to prevent segregation, contamination, or intermixing of the different aggregate sizes.

1.5 ENVIRONMENTAL CONDITIONS

Place bituminous mixture only during dry weather and on dry surfaces. Place courses only when the surface temperature of the underlying course is

greater than 45 degrees F for course thicknesses greater than one inch and 55 degrees F for course thicknesses one inch or less.

1.6 CONSTRUCTION EQUIPMENT

Calibrated equipment, such as scales, batching equipment, spreaders and similar equipment, shall have been recalibrated by a calibration laboratory approved by the Contracting Officer within 12months of commencing work.

1.6.1 Mixing Plant

Design, coordinate, and operate the mixing plant to produce a mixture within the job-mix formula tolerances and to meet the requirements of ASTM D 995, including additional plant requirements specified herein. The plant shall be a batch type, continuous mix type or drum-dryer mixer type, and shall have sufficient capacity to handle the new bituminous construction. Minimum plant capacity shall be [100] [_____] tons per hour. The mixing plant and equipment shall remain accessible at all times for inspecting operation, verifying weights, proportions and character of materials, and checking mixture temperatures.

1.6.1.1 Cold Aggregate Feeder

Provide plant with a feeder or feeders capable of delivering the maximum number of aggregate sizes required in their proper proportion. Provide adjustment for total and proportional feed and feeders capable of being locked in any position. When more than one cold elevator is used, feed each elevator as a separate unit and install individual controls integrated with a master control.

1.6.1.2 Dryer

Provide rotary drum-dryer which continuously agitates the mineral aggregate during the heating and drying process. When one dryer does not dry the aggregate to specified moisture requirements, provide additional dryers.

1.6.1.3 Plant Screens and Bins for Batch and Continuous Mix Plants

Use screen to obtain accurate gradation and allow no bin to contain more than 10 percent oversize or undersize. Inspect screens each day prior to commencing work for plugged, worn, or broken screens. Clean plugged screens and replace worn or broken screens with new screens prior to beginning operations. Divide hot aggregate bins into at least three compartments arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

1.6.1.4 Testing Laboratory

Provide a testing laboratory for control and acceptance testing functions during periods of mix production, sampling and testing, and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall provide adequate equipment, space, and utilities as required for the performance of the specified tests.

1.6.1.5 Surge and Storage Bins

Use for temporary storage of hot bituminous mixtures will be permitted under the following conditions:

a. When stored in surge bins for a period of time not to exceed 3 hours.

b. When stored in insulated and heated storage bins for a period of time not to exceed 12 hours. If it is determined by the Contracting Officer that there is an excessive amount of heat loss, segregation and oxidation of the mixture due to temporary storage, discontinue use of surge bins or storage bins.

1.6.1.6 Drum-Dryer Mixer

Do not use drum-dryer mixer if specified requirements of the bituminous mixture or of the completed bituminous pavement course cannot be met. If drum-dryer mixer is prohibited, use either batch or continuous mix plants meeting the specifications and producing a satisfactory mix.

1.6.2 Paving Equipment

1.6.2.1 Spreading Equipment

Self-propelled electronically controlled type, unless other equipment is authorized by the Contracting Officer. Equip spreading equipment of the self-propelled electronically controlled type with hoppers, tamping or vibrating devices, distributing screws, electronically adjustable screeds, and equalizing devices. Capable of spreading hot bituminous mixtures without tearing, shoving, or gouging and to produce a finished surface of specified grade and smoothness. Operate spreaders, when laying mixture, at variable speeds between 5 and 45 feet per minute. Design spreader with a quick and efficient steering device; a forward and reverse traveling speed; and automatic devices to adjust to grade and confine the edges of the mixture to true lines. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh laid mix during operations is prohibited.

1.6.2.2 Rolling Equipment

Self-propelled pneumatic-tired rollers supplemented by three-wheel and tandem type steel wheel rollers. The number, type and weight of rollers shall be sufficient to compact the mixture to the required density without detrimentally affecting the compacted material. Rollers shall be suitable for rolling hot-mix bituminous pavements and capable of reversing without backlash. Pneumatic-tired rollers shall be capable of being operated both forward and backward without turning on the mat, and without loosening the surface being rolled. Equip rollers with suitable devices and apparatus to keep the rolling surfaces wet and prevent adherence of bituminous mixture. Vibratory rollers especially designed for bituminous concrete compaction may be used provided rollers do not impair stability of pavement structure and underlying layers. Repair depressions in pavement surfaces resulting from use of vibratory rollers. Rollers shall be self-propelled, single or dual vibrating drums, and steel drive wheels, as applicable; equipped with variable amplitude and separate controls for energy and propulsion.

1.6.2.3 Hand Tampers

Minimum weight of 25 pounds with a tamping face of not more than 50 square inches.

1.6.2.4 Mechanical Hand Tampers

Commercial type, operated by pneumatic pressure or by internal combustion.

PART 2 PRODUCTS

2.1 AGGREGATES

Grade and proportion aggregates and filler so that combined mineral aggregate conforms to specified grading.

2.1.1 Coarse Aggregates

ASTM D 692, except as modified herein. At least 75 percent by weight of aggregate retained on the No. 4 sieve shall have two or more fractured faces. Percentage of wear, Los Angeles test, except for slag, shall not exceed 40 in accordance with ASTM C 131. Weight of slag shall not be less than 70 pounds per cubic foot. Soundness test is required in accordance with ASTM C 88; after 5 cycles, loss shall not be more than 12 percent when tested with sodium sulfate or 18 percent when tested with magnesium sulfate.

2.1.2 Fine Aggregate

ASTM D 1073, except as modified herein. Fine aggregate shall be produced by crushing stone, slag or gravel that meets requirements for wear and soundness specified for coarse aggregate. Where necessary to obtain the gradation of aggregate blend or workability, natural sand may be used. Quantity of natural sand to be added shall be approved by the Contracting Officer and shall not exceed 15 percent of weight of coarse and fine aggregate and material passing the No. 200sieve.

2.1.3 Mineral Filler

Nonplastic material meeting the requirements of ASTM D 242.

2.1.4 Aggregate Gradation

The combined aggregate gradation shall conform to gradations specified in Table I, when tested in accordance with ASTM C 136 and ASTM C 117, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but grade uniformly from coarse to fine.

Table I. Aggregate Gradations

	Gradation 1	Gradation 2	Gradation 3
Sieve Size, inch	Percent Passing by Mass	Percent Passing by Mass	Percent Passing by Mass
1	100	---	---
3/4	76-96	100	---
1/2	68-88	76-96	100
3/8	60-82	69-89	76-96
No. 4	45-67	53-73	58-78
No. 8	32-54	38-60	40-60
No. 16	22-44	26-48	28-48
No. 30	15-35	18-38	18-38
No. 50	9-25	11-27	11-27
No. 100	6-18	6-18	6-18

No. 200	3-6	3-6	3-6

2.2 ASPHALT CEMENT BINDER

Asphalt cement binder shall conform to ASTM D 946. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Copies of these certifications shall be submitted to the Contracting OfficerEngineer. The supplier is defined as the last source of any modification to the binder. The Contracting OfficerEngineer may sample and test the binder at the mix plant at any time before or during mix production. Samples for this verification testing shall be obtained by the Contractor in accordance with ASTM D 140 and in the presence of the Contracting OfficerEngineer. These samples shall be furnished to the Contracting OfficerEngineer for the verification testing, which shall be at no cost to the Contractor. Samples of the asphalt cement specified shall be submitted for approval not less than 14 days before start of the test section.

2.3 MIX DESIGN

The Contractor shall develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF). No hot-mix asphalt for payment shall be produced until a JMF has been approved. The hot-mix asphalt shall be designed using procedures contained in AI MS-02 and the criteria shown in Table II. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D 4867/D 4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. If an antistrip agent is required, it shall be provided by the Contractor at no additional cost.

2.3.1 JMF Requirements

The job mix formula shall be submitted in writing by the Contractor for approval at least 14 days prior to the start of the test section and shall include as a minimum:

a. Percent passing each sieve size.

b. Percent of asphalt cement.

c. Percent of each aggregate and mineral filler to be used.

d. Asphalt viscosity grade, penetration grade, or performance grade.

e. Number of blows of hammer per side of molded specimen.

f. Laboratory mixing temperature.

g. Lab compaction temperature.

h. Temperature-viscosity relationship of the asphalt cement.

i. Plot of the combined gradation on the 0.45 power gradation chart,

stating the nominal maximum size.

j. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content as shown in AI MS-02.

k. Specific gravity and absorption of each aggregate.

l. Percent natural sand.

m. Percent particles with two or more fractured faces (in coarse aggregate).

n. Fine aggregate angularity.

o. Percent flat or elongated particles (in coarse aggregate).

p. Tensile Strength Ratio.

q. Antistrip agent (if required) and amount.

r. List of all modifiers and amount.

s. Percentage and properties (asphalt content, binder properties, and aggregate properties) of RAP in accordance with paragraph RECYCLED HOT-MIX ASPHALT, if RAP is used.

Table II. Marshall Design Criteria

Test Property	75 Blow Mix	50 Blow Mix
Stability, pounds minimum	*2150	*1350
Flow, 0.01 inch	8-16	8-18
Air voids, percent	3-5	3-5
Percent Voids in mineral aggregate (minimum)	See Table III	See Table III
TSR, minimum percent	75	75

* This is a minimum requirement. The average during construction shall be significantly higher than this number to ensure compliance with the specifications.

Table III. Minimum Percent Voids in Mineral Aggregate (VMA)**

Aggregate (See Table 2)	Minimum VMA, percent
Gradation 1	13.0
Gradation 2	14.0
Gradation 3	15.0

** Calculate VMA in accordance with AI MS-02, based on ASTM D 2726 bulk

specific gravity for the aggregate.

2.3.2 Adjustments to JMF

The JMF for each mixture shall be in effect until a new formula is approved in writing by the Contracting Officer. Should a change in sources of any materials be made, a new mix design shall be performed and a new JMF approved before the new material is used. The Contractor will be allowed to adjust the JMF within the limits specified below to optimize mix volumetric properties. Adjustments to the JMF shall be limited to plus or minus 3 percent on the 1/2 inch, No. 4, and No. 8 sieves; plus or minus 1.0 percent on the No. 200 sieve; and plus or minus 0.40 percent binder content. If adjustments are needed that exceed these limits, a new mix design shall be developed. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table I; this is acceptable.

2.4 RECYCLED HOT MIX ASPHALT

Recycled HMA shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt cement. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP chunk size shall not exceed 2 inches. The recycled HMA mix shall be designed using procedures contained in AI MS-02. The job mix shall meet the requirements of paragraph MIX DESIGN. RAP should only be used for shoulder surface course mixes and for any intermediate courses. The amount of RAP shall be limited to 30 percent.

2.4.1 RAP Aggregates and Asphalt Cement

The blend of aggregates used in the recycled mix shall meet the requirements of paragraph AGGREGATES. The percentage of asphalt in the RAP shall be established for the mixture design according to ASTM D 2172 using the appropriate dust correction procedure.

2.4.2 RAP Mix

The blend of new asphalt cement and the RAP asphalt binder shall meet the dynamic shear rheometer at high temperature and bending beam at low temperature requirements in paragraph ASPHALT CEMENT BINDER. The virgin asphalt cement shall not be more than two standard asphalt material grades different than that specified in paragraph ASPHALT CEMENT BINDER.

2.5 SOURCE QUALITY CONTROL

Employ a commercial laboratory approved by the Contracting Officer to perform testing. The laboratory used to develop the JMF and the laboratory used to perform all sampling and testing shall meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The certification shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A listing of equipment to be used in developing the job mix.

c. A copy of the laboratory's quality control system.

d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

2.5.1 Tests

Perform testing in accordance with the following:

a. Specific Gravity Test of Asphalt: ASTM D 70

b. Coarse Aggregate Tests:

(1) Bulk Specific Gravity: ASTM C 127

(2) Abrasion Loss: ASTM C 131

(3) Soundness Loss: ASTM C 88

c. Weight of Slag Test: ASTM C 29/C 29M

d. Percent of Crushed Pieces in Gravel: Count by observation and weight

e. Fine Aggregate Tests:

(1) Bulk Specific Gravity: ASTM C 128

(2) Soundness Loss: ASTM C 88

f. Specific Gravity of Mineral Filler: ASTM C 188 or ASTM D 854

g. Bituminous Mixture Tests:

(1) Bulk Specific Gravity: ASTM D 1188 or ASTM D 2726

(2) Theoretical Maximum Specific Gravity: ASTM D 2041

(3) Tensile Strength Ratio: ASTM D 4867/D 4867M

2.5.2 Specimens

ASTM D 1559 for the making and testing of bituminous specimens with the following exceptions:

a. Compaction: Apply 75 blows of the hammer to each flat face of the specimens.

b. Curves: Plot curves for the leveling, wearing courses to show the effect on the test properties of at least four different percentages of asphalt on the unit weight, stability, flow, air voids, and voids in mineral aggregate; each point on the curves shall represent the average of at least four specimens.

c. Cooling of Specimen: After compaction is completed, allow the specimen to cool in air to the same temperature approximately as that of the water, 77 degrees F, to be used in the specific gravity determination.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Preparation of Asphalt Binder Material

The asphalt cement material shall be heated avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. The temperature of unmodified asphalts shall be no more than 160 degrees C 325 degrees F when added to the aggregates. Modified asphalts shall be no more than 174 degrees C 350 degrees F when added to the aggregate.

3.1.2 Preparation of Mineral Aggregates

Store different size aggregate in separate stockpiles so that different sizes will not mix. Stockpile different-sized aggregates in uniform layers by use of a clam shell or other approved method so as to prevent segregation. The use of bulldozers in stockpiling of aggregate or in feeding aggregate to the dryer is prohibited. Feed aggregates into the cold elevator by means of separate mechanical feeders so that aggregates are graded within requirements of the job-mix formulas and tolerances specified. Regulate rates of feed of the aggregates so that moisture content and temperature of aggregates are within tolerances specified herein. Dry and heat aggregates to the temperature necessary to achieve the mixture determined by the job mix formula within the job tolerance specified. Provide adequate dry storage for mineral filler.

3.1.3 Preparation of Bituminous Mixture

Accurately weigh aggregates and dry mineral filler and convey into the mixer in the proportionate amounts of each aggregate size required to meet the job-mix formula. In batch mixing, after aggregates and mineral filler have been introduced into the mixer and mixed for not less than 15 seconds, add asphalt by spraying or other approved methods and continue mixing for a period of not less than 20 seconds, or as long as required to obtain a homogeneous mixture. The time required to add or spray asphalt into the mixer will not be added to the total wet-mixing time provided the operation does not exceed 10 seconds and a homogeneous mixture is obtained. When a continuous mixer is employed, mixing time shall be more than 35 seconds to obtain a homogeneous mixture. Additional mixing time, when required, will be as directed by the Contracting Officer. When mixture is prepared in a twin-pugmill mixer, volume of the aggregates, mineral filler, and asphalt shall not extend above tips of mixer blades when blades are in a vertical position. Overheated and carbonized mixtures, or mixtures that foam or show indication of free moisture, will be rejected. When free moisture is detected in batch or continuous mix plant produced mixtures, waste the mix and withdraw the aggregates in the hot bins immediately and return to the respective stockpiles; for drum-dryer mixer plants, waste the mix, including that in surge or storage bins that is affected by free moisture.

3.1.4 Transportation of Bituminous Mixtures

Transport bituminous material from the mixing plant to the paving site in trucks having tight, clean, smooth beds that have been coated with a minimum amount of concentrated solution of hydrated lime and water or other approved coating to prevent adhesion of the mixture to the truck. Petroleum products will not be permitted for coating truck. If air temperature is

less than 60 degrees F or if haul time is greater than 30 minutes, cover each load with canvas or other approved material of ample size to protect the mixture from the loss of heat. Make deliveries so that the spreading and rolling of all the mixture prepared for one day's run can be completed during daylight, unless adequate approved artificial lighting is provided. Deliver mixture to area to be paved so that the temperature at the time of dumping into the spreader is within the range specified herein. Reject loads that are below minimum temperature, that have crusts of cold unworkable material, or that have been wet excessively by rain. Hauling over freshly laid material is prohibited.

3.1.5 Surface Preparation of Underlying Course

Prior to the laying of the asphalt concrete, clean underlying course of foreign or objectionable matter with power blowers or power brooms, supplemented by hand brooms and other cleaning methods where necessary. During the placement of multiple lifts of bituminous concrete, each succeeding lift of bituminous concrete shall have its underlying lift cleaned and provided with a bituminous tack coat if the time period between the placement of each lift of bituminous concrete exceeds 14 days, or the underlying bituminous concrete has become dirty. Remove grass and other vegetative growth from existing cracks and surfaces.

3.1.6 Spraying of Contact Surfaces

Spray contact surfaces of previously constructed pavement with a thin coat of bituminous materials to act as an anti-stripping agent. Paint contact surfaces of structures with a thin coat of emulsion or other approved bituminous material prior to placing the bituminous mixture. Tack coat the previously placed primed coats on base courses when surface has become excessively dirty and cannot be cleaned or when primed surface has cured to the extent that it has lost all bonding effect.

3.2 PLACEMENT

3.2.1 Machine Spreading

The range of temperatures of the mixtures at the time of spreading shall be between [250] [_____] degrees F and 300 degrees F. Bituminous concrete having temperatures less than minimum spreading temperature when dumped into the spreader will be rejected. Adjust spreader and regulate speed so that the surface of the course is smooth and continuous without tears and pulling, and of such depth that, when compacted, the surface conforms with the cross section, grade, and contour indicated. Unless otherwise directed, begin the placing along the centerline of areas to be paved on a crowned section or on the high side of areas with a one-way slope. Place mixture in consecutive adjacent strips having a minimum width of 10 feet, except where the edge lanes require strips less than 10 feet to complete the area. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of the area to be paved, and place string lines coinciding with the established lines for the spreading machine to follow. Provide the number and location of the lines needed to accomplish proper grade control. When specified grade and smoothness requirements can be met for initial lane construction by use of an approved long ski-type device of not less than [30] [_____] feet in length and for subsequent lane construction by use of a short ski or shoe, in-place string lines for grade control may be omitted. Place mixture as nearly continuous

as possible and adjust the speed of placing as needed to permit proper rolling.

3.2.2 Shoveling, Raking, and Tamping After Machine-Spreading

Shovelers and rakers shall follow the spreading machine. Add or remove hot mixture and rake the mixture as required to obtain a course that when completed will conform to requirements specified herein. Broadcasting or fanning of mixture over areas being compacted is prohibited. When segregation occurs in the mixture during placing, suspend spreading operation until the cause is determined and corrected. Correct irregularities in alinement left by the spreader by trimming directly behind the machine. Immediately after trimming, compact edges of the course by tamping laterally with a metal lute or by other approved methods. Distortion of the course during tamping is prohibited.

3.2.3 Hand-Spreading in Lieu of Machine-Spreading

In areas where the use of machine spreading is impractical, spread mixture by hand. The range of temperatures of the mixtures when dumped onto the area to be paved shall be between [250] [_____] and 300 degrees F. Mixtures having temperatures less than minimum spreading temperature when dumped onto the area to be paved will be rejected. Spread hot mixture with rakes in a uniformly loose layer of a thickness that, when compacted, will conform to the required grade, thickness, and smoothness. During hand spreading, place each shovelful of mixture by turning the shovel over in a manner that will prevent segregation. Do not place mixture by throwing or broadcasting from a shovel. Do not dump loads any faster than can be properly handled by the shovelers and rakers.

3.3 COMPACTION OF MIXTURE

Compact mixture by rolling. Begin rolling as soon as placement of mixture will bear rollers. Delays in rolling freshly spread mixture shall not be permitted. Start rolling longitudinally at the extreme sides of the lanes and proceed toward center of pavement, or toward high side of pavement with a one-way slope. Operate rollers so that each trip overlaps the previous adjacent strip by at least one foot. Alternate trips of the roller shall be of slightly different lengths. Conduct tests for conformity with the specified crown, grade and smoothness immediately after initial rolling. Before continuing rolling, correct variations by removing or adding materials as necessary. If required, subject course to diagonal rolling with the steel wheeled roller crossing the lines of the previous rolling while mixture is hot and in a compactible condition. Speed of the rollers shall be slow enough to avoid displacement of hot mixture. Correct displacement of mixture immediately by use of rakes and fresh mixture, or remove and replace mixture as directed. Continue rolling until roller marks are eliminated and course has a density of at least 95 percent but not more than 100 percent of that attained in a laboratory specimen of the same mixture prepared in accordance with ASTM D 1559. During rolling, moisten wheels of the rollers enough to prevent adhesion of mixture to wheels, but excessive water is prohibited. Operation of rollers shall be by competent and experienced operators. Provide sufficient rollers for each spreading machine in operation on the job and to handle plant output. In places not accessible to the rollers, compact mixture thoroughly with hot hand tampers. Skin patching of an area after compaction is prohibited. Remove mixture that becomes mixed with foreign materials or is defective and replace with fresh mixture compacted to the density specified

herein. Roller shall pass over unprotected edge of the course only when laying of course is to be discontinued for such length of time as to permit mixture to become cold.

3.4 JOINTS

Joints shall present the same texture and smoothness as other portions of the course, except permissible density at the joint may be up to 2 percent less than the specified course density. Carefully make joints between old and new pavement or within new pavements in a manner to ensure a thorough and continuous bond between old and new sections of the course. Vertical contact surfaces of previously constructed sections that are coated with dust, sand, or other objectionable material shall be painted with a thin uniform coat of emulsion or other approved bituminous material just before placing fresh mixture.

3.4.1 Transverse

Roller shall pass over unprotected end of freshly laid mixture only when laying of course is to be discontinued. Except when an approved bulkhead is used, cut back the edge of previously laid course to expose an even, vertical surface for the full thickness of the course. When required, rake fresh mixture against joints, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll. Transverse joints in adjacent lanes shall be offset a minimum of 2 feet.

3.4.2 Longitudinal Joints

Space 6 inches apart. Do not allow joints to coincide with joints of existing pavement or previously placed courses. Spreader screed shall overlap previously placed lanes 2 to 3 inches and be of such height to permit compaction to produce a smooth dense joint. With a lute, push back mixture placed on the surface of previous lanes to the joint edge. Do not scatter mix. Remove and waste excess material. When edges of longitudinal joints are irregular, honeycombed, or poorly compacted, cut back unsatisfactory sections of joint and expose an even vertical surface for the full thickness of the course. When required, rake fresh mixture against joint, thoroughly tamp with hot tampers, smooth with hot smoothers, and roll while hot.

3.5 FIELD QUALITY CONTROL

3.5.1 Sampling

3.5.1.1 Aggregates At Source

Prior to production and delivery of aggregates, take at least one initial sample in accordance with ASTM D 75 from each stockpile. Collect each sample by taking three incremental samples at random from the source material to make a composite sample of not less than 50 pounds. Repeat the sampling when the material source changes or when testing reveals unacceptable deficiencies or variations from the specified grading of materials.

3.5.1.2 Cold Feed Aggregate Sampling

Take two samples daily from the belt conveying materials from the cold feed. Collect materials in three increments at random to make a representative composite sample of not less than 50 pounds. Take samples in accordance

with ASTM D 75.

3.5.1.3 Coarse and Fine Aggregates

Take a 50 pound sample from the cold feed at least once daily for sieve analyses and specific gravity tests. Additional samples may be required to perform more frequent tests when analyses show deficiencies, or unacceptable variances or deviations. The method of sampling is as specified herein for aggregates.

3.5.1.4 Mineral Filler

ASTM D 546. Take samples large enough to provide ample material for testing.

3.5.1.5 Pavement and Mixture

Take plant samples for the determination of mix properties and field samples for thickness and density of the completed pavements. Furnish tools, labor and material for samples, and satisfactory replacement of pavement. Take samples and tests at not less than frequency specified hereinafter and at the beginning of plant operations; for each day's work as a minimum; each change in the mix or equipment; and as often as directed. Accomplish sampling in accordance with ASTM D 979.

3.5.2 Testing

3.5.2.1 Aggregates Tests

a. Gradation: ASTM C 136.

b. Mineral Filler Content: ASTM D 546.

c. Abrasion: ASTM C 131 for wear (Los Angeles test). Perform one test initially prior to incorporation into the work and each time the source is changed.

3.5.2.2 Bituminous Mix Tests

Test one sample for each 500 tons, or fraction thereof, of the uncompacted mix for extraction in accordance with ASTM D 2172; perform a sieve analysis on each extraction sample in accordance with ASTM C 136 and ASTM C 117. Test one sample for each [500] [_____] tons or fraction thereof for stability and flow in accordance with ASTM D 1559. Test one sample for each material blend for Tensile Strength Ratio in accordance with ASTM D 4867/D 4867M.

3.5.2.3 Pavement Courses

Perform the following tests:

a. Density: For each [1000] [_____] tons of bituminous mixture placed, determine the representative laboratory density by averaging the density of four laboratory specimens prepared in accordance with ASTM D 1559. Samples for laboratory specimens shall be taken from trucks delivering mixture to the site; record in a manner approved by the Contracting Officer the project areas

represented by the laboratory densities. From each representative area recorded, determine field density of pavement by averaging densities of 4 inch diameter cores obtained from leveling, wearing courses; take one core for each [2000] [_____] square yards or fraction thereof of course placed. Determine density of laboratory prepared specimens and cored samples in accordance with ASTM D 1188 or ASTM D 2726, as applicable. Separate pavement layers by sawing or other approved means. Maximum allowable deficiency at any point, excluding joints, shall not be more than 2 percent less than the specified density for any course. The average density of each course, excluding joints, shall be not less than the specified density. Joint densities shall not be more than 2 percent less than specified course densities and are not included when calculating average course densities. When the deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

b. Thickness: Determine thickness of binder and wearing courses from samples taken for the field density test. The maximum allowable deficiency at any point shall not be more than 1/4 inch less than the thickness for the indicated course. Average thickness of course or of combined courses shall be not less than the indicated thickness. Where a deficiency exceeds the specified tolerances, correct each such representative area or areas by removing the deficient pavement and replacing with new pavement.

c. Smoothness: Straightedge test the compacted surface of leveling, wearing courses as work progresses. Apply straightedge parallel with and at right angles to the centerline after final rolling. Unevenness of leveling and courses shall not vary more than 1/4 inch in 10 feet; variations in the wearing course shall not vary more than 1/8 inch in 10 feet. Correct each portion of the pavement showing irregularities greater than that specified.

d. Finished Grades: Finish grades of each course placed shall not vary from the finish elevations, profiles, and cross sections indicated by more than 1/2 inch. Finished surface of the final wearing course will be tested by the Contracting Officer by running lines of levels at intervals of [25] [_____] feet longitudinally and transversely to determine elevations of completed pavement. Within 45 days after completion of final placement, The Contracting Officer will inform the Contractor in writing of paved areas that fail to meet the final grades indicated within the specified tolerances. Correct deficient paved areas by removing existing work and replacing with new materials that meet the specifications. Skin patching for correcting low areas is prohibited.

e. Finish Surface Texture of Wearing Course: Visually check final surface texture for uniformity and reasonable compactness and tightness. Final wearing course with a surface texture having undesirable irregularities such as segregation, cavities, pulls or tears, checking, excessive exposure of coarse aggregates, sand streaks, indentations, ripples, or lack of uniformity shall be removed and replaced with new materials.

3.6 PROTECTION

Do not permit vehicular traffic, including heavy equipment, on pavement until surface temperature has cooled to at least 120 degrees F. Measure surface temperature by approved surface thermometers or other satisfactory methods.

-- End of Section --

SECTION 32 16 13

CONCRETE SIDEWALKS AND CURBS AND GUTTERS
04/08

PART 1 GENERAL

1.1 MEASUREMENT FOR PAYMENT

1.1.1 Sidewalks

The quantities of sidewalks to be paid for will be the number of square yards of each depth of sidewalk constructed as indicated.

1.1.2 Curbs and Gutters

The quantities of curbs and gutters to be paid for will be the number of linearfeet of each cross section constructed as indicated, measured along the face of the curb at the gutter line.

1.2 BASIS FOR PAYMENT

1.2.1 Sidewalks

Payment of the quantities of sidewalks measured as specified will be at the contract unit price per squareyard of the thickness specified.

1.2.2 Curbs and Gutters

Payment of the quantities of curbs and gutters measured as specified will be at the contract unit price per linear foot of each cross section.

1.3 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A 185/A 185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 615/A 615M	(2008) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 143/C 143M	(2008) Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C 171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C 172	(2007a) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C 173/C 173M	(2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 231	(2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2008) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 920	(2005) Standard Specification for Elastomeric Joint Sealants
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 5893	(2004) Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements

1.4 SYSTEM DESCRIPTION

1.4.1 General Requirements

Provide plant, equipment, machines, and tools used in the work subject to approval and maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.4.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete

Copies of certified delivery tickets for all concrete used in the construction.

SD-06 Test Reports

Field Quality Control

Copies of all test reports within 24 hours of completion of the test.

1.6 ENVIRONMENTAL REQUIREMENTS

1.6.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40 degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.6.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed95 degrees F at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Provide concrete conforming to the applicable requirements of Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE except as otherwise specified. Concrete shall have a minimum compressive strength of 3500 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches.

2.1.1 Air Content

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

The concrete slump shall be 2 inches plus or minus 1 inch where determined in accordance with ASTM C 143/C 143M.

2.1.3 Reinforcement Steel

Reinforcement bars shall conform to ASTM A 615/A 615M. Wire mesh reinforcement shall conform to ASTM A 185/A 185M.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C 309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 1/2 inch thick, unless otherwise indicated.

2.5 JOINT SEALANTS

Joint sealant, cold-applied shall conform to ASTM C 920 or ASTM D 5893.

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 2 inches nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted as directed .

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope as indicated with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours after finishing has been completed.

3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of

the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be

continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Expansion joints shall be formed with 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D 1752 or building paper. Joint filler shall be held in place with steel pins or other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with cold-applied joint sealant. Joint sealant shall be gray or stone in color. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.5.3 Reinforcement Steel Placement

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.

a. Contraction joints (except for slip forming) shall be constructed by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.

b. When slip forming is used, the contraction joints shall be cut in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. The depth of cut shall be at least one-fourth of the gutter/curb depth and 1/8 inch in width.

3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 1/2 inch in width shall be provided at intervals not less than 30 feet nor greater than 120 feet. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. Expansion joints and the top 1 inch depth of curb and gutter contraction-joints shall be sealed with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.7 CURING AND PROTECTION

3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

3.7.1.2 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid

directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18-inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.7.1.3 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Completed concrete shall be protected from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire

length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.7.4 Protective Coating

Protective coating, of linseed oil mixture, shall be applied to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Concrete to receive a protective coating shall be moist cured.

3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying two coats of protective coating. Concrete shall be surface dry and clean before each application. Coverage shall be by spray application at not more than 50 square yards/gallon for first application and not more than 70 square yards/gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

3.7.4.2 Precautions

Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at ambient or material temperatures lower than 50 degrees F.

3.8 FIELD QUALITY CONTROL

3.8.1 General Requirements

Perform the inspection and tests described and meet the specified requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

Provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 250 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

3.8.2.2 Air Content

Determine air content in accordance with ASTM C 173/C 173M or ASTM C 231. ASTM C 231 shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government

and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

SECTION 32 92 19

SEEDING
10/06

PART 1 GENERAL

1.1 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.

ASTM INTERNATIONAL (ASTM)

ASTM C 602	(2007) Agricultural Liming Materials
ASTM D 4427	(2007) Peat Samples by Laboratory Testing
ASTM D 4972	(2001; R 2007) pH of Soils

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R 1998) Federal Seed Act
DOA SSIR 42	(1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.2 DEFINITIONS

1.2.1 Stand of Turf

95 percent ground cover of the established species.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval.

SD-03 Product Data

Wood cellulose fiber mulch

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil composition tests (reports and recommendations).

SD-07 Certificates

State certification and approval for seed

SD-08 Manufacturer's Instructions

Erosion Control Materials

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery

1.4.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.4.1.2 Fertilizer Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with certificate indicating the above information.

1.4.2 Storage

1.4.2.1 Seed, Fertilizer Storage

Store in cool, dry locations away from contaminants.

1.4.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.4.2.3 Handling

Do not drop or dump materials from vehicles.

1.5 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.5.1 Restrictions

Do not plant when the ground is frozen, muddy, or when air temperature exceeds [90] [_____] degrees Fahrenheit.

1.6 TIME LIMITATIONS

1.6.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Classification

Provide State-certified seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Field mixes

will be acceptable when field mix is performed on site in the presence of the Contracting Officer .

2.1.2 Planting Dates

Planting Season	Planting Dates
Season 1	March 1 thru Sept 30

2.1.3 Seed Purity

Botanical Name	Common Name	Min. Percent Pure Seed	Min. Percent Germination and Hard Seed	Max. Percent Weed Seed
Poa Pratensis	Kentucky Bluegrass	85	80	15

2.1.4 Seed Mixture by Weight

Planting Season	Variety	Percent (by Weight)
[Season 1]	Kentucky Bluegrass	14.64 kg/1000 m2

2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site.

EARTHWORK.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor .

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH shall be tested in accordance with ASTM D 4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

Silt	25-50 percent
Clay	10-30 percent
Sand	20-35 percent
pH	5.5 to 7.0
Soluble Salts	600 ppm maximum

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Lime

Commercial grade hydrate limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C 602 of not less than 60 percent.

2.3.2 Aluminum Sulfate

Commercial grade.

2.3.3 Sulfur

100 percent elemental

2.3.4 Iron

100 percent elemental

2.3.5 Peat

Natural product of peat moss derived from a freshwater site and conforming to ASTM D 4427 . Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.

2.3.6 Sand

Clean and free of materials harmful to plants.

2.3.7 Perlite

Horticultural grade.

2.3.8 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.3.8.1 Particle Size

Minimum percent by weight passing:

No. 4 mesh screen	95
No. 8 mesh screen	80

2.3.8.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.3.9 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 61 percent,

calcium 22 percent, sulfur 17 percent; minimum 96 percent passing through 20 mesh screen, 100 percent passing thru 16 mesh screen.

2.3.10 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent shall pass a No. 8 sieve; a minimum 99 percent shall be retained on a No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

2.4 FERTILIZER

2.4.1 [Enter Appropriate Subpart Title Here]2.5 MULCH

Mulch shall be free from noxious weeds, mold, and other deleterious materials.

2.5.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw shall contrain no fertile seed.

2.5.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay shall be sterile, containing no fertile seed.

2.5.3 Wood Cellulose Fiber Mulch

Use recovered materials of either paper-based (100 percent) or wood-based (100 percent) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2 . Use with hydraulic application of grass seed and fertilizer.

2.6 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation, containing no elements toxic to plant life.

2.7 EROSION CONTROL MATERIALS

Erosion control material shall conform to the following:

2.7.1 Erosion Control Fabric

Fabric shall be knitted construction of polypropylene yarn with uniform mesh openings 3/4 to 1 inch square with strips of biodegradable paper. Filler paper strips shall have a minimum life of 6 months.

2.7.2 Erosion Control Material Anchors

Erosion control anchors shall be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.1.1 Topsoil

Provide 4 inches of existing soil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate pH adjusters into soil a minimum depth of [4] [_____] inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy frozen or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Seed Application Method

Seeding method shall be drill seeding.

3.2.2.1 Broadcast and Drop Seeding

Seed shall be uniformly broadcast at the rate of 50pounds per 1000 square feet. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of 1/4 inch in clay soils and [1/2] [_____] inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

3.2.2.2 Drill Seeding

Seed shall be drilled at the rate of 50pounds per 1000 square feet. Use cultipacker seeders . Drill seed uniformly to average depth of [1/2] [_____] inch.

3.2.2.3 Hydroseeding

First, mix water and fiber. Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydroseeding operation. Fiber shall

be added at 1,000 pounds, dry weight, per acre. Then add and mix seed and fertilizer to produce a homogeneous slurry. Seed shall be mixed to ensure broadcasting at the rate of 50pounds per 1000 square feet. When hydraulically sprayed on the ground, material shall form a blotter like cover impregnated uniformly with grass seed. Spread with one application with no second application of mulch.

3.2.3 Mulching

3.2.3.1 Hay or Straw Mulch

Hay or straw mulch shall be spread uniformly at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

3.2.3.2 Mechanical Anchor

Mechanical anchor shall be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

3.2.3.3 Asphalt Adhesive Tackifier

Asphalt adhesive tackifier shall be sprayed at a rate between 10 to 13 gallons per 1000 square feet. Sunlight shall not be completely excluded from penetrating to the ground surface.

3.2.3.4 Non-Asphaltic Tackifier

Hydrophilic colloid shall be applied at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. A uniform mixture shall be applied over the area.

3.2.3.5 Asphalt Adhesive Coated Mulch

Hay or straw mulch may be spread simultaneously with asphalt adhesive applied at a rate between 10 to 13 gallons per 1000 square feet, using power mulch equipment which shall be equipped with suitable asphalt pump and nozzle. The adhesive-coated mulch shall be applied evenly over the surface. Sunlight shall not be completely excluded from penetrating to the ground surface.

3.2.4 Rolling

Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding [90] [_____] pounds for each foot of roller width. If seeding is performed with cultipacker-type seeder or by hydroseeding, rolling may be eliminated.

3.2.5 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.

3.2.6 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of [2] [_____] inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

3.3 PROTECTION OF TURF AREAS

Immediately after turfing, protect area against traffic and other use.

3.4 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

SECTION 33 40 00

STORM DRAINAGE UTILITIES
01/08

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

1.1.1 Pipe Culverts and Storm Drains

The length of pipe installed will be measured along the centerlines of the pipe from end to end of pipe without deductions for diameter of manholes. Pipe will be paid for at the contract unit price for the number of linear feet of culverts or storm drains placed in the accepted work.

1.1.2 Storm Drainage Structures

The quantity of manholes and inlets will be measured as the total number of manholes and inlets of the various types of construction, complete with frames and gratings or covers and, where indicated, with fixed side-rail ladders, constructed to the depth of 3 feet in the accepted work. The depth of manholes and inlets will be measured from the top of grating or cover to invert of outlet pipe. Manholes and inlets constructed to depths greater than the depth specified above will be paid for as units at the contract unit price for manholes and inlets, plus an additional amount per linear foot for the measured depth beyond a depth of 3 feet.

1.1.3 Walls and Headwalls

Walls and headwalls will be measured by the number of cubic yards of reinforced concrete, plain concrete, or masonry used in the construction of the walls and headwalls. Wall and headwalls will be paid for at the contract unit price for the number of walls and headwalls constructed in the completed work.

1.1.4 Flared End Sections

Flared end sections will be measured by the unit. Flared end sections will be paid for at the contract unit price for the various sizes in the accepted work.

1.1.5 Sheeting and Bracing

Payment will be made for that sheeting and bracing ordered to be left in place, based on the number of square feet of sheeting and bracing remaining below the surface of the ground.

1.1.6 Rock Excavation

Payment will be made for the number of cubic yards of material acceptably excavated, as specified and defined as rock excavation, measured in the original position, and computed by allowing actual width of rock excavation with the following limitations: maximum rock excavation width, 30 inches for pipe of 12 inch or less nominal diameter; maximum rock excavation width, 16 inches greater than outside diameter of pipe of more than 12 inch nominal diameter. Measurement will include authorized overdepth

excavation. Payment will also include all necessary drilling and blasting, and all incidentals necessary for satisfactory excavation and disposal of authorized rock excavation. No separate payment will be made for backfill material required to replace rock excavation; this cost shall be included in the Contractor's unit price bid per cubic yard for rock excavation. In rock excavation for manholes and other appurtenances, 1 foot will be allowed outside the wall lines of the structures.

1.1.7 Backfill Replacing Unstable Material

Payment will be made for the number of cubic yards of select granular material required to replace unstable material for foundations under pipes or drainage structures, which will constitute full compensation for this backfill material, including removal and disposal of unstable material and all excavating, hauling, placing, compacting, and all incidentals necessary to complete the construction of the foundation satisfactorily.

1.1.8 Pipe Placed by Jacking

Payment will be made for the number of linear feet of jacked pipe accepted in the completed work measured along the centerline of the pipe in place.

1.2 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-17	(2002; Errata 2003; Errata 2005) Standard Specifications for Highway Bridges
AASHTO M 190	(2004) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 198	(2005) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
AASHTO M 243	(1996; R 2004) Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M 294	(2007) Standard Specification for Corrugated Polyethylene Pipe, 300- to 1200-mm Diameter

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2007) Manual for Railway Engineering

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and

	Steel Products
ASTM A 48/A 48M	(2003) Standard Specification for Gray Iron Castings
ASTM A 536	(1984; R 2004) Standard Specification for Ductile Iron Castings
ASTM A 798/A 798M	(2007) Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM A 807/A 807M	(2002e1) Standard Practice for Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM A 929/A 929M	(2001; R 2007) Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM B 26/B 26M	(2005) Standard Specification for Aluminum-Alloy Sand Castings
ASTM C 1103	(2003) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C 12	(2007) Standard Practice for Installing Vitrified Clay Pipe Lines
ASTM C 139	(2005) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 231	(2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(2007a) Standard Specification for Mortar for Unit Masonry
ASTM C 32	(2005) Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 425	(2004) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(2005a) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 478	(2008) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 55	(2006e1) Concrete Brick
ASTM C 62	(2005) Building Brick (Solid Masonry Units Made from Clay or Shale)

ASTM C 700	(2007a) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 828	(2006) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 877	(2002; E 2005) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C 923	(2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C 924	(2002) Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM D 1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1999; R 2007) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1557	(2007) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 1784	(2007) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2167	(1994; R 2001) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2321	(2005) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 2729	(2003) Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3034	(2006) Standard Specification for Type PSM

	Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(2007) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(2006) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 6938	(2007a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM F 1417	(1992; R 2005) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air
ASTM F 477	(2007) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(2008) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	(2008) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(2003) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(2007) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(2006a) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Placing Pipe

Printed copies of the manufacturer's recommendations for installation procedures of the material being placed, prior to installation.

SD-04 Samples

Pipe for Culverts and Storm Drains

Samples of the following materials, before work is started: .

SD-07 Certificates

Resin Certification
Pipeline Testing
Hydrostatic Test on Watertight Joints
Determination of Density
Frame and Cover for Gratings

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.4.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Clay Pipe

Standard or extra strength, as indicated, conforming to ASTM C 700.

2.1.2 Perforated Piping

2.1.2.1 Clay Pipe

ASTM C 700, standard strength.

2.1.2.2 PVC Pipe

ASTM D 2729.

2.1.3 PVC Pipe

The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, shall be submitted prior to installation of the pipe.

2.1.3.1 Type PSM PVC Pipe

ASTM D 3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.3.2 Profile PVC Pipe

ASTM F 794, Series 46, produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.3.3 Smooth Wall PVC Pipe

ASTM F 679 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.3.4 Corrugated PVC Pipe

ASTM F 949 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.

2.1.4 PE Pipe

The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

2.1.4.1 Smooth Wall PE Pipe

ASTM F 714, maximum DR of 21 for pipes 3 to 24 inches in diameter and maximum DR of 26 for pipes 26 to 48 inches in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 335434C.

2.1.4.2 Corrugated PE Pipe

AASHTO M 294, Type S or D, for pipes 12 to 48 inches and AASHTO M 294, Type S or D, for pipes 54 to 60 inches produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class in accordance with AASHTO M 294. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)
12	1.50	0.024
15	1.91	0.053
18	2.34	0.062
24	3.14	0.116
30	3.92	0.163
36	4.50	0.222
42	4.69	0.543
48	5.15	0.543
54	5.67	0.800
60	6.45	0.800

2.1.4.3 Profile Wall PE Pipe

ASTM F 894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D 3350, minimum cell class 334433C. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment Of Inertia of Wall Section (in to the 4th/in)	
		Cell Class 334433C	Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	8.08	0.202	0.165
42	7.81	0.277	0.227
48	8.82	0.338	0.277

2.2 DRAINAGE STRUCTURES

2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A 929/A 929M.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements under Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE. The concrete mixture shall have air content by volume of

concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D 1751, or ASTM D 1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D 1752.

2.3.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C 270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed 17 gallons of water per sack of cement. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2.3.3 Precast Concrete Segmental Blocks

Precast concrete segmental block shall conform to ASTM C 139, not more than 8 inches thick, not less than 8 inches long, and of such shape that joints can be sealed effectively and bonded with cement mortar.

2.3.4 Brick

Brick shall conform to ASTM C 62, Grade SW; ASTM C 55, Grade S-I or S-II; or ASTM C 32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.

2.3.5 Precast Reinforced Concrete Manholes

Precast reinforced concrete manholes shall conform to ASTM C 478. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS.

2.3.6 Prefabricated Corrugated Metal Manholes

Manholes shall be of the type and design recommended by the manufacturer. Manholes shall be complete with frames and cover, or frames and gratings.

2.3.7 Frame and Cover for Gratings

Frame and cover for gratings shall be cast gray iron, ASTM A 48/A 48M, Class 35B; cast ductile iron, ASTM A 536, Grade 65-45-12; or cast aluminum, ASTM B 26/B 26M, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.

2.3.8 Joints

2.3.8.1 Flexible Watertight Joints

a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M 198, and rubber-type gaskets shall conform to ASTM C 443. Factory-fabricated resilient joint materials shall conform to ASTM C 425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C 443. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

2.3.8.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877.

2.3.8.3 Flexible Watertight, Gasketed Joints

a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches wide and approximately 3/8 inch thick, meeting the requirements of ASTM D 1056, Type 2 A1 , and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches in diameter for pipe having 1 inch deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

2.3.8.4 PVC Plastic Pipes

Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

2.3.8.5 Smooth Wall PE Plastic Pipe

Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.

2.3.8.6 Corrugated PE Plastic Pipe

Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F 477. Soil tight joints shall conform to the requirements in AASHTO HB-17, Division II, Section 26.4.2.4. (e) for soil tightness and shall be as recommended by the pipe manufacturer.

2.3.8.7 Profile Wall PE Plastic Pipe

Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F 894.

2.3.8.8 Ductile Iron Pipe

Couplings and fittings shall be as recommended by the pipe manufacturer.

2.3.9 Flap Gates

Flap Gates shall be medium -duty with circular opening and double-hinged. Top pivot points shall be adjustable. The seat shall be one-piece casr iron with a raised section around the perimeter of the waterway opening to provide the seating face. The seating face of the seat shall be cast iron. The cover shall be one-piece cast iron with necessary reinforcing rib, lifting eye for manual operation, and bosses to provide a pivot point connection with the links. The seating face of the cover shall be cast iron. Links or hinge arms shall be cast or ductile iron. Holes of pivot points shall be bronze bushed. All fasteners shall be either galvanized steel, bronze or stainless steel.

2.4 STEEL LADDER

Steel ladder shall be provided where the depth of the storm drainage structure exceeds 12 feet. These ladders shall be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M.

2.5 DOWNSPOUT BOOTS

Boots used to connect exterior downspouts to the storm-drainage system shall be of gray cast iron conforming to ASTM A 48/A 48M, Class 30B or 35B. Shape and size shall be as indicated.

2.6 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe to manholes and

inlets shall conform to ASTM C 923.

2.7 HYDROSTATIC TEST ON WATERTIGHT JOINTS

2.7.1 Concrete, Clay, PVC and PE Pipe

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M 198 or ASTM C 443. Test requirements for joints in clay pipe shall conform to ASTM C 425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D 3212.

2.7.2 Corrugated Steel and Aluminum Pipe

A hydrostatic test shall be made on the watertight joint system or coupling band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-17 (Division II, Section 26). The pipe shall be supported for the hydrostatic test with the joint located at the point which develops 15 percent of the moment capacity of the pipe based on the allowable span in feet for the pipe flowing full or 40,000 foot-pounds, whichever is less. Performance requirements shall be met at an internal hydrostatic pressure of 10 psi, for a 10 minute period for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

2.8 EROSION CONTROL RIPRAP

Provide nonerodible rock not exceeding 15 inches in its greatest dimension and choked with sufficient small rocks to provide a dense mass with a minimum thickness ofas indicated.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 150 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheeting and bracing, where required, shall be placed within the trench width as specified, without any overexcavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe.

3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.

3.2.2 Clay Pipe Requirements

Bedding for clay pipe shall be as specified by ASTM C 12.

3.2.3 Corrugated Metal Pipe

Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A 798/A 798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A 807/A 807M.

3.2.4 Ductile Iron and Cast-Iron Pipe

Bedding for ductile iron and cast-iron pipe shall be as shown on the drawings.

3.2.5 Plastic Pipe

Bedding for PVC and PE pipe shall meet the requirements of ASTM D 2321. Bedding, haunching, and initial backfill shall be either Class IB or II

material.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not 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. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Corrugated Steel and Aluminum Alloy	5
Concrete-Lined Corrugated Steel	3
Ductile Iron Culvert	3
Plastic	7.5

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced.

3.3.1 Concrete, Clay, PVC, Ribbed PVC, Ductile Iron and Cast-Iron Pipe

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.

3.3.2 Elliptical and Elliptical Reinforced Concrete Pipe

The manufacturer's reference lines, designating the top of the pipe, shall be within 5 degrees of a vertical plane through the longitudinal axis of the pipe, during placement. Damage to or misalignment of the pipe shall be prevented in all backfilling operations.

3.3.3 Corrugated PE Pipe

Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.

3.3.4 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. Part paved pipe shall be installed so that

the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe or pipe arch and coupling bands shall be handled with care to preclude damage to the coating, paving or lining. Damaged coatings, pavings and linings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating, paving or lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

3.3.5 Structural-Plate Steel

Structural plate shall be installed in accordance with ASTM A 807/A 807M. Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are tightened to meet the torque requirements of 200 foot-pounds plus or minus 50 foot-pounds. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for amount of torque produced. Power wrenches shall be checked and adjusted frequently as needed, according to type or condition, to ensure proper adjustment to supply the required torque.

3.3.6 Structural-Plate Aluminum

Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are torqued to a minimum of 100 foot-pounds on aluminum alloy bolts and a minimum of 150 foot-pounds on galvanized steel bolts. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque produced. Power wrenches shall be checked and adjusted as frequently as needed, according to type or condition, to ensure that they are in proper adjustment to supply the required torque.

3.3.7 Multiple Culverts

Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 3 feet apart, whichever is less.

3.3.8 Jacking Pipe Through Fills

Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of

AREMA Eng Man.

3.4 JOINTING

3.4.1 Concrete and Clay Pipe

3.4.1.1 Cement-Mortar Bell-and-Spigot Joint

The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.

3.4.1.2 Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe

A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.

3.4.1.3 Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe

The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.

a. Diaper Bands: Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 8 inches apart. Wires shall be cut into lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.

b. Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and removed.

c. Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.

3.4.1.4 Cement-Mortar Tongue-and-Groove Joint

The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.

3.4.1.5 Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe

The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch, thick and the width of the diaper band shall be at least 8 inches. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.

3.4.1.6 Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe

Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If nonmastic-type sealant

material is used, the "Squeeze-Out" requirement above will be waived.

3.4.1.7 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.4.1.8 External Sealing Band Joint for Noncircular Pipe

Surfaces to receive sealing bands shall be dry and clean. Bands shall be installed in accordance with manufacturer's recommendations.

3.4.2 Corrugated Metal Pipe

3.4.2.1 Field Joints

Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A 798/A 798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. The annular space between abutting sections of part paved, and fully paved pipe and pipe arch, in sizes 30 inches or larger, shall be filled with a bituminous material after jointing. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.

3.4.2.2 Flexible Watertight, Gasketed Joints

Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts

tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

3.5 DRAINAGE STRUCTURES

3.5.1 Manholes and Inlets

Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.

3.5.2 Walls and Headwalls

Construction shall be as indicated.

3.6 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be installed to provide at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.7 BACKFILLING

3.7.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 150 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.7.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and

compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 300 inches.

3.7.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.7.4 Compaction

3.7.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.7.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.

b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.7.5 Determination of Density

Testing is the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density

relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 6938. When ASTM D 6938 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 6938 results in a wet unit weight of soil and ASTM D 6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 6938. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

3.8 PIPELINE TESTING

3.8.1 Leakage Tests

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall conform to ASTM C 828. Low pressure air testing for concrete pipes shall conform to ASTM C 924. Low pressure air testing for plastic pipe shall conform to ASTM F 1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C 828 or ASTM C 924, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C 1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 250 gallons per inch in diameter per mile of pipeline per day . When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.

3.8.2 Deflection Testing

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

a. Pull-through device: This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common

shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device. Ball, cylinder, or circular sections shall conform to the following:

1 A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.

2 A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F, and a surface Brinell hardness of not less than 150.

3 Center bored and through bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of not less than 70,000 psi, with eyes or loops at each end for attaching pulling cables.

4 Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved by the Contracting Officer prior to use.

c. Pull-through device: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.

d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, remove pipe which has excessive deflection, replace with new pipe, and completely retest in same manner and under same conditions.

e. Warranty period test: Pipe found to have a deflection of greater than 5 percent of average inside diameter when deflection test is performed just prior to end of one-year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection.

3.9 FIELD PAINTING

After installation, clean cast-iron frames, covers, gratings, and steps not buried in masonry or concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

-- End of Section --

SECTION 33 46 13

FOUNDATION DRAINAGE SYSTEM
04/08

PART 1 GENERAL

1.1 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 252	(2007) Corrugated Polyethylene Drainage Pipe
AASHTO M 294	(2007) Standard Specification for Corrugated Polyethylene Pipe, 300- to 1200-mm Diameter

ASTM INTERNATIONAL (ASTM)

ASTM A 74	(2006) Standard Specification for Cast Iron Soil Pipe and Fittings
ASTM A 760/A 760M	(2006) Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM B 745/B 745M	(1997; R 2005) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C 14	(2007) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 33	(2007) Standard Specification for Concrete Aggregates
ASTM C 4	(2004; R 2005) Clay Drain Tile and Perforated Clay Drain Tile
ASTM C 412	(2005a) Concrete Drain Tile
ASTM C 425	(2004) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 444	(2003) Perforated Concrete Pipe
ASTM C 508	(2000; R 2004) Asbestos-Cement Underdrain Pipe
ASTM C 654	(2005a) Porous Concrete Pipe

ASTM C 700	(2007a) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D 2751	(2005) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 3034	(2006) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(2007) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F 405	(2005) Corrugated Polyethylene (PE) Tubing and Fittings
ASTM F 667	(2006) Large Diameter Corrugated Polyethylene Pipe and Fittings
ASTM F 758	(1995; R 2007e1) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F 949	(2006a) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.2 SYSTEM DESCRIPTION

1.2.1 Extent

Furnish and install foundation drainage as a complete system as shown.

1.2.2 Outlet Connections

Foundation pipe shall be connected to the storm drainage system as shown and specified in Section 33 40 00 STORM DRAINAGE .

1.2.3 Drainage Lines

Construct drainage lines of drain tile, perforated pipe, or porous pipe.

1.2.4 Outlet Lines

Construct outlet lines of closed-joint nonperforated, nonporous pipe.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Materials.

Two randomly selected samples of each type of pipe and fitting, prior to delivery of materials to the site.

SD-07 Certificates

Materials.

Certifications from the manufacturers attesting that materials meet specification requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

Protect materials placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Do not expose plastic pipe to direct sunlight for more than 6 months from time of manufacturer to installation.

PART 2 PRODUCTS

2.1 MATERIALS

Pipe for foundation drainage system shall be of the type and size indicated. Appropriate transitions, adapters, or joint details shall be used where pipes of different types or materials are connected.

2.1.1 Clay Pipe

ASTM C 700, standard or extra strength.

2.1.2 Perforated Clay Pipe

ASTM C 700, standard or extra strength.

2.1.3 Concrete Pipe

Concrete pipe shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION and conform to ASTM C 14, Class 1 2 .

2.1.4 Perforated Concrete Pipe

Perforated concrete pipe shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION and conform to ASTM C 14, Class 1 2 with perforations conforming to ASTM C 444, Type I II.

2.1.5 Porous Concrete Pipe

Porous concrete pipe shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION and conform to ASTM C 654, standard or extra strength class.

2.1.6 Clay Drain Tile

ASTM C 4, standard class.

2.1.7 Perforated Clay Drain Tile

ASTM C 4, standard class.

2.1.8 Concrete Drain Tile

Concrete drain tile shall be manufactured in accordance with Section 03 40 00.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION and conform to ASTM C 412, standard- quality.

2.1.9 Cast-Iron Soil Pipe

ASTM A 74, service.

2.1.10 Perforated Corrugated Steel Pipe

ASTM A 760/A 760M, Type III.

2.1.11 Perforated Corrugated Aluminum Alloy Pipe

ASTM B 745/B 745M Type III, Class I .

2.1.12 Perforated Asbestos-Cement Underdrain Pipe

ASTM C 508.

2.1.13 Plastic Pipe

Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

2.1.13.1 Corrugated Polyethylene (PE) Drainage Pipe

Furnish ASTM F 405 heavy duty for pipe 3 to 6 inches in diameter inclusive, ASTM F 667 for pipe 8 to 24 inches in diameter; or AASHTO M 252 for pipe 3 to 10 inches in diameter or AASHTO M 294 for pipe 12 to 24 inches in diameter. Fittings shall be pipe manufacturer's standard type and shall conform to the indicated specification.

2.1.13.2 Acrylonitrile-Butadiene-Styrene (ABS) Pipe

ASTM D 2751, with a maximum SDR of 35.

2.1.13.3 Polyvinyl Chloride (PVC) Pipe

ASTM F 758, Type PS 46, ASTM D 3034, or ASTM F 949 with a minimum pipe stiffness of46 psi.

2.1.13.4 Circular Perforations in Plastic Pipe

Circular holes shall be cleanly cut, not more than 5/16 inch or less than 3/16 inch in diameter, and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 3 inches apart, center-to-center, along rows. The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket and perforations shall continue at uniform spacing over

the entire length of the pipe. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.

2.1.13.5 Slotted Perforations in Plastic Pipe

Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots shall not exceed 1/8 inch or be less than 1/32 inch. The length of individual slots shall not exceed 1-1/4 inches on 3 inch diameter tubing; 10 percent of the tubing inside nominal circumference on 4 to 8 inch diameter tubing; and 2-1/2 inches on 10 inch diameter tubing. Rows of slots shall be symmetrically spaced so that they are fully contained in quadrants of the pipe. Slots shall be centered in the valleys of the corrugations of profile wall pipe. The water inlet area shall be a minimum of 0.5 square inch/linear foot of tubing. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.

2.1.14 Fittings

Fittings shall be of compatible materials for pipe, of corresponding weight and quality, and as specified herein.

2.1.15 Cleanouts and Piping Through Walls

Cleanout pipe and fittings and piping through walls and footings shall be cast-iron soil pipe. Each cleanout shall have a brass ferrule and a cast-brass screw-jointed plug with socket or raised head for wrench.

2.1.16 Cover and Wrapping Materials for Open Joints in Drain Tile

Cover material may be tar paper, roofing paper, reinforced building paper, glass fiber fabric, or other similar type material. Wrapping material shall be 18-14 mesh, 0.01 inch diameter nonferrous wire cloth.

2.1.17 Bedding and Pervious Backfill for Foundation Drains

Bedding and pervious backfill shall be in accordance with coarse aggregate conforming to ASTM C 33, size number [8] [4] inch .

2.1.18 Protective Covering for Pervious Backfill

Protective covering shall be filter fabric conforming to Section 33 46 16 SUBDRAINAGE SYSTEM.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Trenching and Excavation

Perform required trenching and excavation in accordance with Section 31 00 00 EARTHWORK. Keep trenches dry during installation of drainage system. Changes in direction of drain lines shall be made with 1/8 bends. Use wye fittings at intersections.

3.1.2 Bedding

Place graded bedding, minimum 6 inches in depth, in the bottom of trench for its full width and length compacted as specified prior to laying of foundation drain pipe. Each section shall rest firmly upon the bedding, through the entire length, with recesses formed for bell joints. Except for recesses for bell joints, the bedding shall fully support the lower quadrant of the pipe.

3.1.3 Pipe Laying

Lay drain lines to true grades and alignment with a continuous fall in the direction of flow. Bells of pipe sections shall face upgrade. Clean interior of pipe thoroughly before being laid. When drain lines are left open for connection to discharge lines, the open ends shall be temporarily closed and the location marked with wooden stakes. Perforated pipe shall be laid with perforations facing down. Any length that has had its grade or joints disturbed shall be removed and relaid at no additional cost to the Government. Perforated corrugated polyethylene drainage tubing and plastic piping shall be installed in accordance with manufacturer's specifications and as specified herein. Tubing and piping with physical imperfections shall not be installed.

3.1.4 Jointing

3.1.4.1 Perforated and Porous Pipes

Perforated and porous types of drain pipes shall be laid with closed joints.

3.1.4.2 Nonperforated Drain Tile

Nonperforated and plain-end drain tile shall be laid with 1/8 to 1/4 inch open joints. Open joints shall be covered or wrapped. Covered joints shall have one thickness of the cover material placed over the joint. Material shall overlap the joint not less than 4 inches on each side and cover the tile for not less than the upper half or more than the upper two-thirds of the circumference of the tile. Strips of wire cloth wrapping material3 inches wide shall be used for wrapped joints, with ends fastened together.

3.1.4.3 Perforated Corrugated Metal Pipe

Perforated corrugated metal pipe sections shall be joined with standard connecting bands and bolts furnished by the pipe manufacturer.

3.1.4.4 Joints of Concrete or Clay Sewer Pipe

Joints of concrete or clay sewer pipe shall be caulked with oakum and filled solid with cement mortar except where compression joints conforming to ASTM C 425 are used on vitrified clay pipe.

3.1.4.5 Joints of Cast-Iron Pipe

Joints of cast-iron pipe or connections between cast-iron and porous concrete pipes shall be caulked with oakum gasket and filled with lead.

3.1.4.6 Perforated Asbestos-Cement Pipe Joints

Perforated asbestos-cement pipe joints shall be made with tapered couplings

or with sleeve-type couplings suitable for holding the pipe firmly in alignment without use of sealing compound or gaskets.

3.1.4.7 Plain-End Perforated Clay

Plain-end perforated clay drain tile joints shall be made with spring-wire clips, coated with a rust preventive, that will maintain a taut but elastic joint between sections when laid.

3.1.4.8 ABS Pipe

ABS pipe shall be joined using solvent cement or elastomeric joints and shall be in accordance with ASTM D 2751, with dimensions and tolerances in accordance with TABLE II therein.

3.1.4.9 PVC Pipe

PVC pipe joints shall be in accordance with ASTM D 3034, ASTM D 3212, or ASTM F 949.

3.1.4.10 Corrugated Polyethylene

Corrugated polyethylene (PE) pipe joints shall be in accordance with ASTM F 405 or ASTM F 667.

3.1.5 Outlet Lines

The outlet end of drain lines connecting with an open gutter or outfall shall be finished as shown.

3.1.6 Cleanouts

Provide cleanouts in locations indicated. Cleanouts in unpaved areas shall be set in 12 by 12 by 4 inch concrete blocks.

3.2 Backfilling

After joints and connections have been inspected and approved, place the specified pervious backfill material for the full width of the trench and full width between pipe and adjacent walls and 12 inches above the top of the pipe. Place the backfill preventing displacement of or injury to the pipe or tile. Place a protective covering, as specified, over the pervious backfill for the full width of the trench before regular backfill is placed.

-- End of Section --

SECTION 33 46 16

SUBDRAINAGE SYSTEM
04/08

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

1.1.1 Pipe Subdrains

The length of pipe installed will be measured from end to end along the centerlines without any deduction for the diameter of the manholes. Pipe will be paid for according to the number of linear feet of subdrains placed in the accepted work. Payment for bedding and filter materials, except filter fabric, will be included in the payment for the pipe subdrain system.

1.1.2 Blind or French Drains

Blind or french drains will be paid for by the linear footand measured from end to end along the centerlines of the completed drains.

1.1.3 Manholes

Manholes to be paid for will be the number of manholes completed with base, rungs or ladders, frames, and covers or gratings (where specified) constructed in the accepted work.

1.1.4 Flushing and Observation Risers

Flushing and observation risers to be paid for will be the number of flushing and observation risers completed with frames and covers (where specified) constructed in the accepted work.

1.1.5 Filter Fabric

Filter fabric shall be measured for payment by the square yard in place. Overlapped joints and seams shall be measured as a single layer of cloth.

1.2 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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 190	(2004) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 227/A 227M	(2006) Standard Specification for Steel Wire, Cold-Drawn for Mechanical Springs
ASTM A 229/A 229M	(1999; R 2005) Standard Specification for Steel Wire, Oil-Tempered for Mechanical Springs
ASTM A 27/A 27M	(2005) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A 47/A 47M	(1999; R 2004) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A 48/A 48M	(2003) Standard Specification for Gray Iron Castings
ASTM A 760/A 760M	(2006) Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 762/A 762M	(2000) Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM B 745/B 745M	(1997; R 2005) Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C 139	(2005) Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 231	(2008) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 33	(2007) Standard Specification for Concrete Aggregates
ASTM C 4	(2004; R 2005) Clay Drain Tile and Perforated Clay Drain Tile
ASTM C 412	(2005a) Concrete Drain Tile
ASTM C 425	(2004) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 478	(2008) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C 55	(2006e1) Concrete Brick
ASTM C 62	(2005) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 700	(2007a) Standard Specification for Vitrified Clay Pipe, Extra Strength,

	Standard Strength, and Perforated
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D 2751	(2005) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 3034	(2006) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(2007) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3753	(2005e1) Glass-Fiber-Reinforced Polyester Manholes and Wetwells
ASTM D 422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D 5034	(1995; R 2001) Breaking Strength and Elongation of Textile Fabrics (Grab Test)
ASTM F 405	(2005) Corrugated Polyethylene (PE) Tubing and Fittings
ASTM F 667	(2006) Large Diameter Corrugated Polyethylene Pipe and Fittings
ASTM F 949	(2006a) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-04 Samples

Filter Fabric
Pipe for Subdrains

Samples of filter fabric, pipe, and pipe fittings, before starting the work.

SD-07 Certificates

Filter Fabric
Pipe for Subdrains

Certifications from the manufacturers attesting that materials meet specification requirements. Certificates are required for drain pipe, drain tile, fittings, and filter fabric.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage; unload, and store with minimum handling. Do not store materials directly on the ground. The inside of pipes and fittings shall be free of dirt and debris. Keep, during shipment and storage, filter fabric wrapped in burlap or similar heavy duty protective covering. The storage area shall protect the fabric from mud, soil, dust, and debris. Filter fabric materials that are not to be installed immediately shall not be stored in direct sunlight. Install plastic pipe within 6 months from the date of manufacture unless otherwise approved.

1.4.2 Handling

Handle materials in such a manner as to ensure delivery to the trench in sound undamaged condition. Pipe shall be carried and not dragged to the trench.

PART 2 PRODUCTS

2.1 PIPE FOR SUBDRAINS

Pipe for subdrains shall be of the types and sizes indicated.

2.1.1 Clay and Perforated Clay

2.1.1.1 Clay

Clay pipe shall be either standard or extra strength as indicated and shall conform to ASTM C 700.

2.1.1.2 Perforated Clay

Perforated clay pipe shall be either standard or extra strength as indicated and shall conform to ASTM C 700. Plain-end pipe conforming to the strength and perforation requirements of ASTM C 700 will also be acceptable if provided with spring wire clips of approved type to maintain a taut but elastic joint between the sections of pipe when laid. Clips shall be constructed of not smaller than No. 9 hard-drawn or oil-tempered steel wire conforming to ASTM A 227/A 227M or ASTM A 229/A 229M, and shall be coated with an approved rust preventive coating. Wire clips shall withstand 25 cycles of alternate loading and unloading using a stressing force of 125 pounds. The permanent set resulting from this test shall be less than 5 percent, based on the original length of the fastener. Compression joints conforming to ASTM C 425 will also be acceptable.

2.1.2 Perforated Corrugated Steel

Perforated corrugated steel pipe shall conform to ASTM A 760/A 760M, Type

III. Sheet thickness of pipe shall be as indicated.

2.1.3 Perforated Corrugated Steel, Fully Bitumin. Coated

Perforated corrugated steel pipe, fully bituminous coated, shall conform to ASTM A 760/A 760M, Type III, with a coating conforming to AASHTO M 190, Type A. Sheet thickness of pipe shall be as indicated.

2.1.4 Drain Tile

Clay drain tile shall conform to ASTM C 4 standard, extra quality or heavy duty as indicated. Concrete drain tile shall conform to ASTM C 412 standard, extra, heavy duty extra, or special quality as indicated.

2.1.5 Perforated Corrugated Aluminum Alloy

Perforated corrugated aluminum alloy pipe shall conform to ASTM B 745/B 745M, Type III, Class 1 . Sheet thickness of pipe shall be as indicated.

2.1.6 Perforated Corrugated Aluminum Alloy, Fully Bitumin. Coated

Perforated corrugated aluminum alloy pipe, fully bituminous coated shall conform to ASTM B 745/B 745M, Type III, Class 1 with a bituminous coating conforming to AASHTO M 190, Type A.

2.1.7 Precoated Corrugated Steel

Precoated corrugated steel pipe shall conform to ASTM A 762/A 762M, Type III.

2.1.8 Plastic

Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

2.1.8.1 Acrylonitrile-Butadiene-Styrene (ABS)

Acrylonitrile-butadiene-styrene (ABS) piping and fittings shall conform to ASTM D 2751, with maximum SDR of 35.

2.1.8.2 Polyvinyl Chloride (PVC) and Fittings

Polyvinyl chloride (PVC) pipe and fittings shall conform to ASTM D 3034, .

2.1.8.3 Corrugated Polyethylene (PE) and Fittings

Use ASTM F 405 for pipes 3 to 6 inches in diameter, inclusive, ASTM F 667 for pipes 8 to 24 inches in diameter . Fittings shall be manufacturer's standard type and shall conform to the indicated specification.

2.1.8.4 Pipe Perforations

Water inlet area shall be a minimum of 0.5 square inch per linear foot. Manufacturer's standard perforated pipe which essentially meets these requirements may be substituted with prior approval of the Contracting Officer.

a. Circular Perforations in Plastic Pipe: Circular holes shall be cleanly cut not more than 3/8 inch or less than 3/16 inch in diameter

and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 3 inches center-to-center along rows. The rows shall be approximately 1-1/2 inches apart and arranged in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. The rows shall be spaced over not more than 155 degrees of circumference. The spigot or tongue end of the pipe shall not be perforated for a length equal to the depth of the socket, and perforations shall continue at uniform spacing over the entire length of the pipe.

b. Slotted Perforations in Plastic Pipe: Circumferential slots shall be cleanly cut so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots shall not exceed 1/8 inch nor be less than 1/32 inch. The length of individual slots shall not exceed 1-1/4 inches on 3 inch diameter tubing, 10 percent of the tubing inside nominal circumference on 4 to 8 inch diameter tubing, and 2-1/2 inches on 10 inch diameter tubing. Rows of slots shall be symmetrically spaced so that they are fully contained in 2 quadrants of the pipe. Slots shall be centered in the valleys of the corrugations of profile wall pipe.

2.2 FILTER FABRIC

Filter fabric shall be a pervious sheet of polyester, nylon, or polypropylene filaments woven or otherwise formed into a uniform pattern with distinct and measurable openings. The filter fabric shall provide an equivalent opening size (AOS) no finer than the US Standard Sieve No. 4 and no coarser than the US Standard Sieve No. . AOS is defined as the number of the US Standard sieve having openings closest in size to the filter fabric openings. The fabric shall have a minimum physical strength of pounds per inch in any direction when tested in accordance with ASTM D 5034 using the grab test method with 1 square inch jaws and a constant rate of travel of 12 inches per minute. Elongation at failure shall be between 30 and 70 percent. The fabric shall be constructed so that the filaments will retain their relative position with respect to each other.

2.3 SUBDRAIN FILTER AND BEDDING MATERIAL

Subdrain filter and bedding material shall be washed sand, sand and gravel, crushed stone, crushed stone screenings, or slag composed of hard, tough, durable particles free from adherent coatings. Filter material shall not contain corrosive agents, organic matter, or soft, friable, thin, or elongated particles and shall be evenly graded between the limits specified in TABLE I. TABLE II shows values that can be used to complete TABLE I. Gradation curves will exhibit no abrupt changes in slope denoting skip or gap grading. Filter materials shall be clean and free from soil and foreign materials. Filter blankets found to be dirty or otherwise contaminated shall be removed and replaced with material meeting the specific requirements, at no additional cost to the Government.

TABLE I. FILTER GRADATION

Sieve Designation	Percent by Weight Passing		
	Gradation A	Gradation B	Gradation C

TABLE II

[[ASTM D 422 Sieve Size]	[Type I [Gradation E 11 ASTM C 33] [Percent Passing]	Type II [Gradation 57 ASTM C 33] [Percent Passing]	Type III [Gradation [_____]] [_____]] [Percent Passing]
1.5 inches	--	100	[_____]
1 inch	--	90 - 100	[_____]
3/8 inch	100	25 - 60	[_____]
No. 4	95 - 100	5 - 40	[_____]
No. 8	--	0 - 20	[_____]
No. 16	45 - 80	--	[_____]
No. 50	10 - 30	--	[_____]
No. 100	0 - 10	--	[_____]]

2.4 DRAINAGE STRUCTURES

2.4.1 Concrete

Except for precast concrete, reinforcement shall conform to the requirements for [3,000] [_____] psi concrete in Section 03 31 00.00 10 CAST-IN-PLACE STRUCTURAL CONCRETE. The concrete mixtures shall have air content, by volume of concrete, based on measurements made immediately after discharge from the mixer of 5 to 7 percent when coarse-aggregate maximum size is 1-1/2 inches or smaller. Air content shall be determined in accordance with ASTM C 231. The concrete covering over steel reinforcing shall be not less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall be at least 3 inches thick between the steel and the ground. Expansion-joint filler material shall conform to ASTM D 1751 or ASTM D 1752. Exposed concrete surfaces, such as drainage structures that form a continuation of concrete curbs and gutters, shall be given a protective coating of linseed oil as specified in Section 32 16 13 CONCRETE SIDEWALKS AND CURBS AND GUTTERS.

2.4.2 Mortar

Mortar for pipe joints and connections to other drainage structures shall be composed of one part by volume of portland cement and two parts of sand. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of injurious acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes from the time the ingredients are mixed with water.

2.4.3 Manholes and Appurtenances

2.4.3.1 Precast Reinforced Concrete Manhole Risers and Tops

Precast reinforced concrete manhole risers and tops shall conform to ASTM C 478.

2.4.3.2 Precast Concrete Segmental Blocks

Precast concrete segmental blocks shall conform to ASTM C 139 and shall be not more than 8 inches thick, not less than 8 inches long, and of such shape that the joints can be effectively sealed and bonded with cement mortar.

2.4.3.3 Precast Concrete Manhole Bases

If precast concrete manhole bases are used, the bases shall conform to ASTM C 478 and shall be of such a design as to effect suitable connection with influent and effluent lines and to provide a suitable base structure for riser sections.

2.4.3.4 Brick

Brick shall conform to ASTM C 62, Grade SW, or ASTM C 55, Grade S-I or S-II. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in the amount of not more than 25 percent by volume of cement.

2.4.3.5 Prefabricated Corrugated Metal

Steel manholes and risers shall be fabricated of at least gauge galvanized corrugated metal.

2.4.3.6 Glass Fiber-Reinforced Polyester (FRP)

FRP manholes shall conform to ASTM D 3753.

2.4.3.7 Frames and Covers or Gratings

Frames and gratings, or frames and covers, except as otherwise permitted, shall be of either cast iron with tensile strength test not less than ASTM A 48/A 48M Class 25 or steel conforming to ASTM A 27/A 27M, Class 65-35. Weight, shape, and size shall be as indicated. Frames and covers not subjected to vehicular traffic or storage may be of malleable iron where indicated. The malleable-iron frames and covers shall conform to ASTM A 47/A 47M and shall be of the weight, shape, and size indicated.

2.4.3.8 Steel Ladder

A steel ladder shall be provided where the depth of a manhole exceeds 12 feet. The ladder will be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2 inches wide. Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet apart vertically, and shall be so installed as to provide at least 6 inches of space between the wall and the rungs. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M. The wall along the line of the ladder shall be vertical for its entire length.

PART 3 EXECUTION

3.1 EXCAVATION AND BEDDING FOR SUBDRAIN SYSTEMS

Trenching and excavation, including the removal of rock and unstable material, shall be in accordance with Section 31 00 00 EARTHWORK. Bedding material shall be placed in the trench as indicated or as required as replacement materials used in those areas where unstable materials were removed. Compaction of the bedding material shall be as specified for cohesionless material in Section 31 00 00 EARTHWORK.

3.2 MANHOLES AND FLUSHING AND OBSERVATION RISERS

3.2.1 Manholes

Manholes shall be installed complete with frames and covers or gratings at the locations and within the limits and sizes indicated. Manholes shall be constructed of one of the materials specified for manholes in paragraph DRAINAGE STRUCTURES. Joints shall be completely filled and shall be smooth and free of surplus mortar or mastic on the inside of the structure. Brick manholes shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. Brick for square or rectangular structures shall be laid in stretcher courses with a header course every sixth course. Brick for round structures shall be laid radially with every sixth course laid as a stretcher course. Ladders shall be installed in manholes as indicated. Base for manholes shall be either precast or cast-in-place concrete.

3.2.2 Flushing and Observation Risers

Flushing and observation riser pipes with frames and covers shall be installed at the locations indicated. Risers shall be constructed of precast concrete, vitrified clay, or galvanized corrugated metal pipe. Joining of riser pipes to the subdrain system shall be as indicated.

3.3 INSTALLATION OF FILTER FABRIC AND PIPE FOR SUBDRAINS

3.3.1 Installation of Filter Fabric

3.3.1.1 Overlaps on Perforated or Slotted Pipes

One layer of filter fabric shall be wrapped around perforated or slotted collector pipes in such a manner that longitudinal overlaps of fabric are in unperforated or unslotted quadrants of the pipes. The overlap shall be at least 2 inches. The fabric shall be secured to the pipe in such a manner that backfill material will not infiltrate through any fabric overlaps.

3.3.1.2 Installation on Open-Joint Pipe

One layer of filter fabric shall be wrapped around open joints. The overlap should be at least 2 inches. The fabric shall be secured to the pipe in such a manner that backfill material will not infiltrate through the overlap or the edges of the fabric to either side of the open joint.

3.3.1.3 Trench Lining and Overlaps

Trenches to be lined with filter fabric shall be graded to obtain smooth side and bottom surfaces so that the fabric will not bridge cavities in the soil or be damaged by projecting rock. The fabric shall be laid flat but

not stretched on the soil, and it shall be secured with anchor pins. Overlaps shall be at least inches, and anchor pins shall be used along the overlaps.

3.3.2 Installation of Pipe for Subdrains

3.3.2.1 Pipelaying

Each pipe shall be carefully inspected before it is laid. Any defective or damaged pipe shall be rejected. No pipe shall be laid when the trench conditions or weather is unsuitable for such work. Water shall be removed from trenches by sump pumping or other approved methods. The pipe shall be laid to the grades and alignment as indicated. The pipe shall be bedded to the established gradeline. Perforations shall be centered on the bottom of the pipe. Pipes of either the bell-and-spigot type or the tongue-and-groove type shall be laid with the bell or groove ends upstream. All pipes in place shall be approved before backfilling.

3.3.2.2 Jointings

a. Nonperforated Concrete and Clay Pipe: Pipe shall be laid with 1/8 to 1/4 inch opening between the ends of the pipe or as required by spacing lugs constructed in the pipe. Mortar shall be placed in the joint at three points and pressed firmly into place to hold the pipe securely in line. The mortar shall be the full depth of the bell or groove and approximately 1 inch in width, and shall be located at the third points around the joint with the top point at the center of the pipe. The inside of the pipe shall be free of excess mortar.

b. Perforated Concrete and Clay Pipe: The pipe shall be laid with closed joints with positive provision for centering each section of the pipe in the bell or groove of the previously placed section. Plain-end perforated clay pipe sections shall be securely fastened together with spring wire clips furnished by the pipe manufacturer.

c. Perforated Corrugated Metal Pipe or Bituminous Coated, Perforated Corrugated Metal Pipe: The sections of perforated corrugated metal pipe or bituminous coated, perforated corrugated metal pipe shall be securely fastened together with standard connecting bands furnished by the manufacturer of the pipe.

d. Drain Tile: Drain tile shall be bedded as provided for bell-and-spigot or tongue-and-groove types of pipe and laid with open joints of approximately 1/8 inch width but not over 1/4 inch width. Drain tile shall be protected against the entrance of filter material into the line by the use of filter fabric.

e. Porous Concrete Pipe: Porous concrete pipe shall be installed with mortar joints.

f. Perforated Asbestos-Cement Pipe: Couplings shall be of the sleeve type suitable for holding the pipe firmly in alignment without the use of sealing compounds or gaskets. Tapered couplings will be acceptable.

g. Bituminous Coated or Uncoated Semicircular Steel Pipe: Coupling bands shall consist of an uncorrugated top and bottom section fabricated to fit around two adjacent pieces of pipe. Coupling bands shall be bolted together with four bolts.

h. Bituminous Coated or Uncoated Corrugated Aluminum Pipe: If aluminum pipe is to be connected to dissimilar metal, the connection shall be insulated by bituminous coating or other nonconductive material. Standard joints between corrugated aluminum pipe shall be securely fastened with standard connecting bands furnished by the manufacturer of the pipe.

i. Acrylonitrile-Butadiene-Styrene (ABS): Solvent cement or elastomeric joints for ABS pipe shall be in accordance with ASTM D 2751. Dimensions and tolerances shall be in accordance with TABLE II of ASTM D 2751.

j. Polyvinyl Chloride (PVC) Pipe: Joints shall be in accordance with the requirements of ASTM D 3034, ASTM D 3212, or ASTM F 949.

k. Perforated Corrugated Polyethylene Pipe: Perforated corrugated polyethylene drainage pipe shall be installed in accordance with the manufacturer's specifications and as specified herein. A pipe with physical imperfections shall not be installed. No more than 5 percent stretch in a section will be permitted.

3.4 INSTALLATION OF AND BACKFILLING FOR BLIND OR FRENCH DRAINS

Filter material shall be placed as indicated and compacted as specified for cohesionless materials in Section 31 00 00 EARTHWORK. Filter material shall extend to a suitable outlet or to an outlet through a pipeline as indicated. Overlying backfill material shall be placed and compacted as specified in Section 31 00 00 EARTHWORK.

3.5 INSTALLATION OF FILTER MATERIAL AND BACKFILLING FOR SUBDRAINS

After pipe for subdrains has been laid, inspected, and approved, filter material shall be placed around and over the pipe to the depth indicated. The filter material shall be placed in layers not to exceed 8 inches thick, and each layer shall be to obtain the required density. Compaction of filter material and the placement and compaction of overlying backfill material shall be in accordance with the applicable provisions specified in Section 31 00 00 EARTHWORK.

3.6 TESTS

3.6.1 Pipe Test

Strength tests of pipe shall conform to field service test requirements of the Federal Specification, ASTM specification, or AASHTO specification covering the product (paragraph PIPE FOR SUBDRAINS).

3.6.2 JP-4 Fuel Resistance Test

Five unaged fabric samples, 4 (plus or minus 0.2) by 6 (plus or minus 0.2) inches shall be immersed in JP-4 fuel at room temperature for a period of 7 days. Each sample then shall be tested for tensile strength and elongation in accordance with ASTM D 5034. The strength of the fabric in any direction shall be no less than 85 percent of the strength specified in paragraph FILTER FABRIC.

-- End of Section --

40 92 49.98

VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS
04/06

PART 1 GENERAL

1.1 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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991; R 1995) Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 519	(2004) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2000) Industrial Control and Systems: General Requirements
NEMA ICS 3.1	(1997; R 2003) Industrial Control and Systems: Handling, Storage and Installation Guide for AC General-Purpose Medium Voltage Contactors and Class E Controllers, 50 and 60 Hertz
NEMA ICS 7	(2006) Industrial Control and Systems: Adjustable-Speed Drives

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-461	(Rev E) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15	(2008) Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 508C	(2002; Rev thru Feb 2008) Power Conversion Equipment

1.2 RELATED REQUIREMENTS

Section 26 05 00.00 98 BASIC ELECTRICAL MATERIALS AND METHODS, applies to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements

1.3.1.1 Electromagnetic Interference Suppression

Computing devices, as defined by 47 CFR 15, MIL-STD-461 rules and regulations, shall be certified to comply with the requirements for class A computing devices and labeled as set forth in part 15.

1.3.1.2 Electromechanical and Electrical Components

Electrical and electromechanical components of the Variable Frequency Drive (VFD) shall not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.

1.3.2 Electrical Requirements

1.3.2.1 Power Line Surge Protection

IEEE C62.41, IEEE Std 519 Control panel shall have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge arrestor shall be mounted near the incoming power source and properly wired to all three phases and ground. Fuses shall not be used for surge protection.

1.3.2.2 Sensor and Control Wiring Surge Protection

I/O functions as specified shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes.

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Schematic diagrams

Interconnecting diagrams

Installation drawings

Submit drawings for government approval prior to equipment construction or integration. Modifications to original drawings made during installation shall be immediately recorded for inclusion into the as-built drawings.

SD-03 Product Data

Variable frequency drives

Wires and cables

Equipment schedule

Include data indicating compatibility with motors being driven.

SD-06 Test Reports

VFD Test

Performance Verification Tests

Endurance Test

SD-08 Manufacturer's Instructions

Installation instructions

SD-09 Manufacturer's Field Reports

VFD Factory Test Plan

Factory test results

SD-10 Operation and Maintenance Data

Variable frequency drives, Data Package 4

Provide service and maintenance information including preventive maintenance, assembly, and disassembly procedures. Include electrical drawings from electrical general sections. Submit additional information necessary to provide complete operation, repair, and maintenance information, detailed to the smallest replaceable unit. Include copies of as-built submittals. Provide routine preventative maintenance instructions, and equipment required. Provide instructions on how to modify program settings, and modify the control program. Provide instructions on drive adjustment, trouble-shooting, and configuration. Provide instructions on process tuning and system calibration.

1.5 QUALITY ASSURANCE

1.5.1 Schematic Diagrams

Show circuits and device elements for each replaceable module. Schematic diagrams of printed circuit boards are permitted to group functional assemblies as devices, provided that sufficient information is provided for government maintenance personnel to verify proper operation of the functional assemblies.

1.5.2 Interconnecting Diagrams

Show interconnections between equipment assemblies, and external interfaces, including power and signal conductors. Include for enclosures and external devices.

1.5.3 Installation Drawings

Show floor plan of each site, with V.F.D.'s and motors indicated. Indicate ventilation requirements, adequate clearances, and cable routes.

1.5.4 Equipment Schedule

Provide schedule of equipment supplied. Schedule shall provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule shall include the total quantity of each item of equipment supplied. For complete assemblies, such as VFD's, provide the serial numbers of each assembly, and a sub-schedule of components within the assembly. Provide recommended spare parts listing for each assembly or component.

1.5.5 Installation instructions

Provide installation instructions issued by the manufacturer of the equipment, including notes and recommendations, prior to shipment to the site. Provide operation instructions prior to acceptance testing.

1.5.6 Factory Test Results

Document test results and submit to government within 7 working days after completion of test.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 WARRANTY

The complete system shall be warranted by the manufacturer for a period of one year, or the contracted period of any extended warrantee agreed upon by the contractor and the Government, after successful completion of the acceptance test. Any component failing to perform its function as specified and documented shall be repaired or replaced by the contractor at no additional cost to the Government. Items repaired or replaced shall be warranted for an additional period of at least one year from the date that it becomes functional again, as specified in the FAR CLAUSE 52.246-21.

1.8 MAINTENANCE

1.8.1 Spare Parts

Manufacturers provide spare parts in accordance with recommended spare parts list.

1.8.2 Maintenance Support

During the warranty period, the Contractor shall provide on-site, on-call maintenance services by Contractor's personnel on the following basis: The service shall be on a per-call basis with 36 hour response. Contractor shall support the maintenance of all hardware and software of the system. Various personnel of different expertise shall be sent on-site depending on the nature of the maintenance service required. Costs shall include travel, local transportation, living expenses, and labor rates of the

service personnel while responding to the service request. The provisions of this Section are not in lieu of, nor relieve the Contractor of, warranty responsibilities covered in this specification. Should the result of the service request be the uncovering of a system defect covered under the warranty provisions, all costs for the call, including the labor necessary to identify the defect, shall be borne by the Contractor.

1.9 VFD with Electro-Mechanical Bypass

This specification covers complete a variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD panel.

The VFD shall be UL Type 1 or UL Type 12 as required on the schedule. The VFD shall have been evaluated by UL and found acceptable for mounting in a plenum or other air handling compartment. Manufacturer shall supply a copy of the UL plenum evaluation upon request.

The VFD shall be tested to UL 508C. The appropriate UL label shall be applied. VFD shall be manufactured in ISO 9001,2000 certified facilities.

The VFD shall be UL listed for a short circuit current rating of 100 kAIC and labeled with this rating.

The VFD manufacturer shall supply the VFD and all necessary controls as herein specified.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES (VFD)

Provide frequency drive to control the speed of induction motor(s). The VFD shall include the following minimum functions, features and ratings.

A. The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

B. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement)power factor near unity regardless of speed or load.

C. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

VFDs with saturating (non-linear) DC link reactors shall require an

additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

D. The VFD's full load output current rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

E. The VFD shall provide full motor torque at any selected frequency from 20Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive pumps or fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

F. A programmable automatic optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.

G. The VFD must be able to produce full torque at low speed to operate direct drive pumps or fans.

H. Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

I. An automatic motor adaptation algorithm shall measure motor sator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

J. Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

K. VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier are not acceptable.

L. All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the AC power line.

2.2 PROTECTIVE FEATURES

A. A minimum of Class 20 I squared t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

B. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

C. Protect VFD from input phase loss. The VFD should be able to

protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

D. Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

E. Protect from over voltage. The VFD shall continue to operate without faulting with a momentary input voltage as high as 130% of the nominal voltage.

F. The VFD shall incorporate a programmable motor preheat feature to keep the motor warm and prevent condensation build up in the motor when it is stopped in a damp environment by providing the motor stator with a controlled level of current.

G. VFD shall include a "signal loss detection" algorithm with adjustable time delay to sense the loss of an analog input signal. It shall also include a programmable time delay to eliminate nuisance signal loss indications. The functions after detection shall be programmable.

H. VFD shall function normally when the keypad is removed while the VFD is running. No warnings or alarms shall be issued as a result of removing the keypad.

I. VFD shall catch a rotating motor operating forward or reverse up to full speed without VFD fault or component damage.

J. Selectable over-voltage control shall be provided to protect the drive from power regenerated by the motor while maintaining control of the driven load.

K. VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

L. If the temperature of the VFD's heat sink rises to 80 degrees C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.

M. In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output to a programming value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

N. The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increase pump or fan life. At low loads or low ambient temperatures, the pump or fan may be off even when the VFD is running.

O. The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

2.3 INTERFACE FEATURES

A. Hand, Off and Auto Keys shall be provide to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

B. There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.

C. The VFD shall be programmable to provide a digital output to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

D. Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

E. All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

F. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFDs keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. The facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

H. A red FAULT light, a yellow WARNING light, and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

I. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Pump or fan menus specifically designed to faclitate start-up of these applications.

J. A three-feedback PID controller to control the speed of the VFD shall be standard.

1. This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoint and to automatically select either the maximum or the feedback signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of the feedback signals or the difference between a pair of feedback signals.

2. The VFD shall be able to apply individual scaling to each feedback signal.

The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

L. Floating point control interfaces shall be provided to increase/decrease speed in response to contact closures.

M. Five simultaneous meter displays shall be available. They shall include at a minimum frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, among others.

N. Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

O. A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.

P. VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (degrees F).

Q. VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

R. Standard Control and Monitoring Inputs and Outputs

1. Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety circuitry.

2. Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

3. Two programmable relays outputs, Form C240 V AC,2A, shall be provided for remote indication of VFD status.
a} Each relay shall have an adjustable on delay/off dely time.

4. Two programmable analog inputs shall be provided that can be either direct-or-reserve acting.
a) Each shall be independently selectable to be used with either an analog voltage or current signal.

b) The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20mA.
c) A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.
d) The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting.

5. One programmable analog current output (0/4 to 20mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

6. It shall be possible through serial bus communications to read the status of all analog and digital inputs of the VFD.

7. It shall be possible to command all digital and analog output through the serial communication bus.

S. Optional Control and Monitoring Inputs and Outputs

1. It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

2. These modules shall use rigid connectors to plug into the VFD's control card.

3. The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

T. A real-time clock shall be an integral part of the VFD.

1. It shall be possible to use this to display the current date and time on the VFD's display.

2. Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoint and outputs relays. Is shall be possible to program unique events that occur during normal work days, other that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

3. All VFD faults shall be time stamped to aid troubleshooting.

4. It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

5. The real-time clock shall be able to time and date stamp all faults recorded into the VFD fault log.

U. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

V. The VFD shall be include a sequential logic controller to provide advanced control interface capabilities. This shall include:

1. Comparators for comparing VFD analog values to programmed trigger values

2. Logic operators to combine up to three logic expressions using Boolean algebra

3. Delay timers

4 A 20-step programmable structure

W. The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of additional constant speed motor starters.

2.4 SERIAL COMMUNICATIONS

A. The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communications protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

1. Johnson Controls Metasys N2

2. Modbus RTU

B. Option boards for the following protocols shall be available:

1. LonWorks Free Topology (FTP) certified to LonMark standard 3.3

2. BACnet MS/TP

C. VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

D. The VFD shall have provisions for an optional 24 V DC back-up power to interface the VFD's control card. This is to allow the VFD to continue communicate to the building automation system even if power to the VFD is lost.

2.5 ADJUSTMENT

A. The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

B. Four independent setups shall be provided.

C. Four preset speeds per setup shall be provided for a total of 16.

D. Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

E. Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

F. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, current limit, over temperature, and VFD overload.

G. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

H. An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

I. Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges hall simplify the set-up.

2.6 OPTIONAL FEATURES

A. All optional features shall be built, mounted and tested by the VFD manufacturer. The VFD manufacturer's warranty shall apply to the entire assembly as shipped. Packages built by third parties and do not carry the VFD manufacturer's warranty shall not be allowed.

B. All panels shall be marked for 100,000 amp short circuit current rating.

C. The enclosure rating of the VFD w/options shall be consistent with the VFD rating of either NEMA/UL type 1 or NEMA/UL/ type 12, as required for the installation location and/or as called for on the schedule. The package shall include all optional devices and shipped as a complete factory tested assembly.

D. Three-Contactor bypass shall be provided that allows operation of the motor via line power in the event of a failure of the VFD. Motor control selection shall be though either a VFD output contactor or a bypass contactor that are electrically interlocked to ensure that both contactors are not energized simultaneously. A third contactor, the drive input contactor, shall be supplied as standard. This allows the powering of the VFD with the motor off or operating in bypass mode for testing, programming and troubleshooting purposes.

E. The Three-Contactor bypass shall include the following interface and control features:

1. Mode selection via a four position DRIVE/OFF/BYPASS/TEST switch.

a) *DRIVE Mode: Both the drive input and output contactors are closed and the motor is operated via VFD power.*

b) OFF mode: DRIVE input, drive output and bypass contactors are all open.

c) Bypass mode: Bypass contactor is closed and motor is operating from line power. Both the drive input and drive output contactors are open for servicing of the VFD without power.

d) Test mode: Bypass contactor is closed and the motor is operated from line power. The drive input contactor closed but the drive output contactor is open. This allows for the testing and programming of the VFD while the motor is operated via line power.

2. Contactors shall operate from a 24vdc power supply that shall function off of any two legs of the AC line and shall maintain power on the loss of any one of the AC lines.

3. A Bypass pilot light is supplied to indicate that the motor is operating from line power.

4. Common start/stop command when operating in either Bypass or VFD mode.

5. Selectable Run Permissive logic shall operate in either VFD or bypass operation. When activated, any command to start the motor, in either Hand Bypass, Remote Bypass Hand VFD or Remote VFD shall not start the motor, but instead close a relay contact that is used to initiate operation of another device, such as an outside air damper. A contact closure from this device shall confirm that it is appropriately actuated and the motor shall then start.

6. Bypass package shall include an External Safety interlock that will disable motor operation in either bypass or VFD when open.

7. The bypass must include a selectable time delay of 0 to 60 seconds before the initiation of bypass operation. When transferring from VFD to bypass modes, the time delay starts after the motor has decelerated to zero speed. This delay allows the BAS to prepare for bypass operation. Bypass packages that do not include a time delay, or do not include a selectable delay period, will not be acceptable.

8. Automatic bypass shall be selectable. When active, the motor shall be transferred to line power on a VFD fault condition. The bypass time delay shall be activate prior to this transfer to line power to allow the VFD time to attempt to recover from the fault condition prior to running in bypass.

F. Protective Features

1. Main input disconnect shall be provided that removes power from both the bypass and VFD.

2. Main input motor rated fuses that protect the entire package.

3. VFD only fast acting input fuses shall be provided. Packages that include only main input motor rated fusing or circuit breaker

are not acceptable.

4. Overload protection shall be supplied in bypass mode.

a) This overload shall supply minimum class 20 protection as well as wide adjustable current setting for complete motor protection when operating on line power. Those overloads that are not class 20 or current selectable will not be acceptable.

b) Overload protection shall include phase loss and phase imbalance protection.

5. Low voltage contactor operation shall be maintained to 70% of the packages nominally rated voltage. This will ensure VFD operation on low voltage conditions that would otherwise be interrupted due to contactor dropout.

6. The VFD shall be able to operate the motor at a reduced load with the loss of any one of the three phases of power. Contactors shall remain closed regardless of which phase is lost. This will ensure VFD operation on single phase conditions that would otherwise be interrupted due to contactor dropout.

G. Line/load conditioners

1. VFDs that do not include 5% DC link impedance shall include 5% AC line reactors in the options enclosure. Lower levels of impedance will not be acceptable.

2. When the installation requires additional motor dV/dT protection it shall be via a dV/dT filter mounted in the options enclosure. Packages that include only load reactors or filters supplied separately will not accepted.

2.6.1 SERVICE CONDITIONS

A. Ambient temperature, continuous, full speed, full load operation.

1. (14 to 113 degrees F) through 125HP @460 and 600 volt, through 60 HP @ 208 volt

B. 0 to 95% relative humidity, non-condensing.

C. Elevation to 3,300 feet without derating.

D. AC line voltage variation, -10 to +10% of nominal with full output.

E. All power and control wiring shall be done from the bottom.

F. All VFDs shall be plenum rated.

G. No side clearance shall be required for cooling.

2.6 QUALITY ASSURANCE

A. To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

B. All optional features shall be functionally tested at the factory for proper operation.

2.7 NAMEPLATES

Nameplate external to NEMA enclosures shall conform with the requirements of Section 26 05 00.00 98 BASIC ELECTRICAL MATERIAL AND METHODS. Nameplates internal to enclosures shall be manufacturer's standard, with the exception that they must be permanent.

2.8 SOURCE QUALITY CONTROL

2.8.1 VFD Factory Test Plan

To ensure quality, each VFD shall be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test plans and test reports.

PART 3 EXECUTION

3.1 INSTALLATION

Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings. A field representative of the drive manufacturer shall supervise the installation of all equipment, and wiring.

3.2 FIELD QUALITY CONTROL

Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Contractor shall conduct performance verification tests in the presence of Government representative, observing and documenting complete compliance of the system to the specifications. Contractor shall submit a signed copy of the test results, certifying proper system operation before scheduling tests.

3.2.1 VFD Test

A proposed test plan shall be submitted to the contracting officer at least 28 calendar days prior to proposed testing for approval. The tests shall conform to NEMA ICS 1, NEMA ICS 7, and all manufacturer's safety regulations. The Government reserves the right to witness all tests and review any documentation. The contractor shall inform the Government at least 14 working days prior to the dates of testing. Contractor shall provide video tapes, if available, of all training provided to the Government for subsequent use in training new personnel. All training aids, texts, and expendable support material for a self-sufficient presentation shall be provided, the amount of which to be determined by the contracting officer.

3.2.2 Performance Verification Tests

"Performance Verification Test" plan shall provide the step by step procedure required to establish formal verification of the performance of the VFD. Compliance with the specification requirements shall be verified

by inspections, review of critical data, demonstrations, and tests. The Government reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements. The contractor shall inform the Government 14 calendar days prior to the date the test is to be conducted.

3.2.3 Endurance Test

Immediately upon completion of the performance verification test, the endurance test shall commence. The system shall be operated at varying rates for not less than 192 consecutive hours, at an average effectiveness level of 0.9998, to demonstrate proper functioning of the complete PCS. Continue the test on a day-to-day basis until performance standard is met. During the endurance test, the contractor shall not be allowed in the building. The system shall respond as designed.

3.3 DEMONSTRATION

3.3.1 Training

Coordinate training requirements with the Contracting Officer.

3.3.1.1 Instructions to Government Personnel

Provide the services of competent instructors who will give full instruction to designated personnel in operation, maintenance, calibration, configuration, and programming of the complete control system. Orient the training specifically to the system installed. Instructors shall be thoroughly familiar with the subject matter they are to teach. The Government personnel designated to attend the training will have a high school education or equivalent. The number of training days of instruction furnished shall be as specified. A training day is defined as eight hours of instruction, including two 15-minute breaks and excluding lunch time; Monday through Friday. Provide a training manual for each student at each training phase which describes in detail the material included in each training program. Provide one additional copy for archiving. Provide equipment and materials required for classroom training. Provide a list of additional related courses, and offers, noting any courses recommended. List each training course individually by name, including duration, approximate cost per person, and location of course. Unused copies of training manuals shall be turned over to the Government at the end of last training session.

3.3.1.2 Operating Personnel Training Program

Provide one 2 hour training session at the site at a time and place mutually agreeable between the Contractor and the Government. Provide session to train 4 operation personnel in the functional operations of the system and the procedures that personnel will follow in system operation. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. Alarm formats

e. Failure recovery procedures

f. Troubleshooting

3.3.1.3 Engineering/Maintenance Personnel Training

Accomplish the training program as specified. Training shall be conducted on site at a location designated by the Government. Provide a one day training session to train 4 engineering personnel in the functional operations of the system. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. System configuration

e. Alarm formats

f. Failure recovery procedures

g. Troubleshooting and repair

h. Maintenance and calibration

i. System programming and configuration

-- End of Section --

SECTION 41 22 23.19

MONORAIL HOISTS
04/08

PART 1 GENERAL

1.1 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.

ASME INTERNATIONAL (ASME)

ASME B30.11	(2004) Monorails and Underhung Cranes - Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings
ASME B30.16	(2007) Overhead Hoists (Underhung)Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks and Slings
ASME HST-1	(1999; R 2004) Performance Standard for Electric Chain Hoists
ASME HST-4	(1999; R 2004) Performance Standard for Overhead Electric Wire Rope Hoists

ASTM INTERNATIONAL (ASTM)

ASTM A 275/A 275M	(2007) Standard Test Method for Magnetic Particle Examination of Steel Forgings
ASTM E 543	(2008a) Standard Practice for Agencies Performing Non-Destructive Testing
ASTM E 709	(2008) Standard Guide for Magnetic Particle Examination

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 74	(2004) Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist, No. 74

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ESPG	(2004) Electrical Standards and Product Guide
NEMA ICS 8	(2000; R 2005) Industrial Control and Systems Crane and Hoist Controllers
NEMA MG 1	(2007) Standard for Motors and Generators

NEMA MG 2	(2001; Rev 1 2007) Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2007; AMD 1 2008) National Electrical Code - 2008 Edition

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.179	Overhead and Gantry Cranes

1.2 SYSTEM DESCRIPTION

Provide a monorail system with electric powered hoistand plain type (hand operated)trolley complete, tested and ready for operation. Monorail, hoist, trolley,equipment, materials, installation, examination, inspection, and workmanship shall conform to the applicable requirements of NFPA 70, ASME B30.11, ASME B30.16,as modified and supplemented by this specification. Reference in these publications to the "authority having jurisdiction" means the "Contracting Officer."

1.2.1 Design Data: Structural Design Calculations

Submit additional product data for commercially procured items, including as a minimum, the following items:

Festoon System
Bumpers
End Stops

1.2.2 Design Requirements

Submit shop drawings showing crane capacity, hook envelopeand all component details. Include complete schematic wiring diagram with description of operation. Manufacturer's catalog data will suffice for items of standard manufacturer.

1.2.2.1 Trade Coordination

The Contractor is responsible for the coordination of his work with the work of all trades involved and as it relates to the building structure. Verify all building dimensions that relate to fabrication of the monorail system, and notify the Contracting Officer of any discrepancy prior to ordering the monorail.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Monorail system, including attachments to existing building structure G

Complete schematic wiring diagram with description of operation; G

SD-03 Product Data

Electric Chain Hoist; G
Trolley; G
Pendant Pushbutton Station; G

Hook Proof Test; G
Festoon System; G

Bumpers; G
End Stops; G
Manufacturer's Published Tables

Manufacturer's descriptive data and technical literature, performance charts and curves, catalog cuts, and installation instructions, and parts list.

SD-05 Design Data

Structural Design calculations; G
Structural and Load Capacity calculations; G

Load and sizing calculations as specified.

SD-06 Test Reports

125% Rated Load test
No-Load Test
Post-Erection Inspection
Operational Tests
Rated Load Speed Test
Load Chain Proof Test
Hook NDT Report
Hook Tram Measurement

Tests and inspections reports. Magnetic particle inspection of hook and hook nut results.

SD-07 Certificates

Compliance with all listed Standards
Semi-Annual Overload/Safe for Testing
Hazardous Material
Brake Settings
Runway Straightness/Levelness
Loss of Power Test
Hook Proof Test

SD-10 Operation and Maintenance Data

Monorail with hoist system, all components, Data Package 3; G

1.4 QUALITY ASSURANCE

1.4.1 Certificates: Load Chain

a. Certification of minimum Load Chain Proof Test, clearly indicating

load chain breaking strength for each hoist, and clearly identified for traceability. Submit factory certification of load chain rated capacity.

b. Certification that the hoist, hook, and trolley system contains no hazardous material, asbestos, cadmium, lead, elemental mercury, or PCBs.

c. Semi-Annual Overload/Safe for Testing certification that the hoist, hook, and trolley system is safe to test on a semi-annual overload basis with a test load of 131.25% of rated capacity with no detrimental effects.

d. Certification that testing may be performed in which hoist, hook, and trolley system is subjected to a Loss of Power Test during operation with no detrimental effects.

e. Certification that the hoist, hook, and trolley system design and fabrication is in compliance with all listed standards.

f. Hook Proof Test certification that the hoist hook was subjected to a minimum static load of 200% of rated capacity for at least 10 minutes without deformation.

g. Runway Straightness/Levelness certification that the straightness, levelness, and elevation of the monorail system meet MH27.1 requirements.

h. Certification of brake settings, including the allowable range of adjustment for hoist and trolley brakes and the initial setting of each.

1.4.2 Pre-Erection Inspection

Before erection, the Contractor and the manufacturer's representative shall jointly inspect the monorail and hoist systems and components at the job site to determine compliance with specifications and manufacturer's data and shop drawings as approved. Notify the Contracting Officer 5 days before the inspection.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in enclosures or under protective coverings. Protect materials not suitable for outdoor storage to prevent damage or corrosion during periods of inclement weather, including subfreezing temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on ground. When special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.

1.5.2 Handling

Handle materials in such a manner as to ensure delivery to final location in undamaged condition. Make repairs to damaged materials at no cost to Government.

1.6 MAINTENANCE

Submit Monorail with hoist system, all components, Data Package 3 for the entire monorail system.

PART 2 PRODUCTS

2.1 IDENTIFICATION PLATES

Provide manufacturer installed identification plates of non-corrosive metal showing, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating in pounds, and other essential information. Also provide monorail track beam identification plates showing the capacity of the system, in pounds, legible from the floor and from either side of the monorail track beam.

2.2 OVERHEAD MONORAIL SYSTEM

Basis of design is a Coffing EC4006-3-10

Provide overhead monorail system conforming for indoor service, with an electrical chain hoist mounted on a movable trolley & cord reel. Provide plain type (hand operated)trolley. The hoist and trolley shall meet the design requirements specified in ASME HST-4, Duty Class H4.

2.2.1 Capacity and Speed

Provide monorail system with a minimum rated capacity of 4,000 pounds. The hook lift capacity and speed shall be the manufacturer's standard within the limits specified above. The hook lift maximum height limit is 10 feet above the finished floor, and at its lowest point 0 feet above the finished floor.

2.2.2 Material and Design Requirements

Monorail hoist system shall include the following design requirements:

a. Powered hoists shall include a brake and a controlled braking means, and an overload limiting device.

b. Directional contactors shall include electrical and mechanical interlocks. Design the mainline contactor, along with the power-off/power-on circuitry to remove power from the drive motors, brakes and control circuit. The control circuit shall not operate unless a power-on button is depressed.

c. Overcurrent protection for the control circuit and control circuit transformer; fuse or circuit breaker protection for branch circuit short circuit and ground fault protection; and overload protection for each motor, motor controller, and branch circuit conductor shall all conform to the NFPA 70.

d. Provide safety (drop) lugs or a functional equivalent on the trolley frame to prevent derailment in the event of wheel failure.

e. The hoist and trolley shall be capable of general service working conditions.

f. Provide monorail system operating on 208 Volts 60 Hz power supply.

g. Provide a non-resettable hour meter, connected across the main line contactor, readable from the exterior of the main control panel, to indicate the elapsed number of hours the crane is energized.

2.2.3 Safety

Comply with the mandatory and advisory safety requirements of ASME B30.11, ASME B30.16, and 29 CFR 1910.179. The Contractor is responsible for checking the proper operation and condition of safety devices, electrical components, mechanical equipment, and structural assemblies prior to installation. Immediately report any observed defective components and replace. Submit structural and load capacity calculations verifying a design safety factor of 5 to 1 to ultimate strength of weakest material (steel) used for any track suspension device or support which is not a standard cataloged product of the system manufacturer.

2.3 MONORAIL TRACK SYSTEM

Provide patented track beam sections fabricated by a manufacturer regularly engaged in production of this type of beam. The maximum allowable vertical and lateral deflection shall conform to CMAA 74, with the hoist at rated load and at any location. Rail separation at joints shall not exceed 1/16 inch.

2.3.1 Track Beam System

Provide the track beam system with trolley stops at all open end locations. The stops shall retain the hoist on the track. Stops shall contact the wrap-around type trolley frame.

2.3.2 Track Suspension System

Provide rigid type monorail suspension. Install the monorail track beam suspension system and support monorail track system using only the structural members indicated on the drawings.

2.4 ELECTRIC CHAIN HOIST

Electric chain hoist shall conform to ASME HST-1, Class H3 and NEMA ICS 8, NEMA MG 2, and NEMA ESPG except as modified herein. Provide load chain proof test results.

Provide chain hoists with 10 foot lift or more with a load chain bucket.

2.5 TROLLEY

Provide a manual trolley, Coffing HT push trolly or equal, designed to operate from the track beam section shown on the drawings..

2.6 MOTORS

Motors shall conform to NEMA MG 1. All motors shall be minimum 60 minute duty rating. Motor insulation shall be Class H with a Class B temperature rise. Equip all motors with thermal trip type over-temperature protection.

2.6.1 Hoist Motors

Provide AC inverter duty, totally enclosed non-ventilated (TENV), squirrel cage induction type hoist motor.

2.7 CONTROLS

Provide control of electric hoist from a pendant pushbutton station. Arrange pushbuttons in accordance with ASME B30.11 recommendations. If provided, locate pushbutton station 4 feet above the finished floor.

2.8 LIMIT SWITCHES

Equip hoists with limit stops for chain to prevent over-travel in both the raising and lowering directions.

2.9 LOAD BLOCK AND HOOK

Provide safety hook fitted with self-closing, spring loaded steel safety latch, and with hook nuts keyed to hook shanks by means of a setscrew installed in a plane parallel to the longitudinal axis of the hook shank, or by any other similar easily removable securing device. Provide unpainted hook and hook nut, permanently marked with an identification number. Clearly mark the hook and hook nut with a unique identification number corresponding to the number used in non-destructive test (NDT) reports.

2.9.1 Non-Destructive Testing

The following requirements apply:

a. The Hook NDT Report supplier shall provide a letter certifying that the requirements of ASTM E 543 are met.

b. The NDT supplier shall develop, and submit for review, procedures, including technique sheets specific to the types, shapes, and sizes of the parts being examined (e.g., shank hook, eye hook, duplex hook, eye bar nut). For the magnetic particle method, the procedures shall adequately describe the orientation of the hook or nut, or pin with the magnetizing equipment.

c. These procedures shall be reviewed by a Level III examiner who is independent of the NDT supplier and is certified in the applicable NDT method.

2.9.2 Hook and Hook Nut Magnetic Particle Inspections

The hook and hook nut shall be magnetic-particle inspected in compliance with ASTM E 709 over the entire area in accordance with ASTM A 275/A 275M, with the following restrictions: Do not use DC yokes (including switchable AC/DC yokes used in the DC mode) and permanent magnet yokes. Do not use automatic powder blowers or any other form of forced air other than from a hand-held bulb for the application or removal of dry magnetic particles. Remove arc strikes. Equipment ammeters shall have an accuracy of +/- 5 percent of full scale (equipment ammeter accuracy other than that stated is acceptable provided the MT procedure states that a magnetic field indicator is used to establish and verify adequate field strength for the aspects of the inspection). The acceptance standard is no linear indications greater than 1/16 inch.

2.10 BEARINGS

All bearings except those subject to a small rocker motion shall be anti-friction type. Provide a means for lubrication for bearings not considered to be lifetime lubricated by the manufacturer.

2.11 ELECTRIFICATION

Provide runway electrification of the cord reel type, Coffing DN3-25 or equal. Provide electrical work for the monorail system in accordance with NFPA 70 .

2.12 PAINTING SYSTEM

Provide manufacturer's standard painting of components. Provide a primer and a finish coat. Blast clean all components prior to painting. Primer shall be inorganic zinc type. Paint coats shall be smooth and even, free of runs, sags, orange peel, or other defects.

PART 3 EXECUTION

3.1 ERECTION AND INSTALLATION

Erect and install the monorail system, complete in accordance with the approved submittals and in condition to perform the operational and acceptance tests.

3.2 ERECTION SERVICES

Provide supervisory erection services from the monorail system manufacturer.

3.3 FIELD QUALITY CONTROL

3.3.1 Post-Erection Inspection

After erection, the Contractor, the Contracting Officer, and a representative of the activity crane maintaining organization, shall jointly inspect the monorail and hoist systems and components to determine compliance with specifications and approved submittals. Notify the Contracting Officer 5 days before the inspection. A list of deficient items, including a determination of criticality will be provided to the Contractor for corrective action. Outstanding items shall be noted for correction during the inspection. Items considered critical (load bearing, load controlling, or operational safety devices) shall be corrected prior to further testing. Upon correction, provide a report of the inspection indicating the monorail system is considered ready for operational tests.

3.3.2 Operational Tests

a. After erection and inspection, test the monorail system, hoist, and trolley as specified herein. Test the systems in service to determine that each component of the system operates as specified, is properly installed and adjusted, and is free from defects in material, manufacturing, installation, and workmanship. Rectify all deficiencies disclosed by testing and retest the system or component to prove the monorail system is operational.

c. Furnish test loads, operating personnel, instruments, and other

apparatus as necessary to conduct field tests on hoist and monorail. Perform test and final adjustments of the equipment under the supervision of the Contracting Officer, and a representative of the activity crane maintaining organization.

3.3.3 Test Data

Record test data on appropriate test record forms suitable for retention for the life of the monorail system. Record operating and startup current measurements for electrical equipment (motors and coils) using appropriate instrumentation (i.e., clamp-on ammeters). Compare recorded values with design specifications or manufacturer's recommended values. Abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) shall be justified or appropriate adjustments performed. In addition, note any high temperatures or abnormal operation of any equipment or machinery , investigate and correct. Record hoist speeds during each test cycle.

3.3.4 Hook Tram Measurement

Measure hook for hook throat spread before and after load test. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/64 inch). Record this base dimension. Measure the distance between tram points before and after load test. An increase in the throat opening from the base measurement is cause for rejection.

3.3.5 No-Load Test

a. Hoist: Raise the load hook the full operating lift distance and verify satisfactory operation of hoist, upper limit switches, lower limit switch, and the hoisting and lowering speeds. Operate the hoist at low and high speed in both directions.

3.3.6 125% Rated Load Test

125 Percent (plus 5 percent minus 0) of rated capacity

a. Hoist Static Test: Raise test load approximately one foot above the floor and hold for 10 minutes. Observe load lowering that may occur which indicates malfunction of hoisting component or brake. Lower the test load to the floor until the hoist line is slack.

b. Hoist Dynamic Test: Raise the test load to approximately 5 feet above the floor using both speed points in the process. Lower the load back to the floor using both speed points. Stop the test load at least once while lowering at high speed and observe proper brake operation. Wait 5 minutes, then repeat the above cycle.

c. Load Brake Test (if equipped): Raise test load approximately 5 feet. With the hoist controller in the neutral position, release the holding brake. The load brake must hold the test load. Again with the holding brake in the released position, start the test load down at low speed and return the controller to off position as the test load lowers. The load brake must stop and hold the test load. If the load brake does not stop the test load, but prevents the test load from accelerating, activities will contact the OEM or activity engineering organization to ensure that the load brake is operating as designed.

d. Loss of Power Test: Raise the test load approximately 3 feet and while lowering test load at low speed, cut main power to hoist. The load must stop.

e. Trolley Test: With test load hoisted to a height of one foot above the floor, operate trolley the full distance of the monorail in both directions. Observe for any malfunctioning of the trolley assembly and monorail system.

3.4 MONORAIL FIELD TEST PROCEDURES

MONORAIL FIELD TEST PROCEDURES

Supported Command: **Date of Inspection:** _____
Contract No.:

Names and Titles of Participating Government, Supported Command, and Contractor Representatives:

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

3.4.1 General Instructions

The crane and supporting structure shall be tested in accordance with the applicable paragraphs of this guide. Assure that all components and features that affect load bearing, load controlling, or operational safety devices of the cranes are properly tested. Perform all the tests described below along with any other tests required to verify that the crane meets the contract requirements including any contract modifications. The sequence of testing is at the option of the contractor's test director except that the no-load test shall be performed first. Develop data sheets for tests that require data recording. Include in the data sheets the expected results along with the allowable tolerance in accordance with the requirements of the specification. Determine the tools, meters, measuring devices, etc. that are required to perform the test and have them available at the site. When measuring currents less than 5 amps, a 10-amp series type amp meter is recommended instead of an amp probe or use of the drive monitoring display. All equipment shall be calibrated

3.4.2 Equipment Monitoring

During the load test, check for the proper operation and condition of safety devices, electrical components, mechanical equipment, and structural assemblies. Immediately report any observed defects critical to continuing testing to the contractor's test director, who shall suspend the testing until the deficiency is corrected.

3.4.3 **Hooks**

Record hook serial number. Measure the hook for hook throat spread before load testing. Install two tram points on hook throat. Measure the distance between these tram points (+/- 1/64 inch). Record this base dimension. Check operation of safety latches.

Load Hook Unique Identification Number _____

Load Hook Nut Unique Identification Number _____

Load Hook Throat Measurement - Before Load Testing _____

Load Hook Safety Latches SAT_____ UNSAT_____ NA_____

3.4.4 **Preparing For Load Testing**

a.) Select a safe test area and clear all traffic, unauthorized personnel, and equipment from test area. This test area shall be roped off or otherwise secured to prevent entry of unauthorized personnel and equipment.

b.) All rigging used in crane load testing shall conform to applicable OSHA regulations and ASME standards for inspection and testing. Note that test loads INCLUDE the weight of rigging used to connect them to the load block.

3.4.5 **Precautions During Load Testing**

a.) Observe extreme caution at all times.

b.) Personnel shall remain clear of suspended loads and areas where they could be struck in the event of component failure.

c.) Raise test load only to a height sufficient to perform the test.

3.4.6 **Testing**

Inspection Codes: SAT = Satisfactory, UNSAT = Unsatisfactory, NA=Not applicable

3.4.6.1 **No Load Test**

Pendant Control

From the pendant station energize the main line contactor by activating the **START** button.

a.) Power On SAT_____ UNSAT_____ NA_____

De-energize the crane by activating the **E-STOP** button.

b.) E-Stop SAT_____ UNSAT_____ NA_____

c.) Power Off SAT_____ UNSAT_____ NA_____

From the pendant controller check all the function of the crane. Verify that the motions match the button labels and the directions of operation are correct.

d.)	Main Hoist Up	SAT_____	UNSAT_____	NA_____
e.)	Main Hoist Down	SAT_____	UNSAT_____	NA_____
f.)	Trolley North/West	SAT_____	UNSAT_____	NA_____
g.)	Trolley South/East	SAT_____	UNSAT_____	NA_____
h.)	Indicator Lights (Power On, Power Available, etc.)	SAT_____	UNSAT_____	NA_____

Motor Controls

Hoist controls shall be tested to verify that sequencing and timing are in accordance with the requirements of the specification.

Record the following:		*Nameplate:*	*Actual:*
a.)	Disconnect Switch Voltage	_____Volts	_____Volts
b.)	Current (High Speed) Up	_____Amps	_____Amps
c.)	Voltage (High Speed) Up	_____Volts	_____Volts

Note: The current and voltage will be measured at the disconnect switch.

d.)	Current (High Speed) Down	_____Amps	_____Amps
e.)	Voltage (High Speed) Down	_____Volts	_____Volts

Note: The current and voltage will be measured at the floor disconnect switch.

Hoist Speeds: Measure hoist speed in FPM at fast speed in each direction.

		Actual	*Required*
a.)	Up (High Speed, No Load)	_____ FPM	_____ FPM
b.)	Down (High Speed, No Load)	_____ FPM	_____ FPM

Measure hoist speed in FPM at slow speed in each direction.

c.)	Up (Slow Speed)	_____ FPM	_____ FPM
d.)	Down (Slow Speed)	_____ FPM	_____ FPM

Note: Full speed tolerance is 10%. Rated high speed is 7 fpm with fast speed switch in the OFF position.

Test **Trolley Controls** to verify that sequencing and timing are in accordance with the requirements of the specification.

Record the following:	*Nameplate:*	*Actual:*
a.) Disconnect Switch Voltage	_____Volts	_____Volts
b.) Current (High Speed) North/East	_____Amps	_____Amps
c.) Voltage (High Speed) North/East	_____Volts	_____Volts
d.) Current (High Speed) South/West	_____Amps	_____Amps
e.) Voltage (High Speed) South/West	_____Volts	_____Volts

Note: The current and voltage will be measured at the floor disconnect switch.

Measure **trolley speed in FPM** high speed in each direction.

	Actual	*Required*
a.) North/East (High Speed)	_____ FPM	_____ FPM
b.) South/West (High Speed)	_____ FPM	_____ FPM

Measure **trolley speed in FPM** slow speed in each direction.

c.) North/East (Slow Speed)	_____ FPM	_____ FPM
d.) South/West (Slow Speed)	_____ FPM	_____ FPM

Note: Full Speed tolerance is 10%.

Bumper Stops: At slow speed, contact the trolley bumpers with the bumper stops. Verify satisfactory performance of the bumpers, and the alignment of the bumpers with stops.

SAT_____ UNSAT_____ NA_____

Limit Switches

Test all limit switches to determine that they function and that all associated functions occur in accordance with specifications.

Hoist Upper Geared Limit Switch (Primary)

Raise the hoist. Slowly raise the hoist into the upper-geared limit switch and verify that the hoist stops after the limit switch is tripped and the hook is only capable of lowering. Ensure that the runout distance at full speed is greater than the distance to the weighted upper limit by gradually increasing hoist control lever travel to achieve full hoist speed and verify that the weighted limit is not tripped when the geared limit is engaged at this "full speed." If the hoist is equipped with a slow down function, verify that the hoist speed decreases to 25% (+/- 10%) of the full rated speed before entering the primary limit switch.

a.) Hoist in slow speed approaching Upper-Geared Limit Switch SAT_____ UNSAT_____ NA_____

b.) Hoist Upper Geared Limit Switch SAT_____ UNSAT_____ NA_____

c.) Hoist can lower only SAT_____ UNSAT_____ NA_____

d.) Hoist slows before primary limit (if slow down enabled) SAT_____ UNSAT_____ NA_____

Hoist Upper Limit Switch (Secondary)

Using the geared limit switch by-pass key switch, by-pass the hoist upper-geared limit switch and continue slowly raising the hoist. Once the switch is tripped, verify that the hoist motion stops and hoist drive is inoperable.

a.) Hoist in slow speed approaching Upper Limit Switch SAT_____ UNSAT_____ NA_____

b.) Hoist Upper Limit Switch SAT_____ UNSAT_____ NA_____

c.) Hoist drive inoperable SAT_____ UNSAT_____ NA_____

Using the hoist reset key switch, reset the hoist drive and verify that the hoist is only operable in down direction until the upper limit switch is deactivated.

d.) Hoist Up inoperable SAT_____ UNSAT_____ NA_____

e.) Hoist can lower only SAT_____ UNSAT_____ NA_____

Hoist Lower Geared Limit Switch

Lower the hoist. Slowly lower the hook into geared lower limit switch. When the limit switch is tripped, verify that the hoist motion stops. Verify hoisting up capability for lower limit switch.

a.) Hoist in slow speed approaching Lower Geared Limit Switch SAT_____ UNSAT_____ NA_____

b.) Hoist Lower Geared Limit Switch SAT_____ UNSAT_____ NA_____

c.) Hoist up capability SAT_____ UNSAT_____ NA_____

Warning Devices and Lights

Crane Status Lights

Verify that White status light illuminates when power is available to crane.
White Status Light SAT_____ UNSAT_____ NA_____

Verify that Blue status light illuminates when power to crane is on (main contactor energized).
Blue Status Light SAT_____ UNSAT_____ NA_____

3.4.6.2 **Hoist Load Testing**

50 Percent of Rated Capacity (+5%, -0%) Load Test

Dynamic Load Test.

Record the actual certified weight, including rigging, that will be used:_____Lbs.

1. Place 50% (+5%, -0%) of rated load on the hook.

2. Start at ground level and hoist up to one foot below upper limit using the full range of speeds.

3. Hoist down to one foot above ground level using full range of speeds.

4. Measure and record the motor current, voltage, and hook speed in FPM at maximum speed in both directions.

Record the following:	*Nameplate:*	*Actual:*
a.) Current (High Speed) Up	_____Amps	_____Amps
b.) Voltage (High Speed) Up	_____Volts	_____Volts
c.) Current (High Speed) Down	_____Amps	_____Amps
d.) Voltage (High Speed) Down	_____Volts	_____Volts

Note: The current and voltage will be measured at the floor disconnect switch.

Measure hoist speed in FPM at **fast speed** in each direction.

Hoist	*Actual*	*Required*
a.) Up (High Speed)	_____ FPM	_____ FPM
b.) Down (High Speed)	_____ FPM	_____ FPM

Measure hoist speed in FPM at **slow speed** in each direction.

a.) Up (Slow Speed)	_____ FPM	_____ FPM
b.) Down (Slow Speed)	_____ FPM	_____ FPM

Note: Speed tolerance is 10%

3.4.6.3 **100 Percent of Rated Capacity (+0%, -5%) Load Test**

A. Dynamic Load Test.

Record the actual weight of the certified weight, including rigging gear that will be used:_____ Lbs.

1. ***Trolley loss of power test***

Raise the test load approximately midway between the trolley and any permanent obstructions on the operating floor. Starting at a safe distance from walls or other obstructions, attain a slow speed of trolley travel. While maintaining a safe distance from obstructions, disconnect the main power source to simulate a power failure. Restart trolley travel and allow the drive to reach an intermediate speed. Repeat the simulated power failure. Restart trolley travel and allow the drive to reach maximum operating speed. Repeat the simulated power failure. Verify that the trolley stops and that the brake sets properly at all speeds.

SAT_____ UNSAT_____ NA_____

2. ***Hoist loss of power test at rated load***

Raise the test load a minimal distance. Lower the test load at slow speed. Disconnect the main power source and return the controller to the neutral position to simulate a power failure. Restart hoist in a downward direction and allow the drive to reach an intermediate speed. Repeat the simulated power failure. Restart hoist in a downward direction and allow the drive to reach maximum operating speed. Repeat the simulated power failure. Verify that the hoist stops and that the brake sets properly to bring the test load to a stop at all speeds.

SAT_____ UNSAT_____ NA_____

3. ***Hoist Maximum Speed Test at rated load***

Measure and record the motor current, voltage, and hook speed in FPM at maximum speed in both directions. Stop the load during hoisting and lowering to verify that brake stops and holds the load.

Record the following:	*Nameplate:*	*Actual:*
a.) Current (High Speed) Up	_____Amps	_____Amps
b.) Voltage (High Speed) Up	_____Volts	_____Volts
c.) Current (High Speed) Down	_____Amps	_____Amps
d.) Voltage (High Speed) Down	_____Volts	_____Volts

Note: The current and voltage will be measured at the floor disconnect switch.

Measure hoist speed in FPM at **fast speed** in each direction.

Hoist	*Actual*	*Required*
a.) Up (High Speed)	_____ FPM	_____ FPM
b.) Down (High Speed)	_____ FPM	_____ FPM

Measure hoist speed in FPM at **slow speed** in each direction.

a.) Up (Slow Speed)	_____ FPM	_____ FPM
b.) Down (Slow Speed)	_____ FPM	_____ FPM

Note: Speed tolerance is 10%

4. ***Maximum Runway Deflection***

Measure the maximum runway deflection with the trolley centered between vertical supports and 100% (+5%, -0%) of rated load on the hook. Repeat the measurement for each segment of runway and record the maximum value. The vertical and lateral deflection must not be greater than the values stated in CMAA 74.

_____Max deflection _____Unsupported Distance at Max deflection

_____Allowable Deflection (1/450 of unsupported distance)

SAT_____ UNSAT_____ NA_____

5. ***Rollback Check***

Check rollback. With the load approximately 2 feet above the ground, engage the hoist up controller to the slowest hoist position. Verify that the motor turns in raise direction only.

SAT_____ UNSAT_____ NA_____

B. Trolley Functionality Test.

1a.) Operate the trolley the full distance of the runway in both directions. Verify that the brake operates properly. Measure and record the distance required to come to a full stop from rated speed.

_____Stopping distance

1b.) Measure and record the motor current, voltage, and hook speed in FPM at maximum speed in both directions.

Record the following:	*Nameplate:*	*Actual:*
a.) Current (High Speed) North/East	_____Amps	_____Amps
b.) Voltage (High Speed) North/East	_____Volts	_____Volts
c.) Current (High Speed) South/West	_____Amps	_____Amps
d.) Voltage (High Speed) South/West	_____Volts	_____Volts

Note: The current and voltage will be measured at the floor disconnect switch.

Measure Trolley speed in FPM **high speed** in each direction.

a.) North/East (High Speed)	_____ FPM	_____ FPM
b.) South/West (High Speed)	_____ FPM	_____ FPM

Measure trolley speed in FPM at **slow speed** in each direction.

c.) North/East (Slow Speed)	_____ FPM	_____ FPM
d.) South/West (Slow Speed)	_____ FPM	_____ FPM

Note: Speed tolerance is 10%

3.4.6.4 **125 Percent of Rated Capacity (+5%, -0%) Load Test**

A. Dynamic Load Test

Record the actual weight of the certified weight, including rigging, that will be used: _____ Lbs.

1. Control and Brake Stop Test

Place 125% (+5%, -0%) of rated load on the hook. Raise and lower test load on each controller point and visually observe smooth control between points. Stop the load during hoisting and lowering to verify that the brake stops and holds the load.

SAT_____ UNSAT_____ NA_____

2. Hoist loss of power test

Raise the test load a minimal distance. Lower the test load at slow speed. Disconnect the main power source and return the controller to the neutral position to simulate a power failure. Verify that the hoist stops and that the brake sets properly to bring the test load to a stop.

NOTE: This test is designed to also verify proper operation of dynamic load brakes including eddy current brakes and regenerative braking.

SAT_____ UNSAT_____ NA_____

B. Hoist Brake(s) Test

Raise the test load approximately 1 foot and hold for 10 minutes. If more than one brake on the hoist, manually open the secondary brake during the primary brake test. Rotate load and hook to check for smooth bearing operation. Observe for noticeable lowering of test load that may occur which will indicate the malfunction of hoisting components or brakes. If more than one brake on the hoist, close the secondary brake and manually open the primary brake. Repeat the 10 minute test.

SAT_____ UNSAT_____ NA_____

C. Trolley Test

Operate the trolley the full distance of the bridge in both directions (if clear trolley space is available). Verify smooth control and proper brake operation.

SAT_____ UNSAT_____ NA_____

Comments:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

-- End of Section --

Addendum #1 to Construction Documents

FY09 Shop Addition to Building 11

June 17, 2009

1. Drawing M-001 – PIPING AND PLUMBING MATERIAL SCHEDULE: Category "JOINTS" Chilled Water (all), Heating Water, A/C Humidifier & Condensate and Non Potable Domestic Cold Water should be changed to: "PRO PRESS COPPER FITTINGS & JOINTS".

2. Drawing M-001 – PIPING NOTES: Note F should be changed to the following:

   - Insulation shall be mineral fiber with vapor barrier jacket, Type T-1. Thickness shall be not less than that given in the following table. Aboveground pipes, valve bodies, fittings, unions, and flanges shall be insulated.

PIPE SIZE (INCH)	INSULATION THICKNESS (INCH)
Up to 1-1/4	1-1/2
1-1/4 to 3	1-1/2
3 or larger	2

Piping shall be covered with mineral-fiber pipe insulation with factory-and field-attached vapor-barrier jacket. Vapor seal shall be maintained. Jackets, jacket laps, flaps, and bands shall be securely cemented in place with vapor-barrier adhesive. Jacket overlap shall be not less than 1-1/2 inches. Jacketing bands for butt joints shall be 3 inches wide.

Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. It shall be of a wicking type suitable for installation on piping systems. Product shall include a factory applied integral vapor retarder extending under the evaporator area of the wick and covering not less than 98% of the circumference of the product. Exposed evaporator area shall be not less than 0.1 sq. ft./linear ft. of product.

Fittings and valves shall be insulated per manufacturer's instructions:

Fittings and valves shall be wrapped continuously with wicking material prior to installing to ensure a continuous path for removal of condensation.

Standard site fabricated connections (e.g. mitered, segmented, or fish mouth) are recommended for bends and fittings.

Standard PVC fittings with blanket insulation or molded/preformed fiberglass fittings may be used.

Standard oversizing practices shall be used for valves and flanges.

Exposed-to-view fittings and valve bodies shall be covered with preformed mineral-fiber pipe-fitting insulation of the same thickness as the pipe-barrel insulation. Fitting insulation shall be temporarily secured in place with light cord ties. A 60-mil coating of white indoor vapor-barrier coating shall be applied and, while still wet, wrapped with glass lagging tape with 50 percent overlap, and shall be smoothly blended into the adjacent jacketing. Additional coating shall be applied as needed and rubber-gloved to smooth fillet or contour coating, then allowed to fully cure before the finish coating is applied. On-the-job fabricated insulation for concealed fittings and special configurations shall be built up from mineral fiber and a special mastic consisting of a mixture of insulating cement and lagging adhesive diluted with 3 parts water.

In lieu of materials and methods previously specified, fittings may be wrapped with a twine-secured, mineral-wool blanket to the required thickness and covered with premolded polyvinylchloride jackets. Seams shall be made vapor tight with a double bead of manufacturer's standard vapor-barrier adhesive applied in accordance with the manufacturer's instructions. All jacket ends shall be held in place with AISI 300 series corrosion-resistant steel straps, 15 mils thick by 1/2 inch wide.

Staples shall not be used in applying insulation. Vapor-barrier materials shall be continuous over all surfaces, including areas inside pipe sleeves, hangers, and other concealments.

All piping shall be supported in such a manner that the insulation is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing shall be such that the circumferential joint may be made outside the hanger. Cover the evaporating holes with contractor supplied wicking sealing tape for the length of the metal saddle.

Piping systems 3" in diameter or less, insulated with fiberglass pipe insulation, may be supported by placing saddles of the proper length and spacing under the insulation.

For hot or cold piping systems larger than 3" in diameter, operating at temperatures less than +200F and insulated with fiberglass, high impact glass reinforced polyproylene saddle system (V-block design) with sufficient compressive strength shall be used to support the weight of the piping system.

On vertical runs, insulation support rings shall be used.

3. Drawing M-101 Coded Note 12: see Figure 1 for HOUSEKEEPING PAD DETAIL.

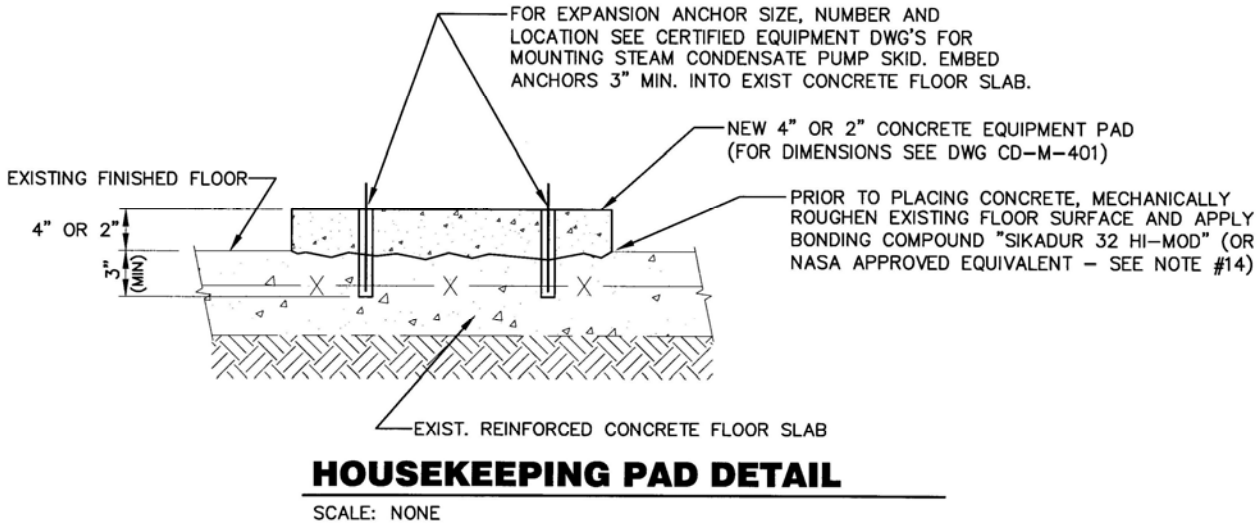

Figure 1

4. Drawing M-501 – CHILLED WATER PIPING DIAGRAM FOR HVAC-5: Provide pressure and temperature gauges and by-pass piping.

5. Drawing M-502 – Use detail shown in Figure 2 for CONDENSATE PUMP PIPING DIAGRAM.

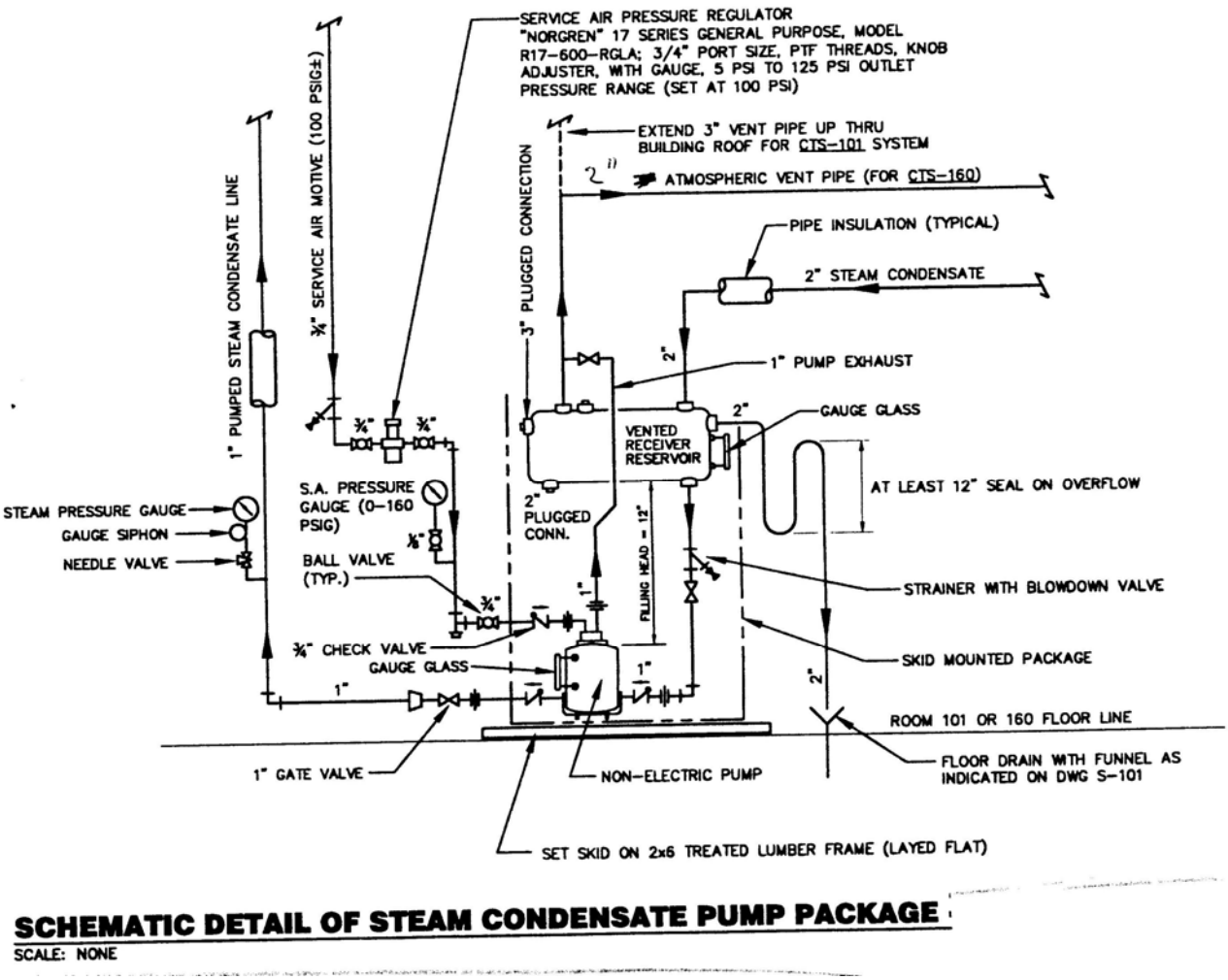

Figure 2

6. Drawing M-601 – Add VFD-2 to VARIABLE SPEED DRIVE SCHEDULE; see M-801 for VFD-2 on SF-1.

7. Drawing E-103 –Provide and install a bare copper ground/bonding wire to the new panel P0206 from building steel.

8. Drawing E-103 – Coded Note 1: drawing should show an exothermic weld in two (2) spots.

9. Drawing E-601 – Panel P0206 dimensions shall be 20” wide x 5.75” deep x 50” high.

10. Drawing E-601 – Panel P0206 panel shall have a 225 amp main breaker, not a 400 amp breaker as indicated in the schedule or a 200 amp breaker as indicated in the Panelboard Note 1.

11. Drawing E-601 – Panel P0206 Panelboard Note 1 shall be: New panelboard is based on Square D “NQ” Series, Class 1640 panelboard. 208Y/120VAC, 3 phase 4 wire, 60 Hz., 22,000AIC, 225A Main circuit breaker, 42 circuit. Branch breakers (bolt-on type) shall be as follows:

(8) 20A, 1 pole
(1) 70A, 3 pole
(1) 60A, 3 pole
(1) 15A, 3 pole.

12. Drawing E-801 – Panel P0206 shall have a 225AT/225AF main circuit breaker, not a 200AT/200AF as shown.

13. Drawing E-801 – The feed to HVAC-5 from P0206, circuit # 38,40,42 (60 amp) shows wire size of 3-#8, 1-#10 G in 3/4” conduit. This should be a minimum of 3-#6, 1-#10G in 1” conduit.