STANDARD DESIGN

MAGAZINE, STEEL AND CONCRETE BOX, EARTH COVERED STD 421-80-02

VOLUME II

SPECIFICATIONS

Huntsville Division
U. S. Army Corps of Engineers
Huntsville, Alabama

1 January 1993

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STANDARD SPECIFICATIONS

STD 421-80-02

FOR

MAGAZINE, STEEL AND CONCRETE BOX,

EARTH-COVERED

DEPARTMENT OF THE ARMY
HEADQUARTERS, U. S. ARMY CORPS OF ENGINEERS
WASHINGTON, DC

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GENERAL NOTES

- 1. This standard specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720. It will not be made a part of a contract merely by reference; pertinent portions will be copied verbatim into the contract documents.
- 2. The designations for publications listed in the Applicable Publication paragraphs are those that were in effect when this standard specification was being prepared.
- 3. Additions to or deletions from this standard specification will be only that which is necessary to adapt the specification to site conditions, such as foundation design or abnormal climate conditions.
- 4. This specification is intended to be used in specifying Earth Covered, Steel and Concrete Box Magazines as shown on the following drawings:

Drawing No.	Sheet No.	Title
STD 421-80-02	G-1	Drawing Index and Cover Sheet
STD 421-80-02	s-1	Floor Plan and Sections
STD 421-80-02	s-2	Portal Wall Plan, Elevation and Details
STD 421-80-02	s-3	Miscellaneous Sections
STD 421-80-02	s-4	Miscellaneous Sections and Details
STD 421-80-02	s-5	Miscellaneous Sections and Details
STD 421-80-02	s-6	10'-0" Blast Door
STD 421-80-02	s-7	8'-0" Blast Door
STD 421-80-02	s-8	Blast Door Details
STD 421-80-02	E-1	Electrical Plan and Sections
STD 421-80-02	E-2	Electrical Details

5. The following Corps of Engineers Guide Specifications were used in preparation of this standard specification:

Section No.	Title	Guide Specification No./ Date/Latest Notice
01300	Submittal Descriptions	CEGS 01300/Mar 91
01305	Submittal Procedures	CEGS 01305/Dec 89/N1
02147	Drainage Composites	N/A
02221	Excavation, Filling and Backfilling for Buildings	CEGS 02221/Mar 91/N1
02711	Foundation Drainage System	CEGS 02711/Apr 89/N3
03300	Concrete for Building Construction	CEGS 03300/Dec 88/N5
05315	Blast and Fragment Resistant Walls	N/A
05500	Miscellaneous Metal	CEGS 05500/Jan 89/N5
07111	Elastomeric Membrane Waterproofing	CEGS 07111/May 90/N2
07120	Fluid-Applied Waterproofing	ETL 1110-3-306
09900	Painting, General	CEGS 09900/Feb 89/N5
16415	Electrical Work, Interior	CEGS 16415/Dec 91/N1
16670	Lightning Protection System	CEGS 16670/Dec 88/N2

TECHNICAL NOTES

1. These standard specifications include numerous options left to be completed by the final designing or site adapting agency. These are generally either site-specific technical options, or options for procedures, submittals, or schedules that vary between design agencies. These Technical Notes indicate the location and required actions or choices for each of these options. For most submittals, the specifications designate the most reasonable choice of Government Approval (GA) or For Information Only (FIO). However, any of the required submittals may be designated GA or FIO at the discretion of the final designer.

2. Section 01305:

- a. Paragraph 3.2: The Submittal Register (ENG Form 4288) is not a part of this specification. The completed ENG Form 4288 must be developed locally for each project and included at the end of this section. Indicate the required number of copies of the submittal register to be provided and the deadline for this submittal.
- b. Paragraph 3.3: Indicate the required number of days for review and approval of submittals.
- c. Paragraph 3.4: The Transmittal Form (ENG Form 4025) is not a part of this standard specification. The sample ENG Form 4025 must be added locally at the end of this section.
 - d. Paragraph 3.5.1: Add applicable submittal procedures.
- e. Paragraph 3.7: Indicate the number of submittal copies to be retained by the Contracting Officer and returned to the Contractor.

3. Section 02147:

a. Paragraph 2.1.1: Select maximum and minimum Equivalent Opening Sizes (EOS) for the geotextile based on the soil materials to be used as filter materials and fill. Guidance on geotextiles is contained in Civil Works Guide Specification 02215.

4. Section 02211:

- a. Paragraph 2.1.5: Select maximum particle size, based on site conditions. See TM 5-818-2.
- b. Paragraph 2.1.7: Sand and gravel filter material gradations must be designed for the particular conditions present at each individual site. Guidance on filter design is contained in TM 5-820-2.

- c. Paragraph 3.1: Select appropriate disposition of cleared and grubbed materials.
 - d. Paragraph 3.2: Indicate depth of topsoil removal.
- e. Paragraph 3.6: If rock excavation is not anticipated, excavation should be unclassified.
- f. Paragraph 3.7: If blasting will be permitted, provide reference to appropriate safety standards for blasting, and provide POC at the installation Safety Office for coordination.
- g. Paragraph 3.9: Define source, extent, and quality of available borrow at the site. Delete bracketed text if bidding is on a lump sum basis.
- h. Paragraph 3.10: Select appropriate disposition of excavated materials.
- i. Paragraph 3.12: Determine requirements for moisture content control of fill material and provide allowable limits.
- j. Paragraph 3.13: Indicate compaction limits for expansive materials, if used.
- k. Paragraph 3.14: (1) Select appropriate test method(s) for the particular site. (2) Provide specific types and frequencies of tests required for the particular site in question.

5. Section 02285:

a. Paragraph 1.7: Indicate warranty period.

6. Section 02711:

- a. Paragraph 2.1: Select materials for contract requirements.
- b. Paragraph 3.2.5: Select end treatment for outlet lines.
- c. Paragraph 3.2.6: Select preferred extent of initial backfilling around the drainage pipes.
- d. Paragraph 3.2.7: When required, provide cleanout locations on the appropriate drawings.

7. Section 05500:

a. Paragraph 2.11: The high security shrouded hasp is a Government furnished, Contractor installed item. The hasp must conform to Military Specification MS MIL-H-29181 as specified. The hasp assembly, including its

mounting jig, is available through supply channels directly from the following manufacturers:

Tennessee Investment Casting Company Bristol, TN 37620 (615) 968-4522

Shell Cast Incorporated Whitehall, MI (616) 893-8245

8. Section 09900:

a. General: The only surfaces that absolutely require painting are the ferrous metal surfaces of the door, door frame, and weather hood. Painting the interior and exterior galvanized surfaces and the exterior concrete surfaces is at the option of the site adapting agency. Modify the painting schedule and the specification as required to reflect the actual building components to be painted.

9. Section 16415:

- a. Paragraph 3.5.2: Select the cover mechanism for exterior weatherproof receptacles.
- 10. General: Ground cover over igloos MUST be provided in the Specifications. This cover should be grass only and should not be any species with roots that would penetrate deeper than the 4-inch topsoil layer.
- 11. Waterproofing and Drainage Systems: The design drawings include details for both the drainage composite mat system and the sand and gravel filter drainage system. The drainage composite mat system is recommended. Only the drainage composite system is reflected in the cost estimate. If the sand and gravel system is used, Section 02147 can be omitted, and the cost estimate must be revised. If the sand and gravel filter system is used, the magazine must be waterproofed using the fluid-applied waterproofing system specified in Section 07120. If the drainage composite system is used, the magazine must be waterproofed with the elastomeric membrane system specified in Section 07111.

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STD 421-80-02

MAGAZINE, STEEL AND CONCRETE BOX, EARTH COVERED

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SECTION 01300

SUBMITTAL DESCRIPTIONS

PART 1 GENERAL

- 1.1 SUMMARY (Not Applicable)
- 1.2 REFERENCES (Not Applicable)
- 1.3 SUBMITTALS

The submittals described below are those required and further described in other sections of the specifications. Other requirements pertaining to submittals are included in the SPECIAL CLAUSES and Section 01305 SUBMITTAL PROCEDURES. Submittals required by the CONTRACT CLAUSES and other nontechnical parts of the contract are not included in this section.

SD-01 Data

Submittals which provide calculations, descriptions, or documentation regarding the work.

SD-04 Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, details of fabrication, layouts of particular elements, connections, and other relational aspects of the work.

SD-06 Instructions

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

SD-07 Schedules

Tabular lists showing location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work.

SD-08 Statements

A document, required of the Contractor, or through the Contractor, from a supplier, installer, manufacturer, or other lower tier Contractor, the purpose of which is to confirm the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel, qualifications, or other verifications of quality.

SD-09 Reports

Reports of inspections or tests, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used shall be identified and test results shall be recorded.

SD-13 Certificates

Statement signed by responsible official of a manufacturer of a product, system or material, attesting that the product, system or material meets specified requirements. The statement must be dated after the award of this contract, must name the project, and must list the specific requirements which are being certified.

SD-14 Samples

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

SD-18 Records

Documentation to record compliance with technical or administrative requirements.

SD-19 Operation and Maintenance Manuals

Data which forms a part of an operation and maintenance manual.

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SECTION 01305

SUBMITTAL PROCEDURES

PART 1 GENERAL

- 1.1 SUMMARY (Not Applicable)
- 1.2 REFERENCES (Not Applicable)
- 1.3 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.3.1 Government Approved

Governmental approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer. Within the terms of the Contract Clause entitled "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.3.2 Information Only

All submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.4 APPROVED SUBMITTALS

The approval of submittals by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the CQC requirements of this contract, is responsible for the dimensions and design of adequate connections, details and satisfactory construction of all work. After submittals have been approved by the Contracting Officer, no resubmittal for the purpose of substituting materials or equipment will be given consideration unless accompanied by an explanation as to why a substitution is necessary.

1.5 DISAPPROVED SUBMITTALS

The Contractor shall make all corrections required by the Contracting Officer and promptly furnish a corrected submittal in the form and number of copies as specified for the initial submittal. If the Contractor considers any correction indicated on the submittals to constitute a change to the contract, notice as required under the Contract Clause entitled "Changes" shall be given promptly to the Contracting Officer.

1.6 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall submit all items listed on the Submittal Register (ENG Form 4288) or specified in the other sections of these specifications. The Contracting Officer may request submittals in addition to those listed when deemed necessary to adequately describe the work covered in the respective sections. Units of weights and measures used on all submittals shall be the same used in the contract drawings. Submittals shall be made in the respective number of copies and to the respective addresses set forth below. Each submittal shall be complete and in sufficient detail to allow ready determination of compliance with contract requirements. Prior to submittal, all items shall be checked and approved by the Contractor's Quality Control (CQC) representative and each respective transmittal form (ENG Form 4025) shall be stamped, signed, and dated by the CQC representative certifying that the accompanying submittal complies with the contract requirements. Proposed deviations from the contract requirements shall be clearly identified. Submittals shall include items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals including parts list; certifications; warranties and other such required submittals. Submittals requiring Government approval shall be scheduled and made prior to the acquisition of the material or equipment covered thereby.

3.2 SUBMITTAL REGISTER (ENG Form 4288)

at the second se
At the end of this section is one set of ENG Forms 4288 listing each item
of equipment and material for which submittals are required by the
specifications. Columns "c" thru "o" have been completed by the
Government. The Contractor shall complete columns "a," "b," and "p" thru
"u" and return [] completed copies to the Contracting Officer for
approval within [] calendar days after Notice to Proceed for approval
The approved submittal register will become the scheduling document and
will be used to control submittals throughout the life of the contract.
This register and the progress schedules shall be coordinated.

3.3 SCHEDULING

Submittals covering component items forming a system or items that are interrelated shall be scheduled to be coordinated and submitted concurrently. Certifications to be submitted with the pertinent drawings shall be so scheduled. Adequate time (a minimum of [____] calendar days exclusive of mailing time) shall be allowed on the register for review and approval. No delays damages or time extensions will be allowed for time lost in late submittals.

3.4 TRANSMITTAL FORM (ENG Form 4025)

The sample transmittal for (ENG Form 4025) attached to this section shall be used for submitting both Government approved and information only submittals in accordance with the instructions on the reverse side of the form. These forms will be furnished to the Contractor. This form shall be properly completed by filling out all the heading blank spaces and identifying each item submitted. Special care will be exercised to ensure proper listing of the specification paragraph and/or sheet number of the contract drawings pertinent to the data submitted for each item.

3.5 SUBMITTAL PROCEDURE

Submittals shall be made as follows:

3.5.1 Procedures

[____]

3.5.2 Deviations

For submittals which include proposed deviations requested by the Contractor, the column "variation" of ENG Form 4025 shall be checked. The Contractor shall set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

3.6 CONTROL OF SUBMITTALS

The Contractor shall carefully control his procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

3.7 GOVERNMENT APPROVED SUBMITTALS

Upon completion of review of submittals requiring Government approval, the submittals will be identified as having received approval by being so stamped and date. [____] copies of the submittal will be retained by the Contracting Officer and [_____] copies of the submittal will be returned to the Contractor.

3.8 INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. Approval of the Contracting Officer is not required on information only submittals. These submittals will be used for information purposes. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications and will not prevent the Contracting Office from requiring removal and replacement if nonconforming material is incorporated in the work. This does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or check testing by the Government in

those instances where the technical specifications so prescribe.

3.9 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements shall be similar to the following:

CONTRACTOR
(Firm Name)
Approved
Approved with corrections as noted on submittal data and/or attached sheets(s).
SIGNATURE:
TITLE:
DATE:

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SECTION 02147

DRAINAGE COMPOSITES

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4355	(1984) Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
ASTM D 4533	(1985) Trapezoidal Tearing Strength of Geotextiles
ASTM D 4632	(1986) Breaking Load and Elongation of Geotextiles (Grab Method)
ASTM D 4833	(1988) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01300 SUBMITTALS:

SD-09 Reports

Test Reports; FIO.

Certified copies of laboratory test reports attesting that the drainage composite conforms to the standard specified herein. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials and shall be submitted at least 30 days prior to commencement of work, and shall be approved prior to use on the project.

1.4 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

1.4.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded and stored with the minimum of handling. Materials shall not be stored

directly on the ground. During shipment and storage, drainage composites shall be wrapped in a heavy-duty protective covering. The storage area shall be such that the composite is protected from mud, soil, dust, debris, and temperatures greater than 140 degrees F.

1.4.2 Handling

Drainage composites shall be handled in such a manner as to insure delivery to area of placement in sound, undamaged condition.

PART 2 PRODUCTS

2.1 DRAINAGE COMPOSITES

The drainage composite shall consist of a filter fabric and a drainage mat meeting the requirements specified below. The filter fabric and drainage mat may be separate materials or a composite of the two materials bonded together during manufacture.

2.1.1 Filter Fabric

Filter fabric shall be non-woven pervious sheet of long chain polymeric filaments of polypropylene or polyester, formed by needle punching into a pattern with distinct and measurable openings. The filter fabric shall provide an Equivalent Opening Size (EOS) no finer than the US Standard Sieve No.[____]. EOS is defined as the number of the US Standard sieve having openings closest in size to the filter cloth openings. The fabric shall conform to the physical strength requirements in Table I. The edges of the fabric shall be selvaged or otherwise finished, as required, to prevent the outer material from pulling away from the fabric.

2.1.2 Drainage Mat

The drainage mat shall be nylon, polyethylene or other high-strength plastic of adequate size to carry groundwater from the filter fabric to the drainage outlet and of adequate strength to prevent crushing during installation or by lateral earth pressures during in-service use. The mat configuration shall provide multi-directional water flow.

TABLE I. Physical Strength Requirements

Physical Property	Test Procedure	Acceptable Test Results
Tensile Strength (unaged fabric)*	ASTM D 4632	215 pounds per inch minimum in any principle direction
Puncture Strength (unaged fabric)*	ASTM D 4833	90 pound minimum
Elongation at Failure (unaged fabric)*	ASTM D 4632	60 percent minimum
Trapezoidal Tear Strength (unaged fabric)*	ASTM D 4533	80 pounds minimum
Resistance to Ultraviolet Light	ASTM D 4355	TBD

*NOTE 1: Unaged fabric is defined as fabric in the condition as received from the Manufacturer or Distributor.

PART 3 EXECUTION

3.1 INSTALLATION OF DRAINAGE COMPOSITES

The drainage composite shall be placed against the structure after the elastomeric membrane waterproofing has been applied. The composite shall be laid smooth and free of tension, stress, wrinkles, folds, or creases. Drainage mat material shall be cut back at the edges where the composite is terminated so that sufficient filter fabric material is left to overlap and join to structures or wrap around drain pipes. Care shall be taken during installation to prevent damage to the drainage composite, waterproofing, or the structure.

3.2 CONTRACTOR'S RESPONSIBILITY

Any drainage composite with defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, storage, handling, installation, or backfilling will be rejected by the Contracting Officer and will be replaced or repaired by the Contractor, as directed, at no additional cost to the Government.

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SECTION 02221

EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1556	(1982) Density of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1978) Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop
ASTM D 2167	(1984) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216	(1980) Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures
ASTM D 2487	(1985) Classification of Soils For Engineering Purposes
ASTM D 2922	(1981) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937	(1983) Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017	(1988) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 4318	(1984) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.3 SUBMITTALS (Not Applicable)

1.4 DEFINITIONS

1.4.1 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557, Method D, abbreviated hereinafter as percent laboratory maximum density.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Satisfactory Materials

Satisfactory materials include materials classified in ASTM D 2487 as GW, GP, SW, GM, GC, SP, SM, SC, and CL, and shall be free of trash, debris, roots or other organic matter, or stones larger than 3 inches in any dimension. CH material shall be considered satisfactory only for use as impervious fill. SM material shall not have more than 25 percent by weight passing the No. 200 sieve. Earth fill shall contain no stones heavier than 10 pounds or larger than 6 inches in any dimension.

2.1.2 Unsatisfactory Materials

Unsatisfactory materials include materials classified in ASTM D 2487 as Pt, OH, OL, ML, MH, and any other materials not defined as satisfactory.

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 and SM will be identified as cohesionless only when the fines are nonplastic. Earth fill over and adjacent to the magazine shall contain no stones heavier than 10 pounds or larger than 6 inches in any dimension.

2.1.4 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.

2.1.5 Nonfrost Susceptible (NFS) Material

Nonfrost susceptible material shall be a uniformly graded washed sand with a maximum particle size of [____] 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 Impervious Fill

Impervious fill shall be satisfactory material classified in ASTM D 2487 as CL or CH, with liquid limit greater than 30 and plasticity index greater than 15. Earth fill over and adjacent to the arches shall contain no stones heavier than 10 pounds or larger than 6 inches in any dimension.

2.1.7 Filter Materials

Filter materials 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 materials shall be uniformly graded between the limits specified hereinafter. Points on the individual

grading curves obtained from representative samples of filter materials not only shall lie between smooth curves drawn through a plot of the tabulated grading limits specified, but also shall exhibit no abrupt changes in slope denoting skip grading, scalping of certain sizes, or other irregularities that would be detrimental to the proper functioning of the filter.

Sand filter material shall be a uniformly grade material conforming to the following gradation:

Sieve Size	Percent by Weight Passing
3/8-inch	
No. 4	
No. 10	
No. 20	
No. 40	
No. 100	
No. 200	

Gravel filter material shall be uniformly graded material conforming to the following gradation:

Sieve Size	Percent by Weight Passing
1-1/2 inch	
1/2-inch 3/8-inch	
No. 4	
No. 200	

2.2 CAPILLARY WATER BARRIER

Capillary Water Barrier shall consist of clean, crushed, nonporous rock, crushed gravel, or uncrushed gravel. The maximum particle size shall be 1-1/2 inches and no more than 2 percent by weight shall pass the No. 4 size sieve.

PART 3 EXECUTION

3.1 CLEARING AND GRUBBING

The areas within the limits shown shall be cleared and grubbed of trees, stumps, roots, brush and other vegetation, debris, existing foundations, pavements, utility lines, structures, fences, and other items that would interfere with construction operations. Stumps, logs, roots, and other organic matter shall be completely removed and the resulting depressions shall be filled with satisfactory material, placed and compacted in accordance with paragraph FILLING AND BACKFILLING. Materials removed shall be disposed of [in the designated waste disposal areas] [outside the limits of Government-controlled property at the Contractor's responsibility]

3.2 TOPSOIL

Topsoil shall be stripped to a depth of [____] inches below existing grade within the designated excavations and grading lines and deposited in storage piles for later use. Excess topsoil shall be disposed as specified for excess excavated material.

3.3 EXCAVATION

Excavation shall conform to the dimensions and elevations indicated for each building, structure, and footing except as specified hereinafter, and shall include trenching for utility and foundation drainage systems to a point 5 feet beyond the building line of each building and structure, and all work incidental thereto. Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms. 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 and replaced with satisfactory material. Payment therefor will be made in conformance with the CHANGES clause of the CONTRACT CLAUSES. Satisfactory material removed below the depths indicated without specific direction of the Contracting Officer shall be replaced at no additional cost to the Government to the indicated excavation grade with satisfactory materials, except that concrete footings shall be increased in thickness to the bottom of the overdepth excavations and over-break in rock excavation. Satisfactory material shall be placed and compacted as specified in paragraph FILLING AND BACKFILLING. 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.

3.4 DRAINAGE AND DEWATERING

3.4.1 Drainage

Surface water shall be directed away from excavation and construction sites so as to prevent erosion and undermining of foundations. Diversion ditches, dikes and grading shall be provided and maintained as necessary during construction. Excavated slopes and backfill surfaces shall be protected to prevent erosion and sloughing. Excavation shall be performed so that the site and the area immediately surrounding the site and affecting operations at the site shall be continually and effectively drained.

3.4.2 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 below the working

level.

3.5 SHORING

Shoring, including sheet piling, shall be furnished and installed as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Shoring, bracing, and sheeting shall be removed as excavations are backfilled, in a manner to prevent caving.

3.6 CLASSIFICATION OF EXCAVATION

[Excavation will be unclassified regardless of the nature of material encountered.] [Rock excavation shall consist of the removal and disposal of boulders 1 cubic yard or more in volume; solid rock; materials that cannot be removed without systematic drilling and blasting such as rock material in ledges or aggregate conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock; and concrete or masonry structures exceeding 1 cubic yard in volume, except sidewalks and paving. Hard and compact materials such as cemented gravel, glacial till, and relatively soft or disintegrated rock that can be removed without continuous and systematic drilling and blasting will not be considered as rock excavation. Rock excavation will not be considered as such because of intermittent drilling and blasting that is performed merely to increase production. 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.]

3.7 BLASTING

Blasting [will] [will not] be permitted.

3.8 UTILITY AND DRAIN TRENCHES

Trenches for underground utilities systems and drain lines shall be excavated to the required alignments and depths. The bottoms of trenches shall be graded to secure the required slope and shall be tamped if necessary to provide a firm pipe bed. 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, and the overdepth shall be backfilled with satisfactory material placed and compacted in conformance with paragraph FILLING AND BACKFILLING.

3.9 BORROW

Where satisfactory materials are not available in sufficient quantity from required excavations, approved materials shall be obtained [from the borrow areas shown] [or] [from approved sources outside the limits of Government-controlled land at the Contractor's responsibility]. [The Contracting Officer shall be notified sufficiently in advance prior to opening any borrow area to permit elevations and measurements of the undisturbed ground area to be taken.] Borrow areas shall be neatly trimmed and drained after borrow excavations are completed.

3.10 EXCAVATED MATERIALS

Satisfactory excavated material required for fill or backfill shall be placed in the proper section of the permanent work required under this section or shall be separately stockpiled if it cannot be readily placed. Satisfactory material in excess of that required for the permanent work and all unsatisfactory material shall be disposed of [in designated spoil areas] [outside the limits of Government-controlled land and at the Contractor's responsibility].

3.11 FINAL GRADE OF SURFACES TO SUPPORT CONCRETE

Excavation to final grade shall not be made until just before concrete is to be placed. 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 or other erosion resulting from ponding or flow of water.

3.12 SUBGRADE PREPARATION

Unsatisfactory material in surfaces to receive fill or in excavated areas shall be removed and replaced with satisfactory materials. 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 plus or minus [____] percent of optimum moisture. Minimum subgrade density shall be as specified in paragraph FILLING AND BACKFILLING.

3.13 FILLING AND BACKFILLING

Satisfactory materials shall be used in bringing fills and backfills to the lines and grades indicated and for replacing unsatisfactory materials. Satisfactory materials shall be placed in horizontal layers not exceeding 8 inches in loose thickness, or 6 inches when hand-operated compactors are used. After placing, each layer shall be plowed, disked, or otherwise broken up, moistened or aerated as necessary, thoroughly mixed and compacted as specified. 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. Backfill shall not be placed in wet or frozen areas. 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. Each layer of fill and backfill shall be compacted to not less than the percentage of maximum density specified below:

Percent Laboratory

maximum density Cohesionless Cohesive material material Fill, embankment, and backfill Under structures, building slabs, steps, paved areas, around 95 footings, and in trenches 90 90 85 Under sidewalks and grassed areas Compacted to not less than [_____ [Expansive materials percent nor more than [____] percent] 95 Nonfrost susceptible materials Subgrade Under building slabs, steps, and paved 90 95 areas, top 12 inches 90 85 Under sidewalks, top 6 inches

Approved compacted subgrades that are disturbed by the Contractor's operations or adverse weather shall be scarified and compacted as specified herein before to the required density prior to further construction thereon. Recompaction over underground utilities and heating lines shall be by hand tamping. Compaction equipment or methods that produce horizontal or vertical earth pressures which cause excessive distortion or damage to the structure shall not be used.

3.14 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or may be performed by the Contractor subject to approval. Field in-place density shall be determined in accordance with [ASTM D 1556], [ASTM D 2167], or [ASTM D 2922]. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted if necessary by the procedure described in ASTM D 2922, paragraph ADJUSTING CALIBRATION CURVE. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D 3017. 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 by the Contracting Officer. ASTM D 2937 shall be used only for soft, fine-grained, cohesive soils. The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

3.14.1 In-Place Densities

3.14.1.1	In-Place Density of Subgrades			
One test	per [] square foot or fraction thereof.			
3.14.1.2	In-Place Density of Fills and Backfills			

One test per [] square foot or fraction thereof of each fift for fift
or backfill areas compacted by other than hand or hand-operated machines.
The density for each lift of fill or backfill materials for trenches, pits
building perimeters or other structures or areas less than [] feet in
width, which are compacted with hand or hand-operated machines shall be
tested as follows: One test per each area less than [] square feet,
or one test for each [] linear foot of long narrow fills [] feet
or more in length. [If ASTM D 2922 is used, in-place densities shall
be checked by ASTM D 1556 as follows: One check per lift for each
[] linear feet of long narrow fills, and a minimum of [] checks
per lift for other fill and backfill areas.]

3.14.2 Moisture Content

In the stockpile, excavation or borrow areas, a minimum of two tests shall be made per day per type of material or source of materials being placed 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.

3.14.3 Optimum Moisture and Laboratory Maximum Density

Tests shall be made 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 [____] cubic yards of fill and backfill, or when any change in material occurs which may affect the

optimum moisture content or laboratory maximum density will be made.

3.15 CAPILLARY WATER BARRIER

Capillary water barrier under concrete floor and area-way slabs on grade shall be placed directly on the subgrade and shall be compacted with a minimum of two passes of a hand-operated plate-type vibratory compactor.

3.16 GRADING

Areas outside of each building and structure line shall be constructed true-to-grade, shaped to drain, and shall be maintained free of trash and debris until final inspection has been completed and the work has been accepted.

3.17 SPREADING TOPSOIL

Areas outside the building lines from which topsoil has been removed shall be topsoiled. The surface shall be free of materials that would hinder planting or maintenance operations. The subgrade shall be pulverized to a depth of 2 inches by disking or plowing for the bonding of topsoil with the subsoil. Topsoil shall then be uniformly spread, graded, and compacted to the thickness, elevations, slopes shown, and left free of surface irregularities. Topsoil shall be compacted by one pass of a cultipacker, roller, or other approved equipment weighing 100 to 160 pounds per linear foot of roller. 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.

3.18 PROTECTION

Settlement or washing that occurs in graded, topsoiled, or backfilled areas prior to acceptance of the work shall be repaired and grades reestablished to the required elevations and slopes.

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SECTION 02285

SOIL TREATMENT FOR SUBTERRANEAN TERMITE CONTROL

PART	1 GENERAL
1.1	SUMMARY (Not Applicable)
1.2	REFERENCES (Not Applicable)
1.3	SUBMITTALS
su fo	vernment approval is required for submittals with a "GA" designation; bmittals having an "FIO" designation are for information only. The llowing shall be submitted in accordance with Section 01300 SUBMITTAL SCRIPTIONS:
	SD-01 Data
Qu	alifications; [].
Qu	alifications of the pesticide applicator.
	SD-06 Instructions
Pe	sticides; [].
	nufacturer's label and Material Safety Data Sheet (MSDS) for pesticides oposed for use.
	SD-14 Samples
Pe	sticides; [].
Sa	mples of the pesticides used in this work, upon request.
1.4	QUALIFICATIONS OF PESTICIDE APPLICATORS
pe Pr	e pesticide applicator's principal business shall be pest control and the sticide applicator shall be State certified in the U.S. Environmental otection Agency (EPA) pesticide applicator category which includes ructural pest control, and certified in the State.

1.5 DELIVERY, STORAGE, AND HANDLING

Pesticides shall be delivered to the project site in sealed and labeled containers in good condition as supplied by the manufacturer or formulator. Pesticides shall be stored, handled, and used in accordance with manufacturer's labels. Labels shall bear evidence of registration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended.

1.6 SAFETY REQUIREMENTS

The Contractor shall formulate, treat, and dispose of termiticides and their containers in accordance with label directions. Water for formulating shall only come from sites designated by the Contracting Officer, and filling hose shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Pesticides and related materials shall be kept under lock and key when unattended. Proper protective clothing and equipment shall be worn and used during all phases of termiticide application.

1.7 WARRANTY

The Contractor shall provide a [3] [5] [____]-year written warranty against infestations or reinfestations by subterranean termites of the buildings or building additions constructed under this contract. Warranty shall include annual inspections of the building[s] or building addition[s]. If live subterranean termite infestation or subterranean termite damage is discovered during the warranty period, and the soil and building conditions have not been altered in the interim, the Contractor shall:

- a. Re-treat the soil and perform other treatment as may be necessary for elimination of subterranean termite infestation;
- b. Repair damage caused by termite infestation; and
- c. Reinspect the building approximately 180 days after the retreatment.

PART 2 PRODUCTS

2.1 MATERIALS

Termiticides shall be currently registered by the EPA.

PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

At the time of application, the soil moisture content shall be sufficiently low to allow uniform distribution of the treatment solution throughout the soil. Applications shall not be made during or immediately following heavy rains or when conditions may cause runoff and create an environmental hazard.

3.2 APPLICATION

3.2.1 Treatment of New Structures

The Contractor shall establish complete and unbroken vertical and/or horizontal (as necessary) soil poison barriers between the soil and all portions of the intended structure which may allow termite access to wood and wood related products. Termiticide shall be applied as a coarse spray and provide uniform distribution unto the soil surface. Treatment shall be

applied prior to placement of a vapor barrier or waterproof membrane and at least 12 hours prior to concrete placement. Where treated soil or fill material is not to be covered with a vapor barrier or waterproof membrane, adequate precautions shall be taken to prevent its disturbance. Soil or fill material disturbed after treatment shall be re-treated as specified above before placement of slabs or other covering structures. Treatment of the soil on the exterior sides of foundation walls, grade beams, and similar structures shall be coordinated with final grading and planting operations so as to avoid disturbance of the treated barriers. Manufacturer's warnings and precautions shall be observed in the handling and use of such materials. Care shall be taken to prevent these chemicals from entering water supply systems, potable water supplies, or aquifers; and that they do not endanger plants or animals. The Contracting Officer shall be notified at least 48 hours prior to beginning of treatment and formulating, mixing, and application shall be performed in the presence of the Contracting Officer's representative.

3.2.2 Rates and Methods of Application

Rates and methods of application shall be in accordance with the manufacturer's instructions on the pesticide label. Maximum application or dosage rates shall be used. If the pesticide contains less than the amount of active ingredient specified on the label, work shall be repeated with pesticides conforming to this specification.

3.3 DISPOSAL

The Contractor shall dispose of residual pesticides and containers off Government property in accordance with label instructions and EPA criteria.

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 - 2.1.1.3 Polyvinyl Chloride (PVC) Pipe
 - 2.1.1.4 Circular Perforations in Plastic Pipe
 - 2.1.1.5 Slotted Perforations in Plastic Pipe
- 2.1.2 Fittings
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- 2.1.4 Sand and Gravel Filter Materials for Foundation Drains
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 - 3.2.3 Pipe Laying
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SECTION 02711

FOUNDATION DRAINAGE SYSTEM

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

ASTM C 33

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

AMERICAN ASSN OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 252	(1985) Corrugated Polyethylene Drainage Tubing		
AASHTO M 278	(1987I) Class PS50 Polyvinyl Chloride (PVC) Pipe		
AASHTO M 294	(1986) Corrugated Polyethylene Pipe, 12 to 24-inch Diameter		

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2751	(1988a) Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D 3034	(1988b) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1986) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F 405	(1985) Corrugated Polyethylene (PE) Tubing and Fittings
ASTM F 667	(1985) Large Diameter Corrugated Polyethylene Tubing and Fittings
ASTM F 758	(1982) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F 949	(1986a) Poly(Vinyl Chloride) (PVC)

(1986) Concrete Aggregates

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1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS:

SD-13 Certificates

Materials; FIO.

Certifications from the manufacturers attesting that materials meet specification requirements.

SD-14 Samples

Materials; GA

Two randomly selected samples of each type of pipe and fitting, prior to delivery of materials to the site.

1.4 DELIVERY, STORAGE AND HANDLING

Materials placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Plastic pipe shall not be exposed 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. Any of the types listed may be used; however, the same type shall be used throughout the project.

2.1.1 Plastic Pipe

Plastic pipe shall contain ultraviolet inhibitor to provide protection from exposure to direct sunlight.

2.1.1.1 Corrugated Polyethylene (PE) Drainage Pipe

Use ASTM F 405 heavyduty for pipe 3 to 6 inches in diameter inclusive, ASTM F 667 for pipe 8 to 24 inches in diameter; or use 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.

2.1.1.2 Acrylonitrile-Butadiene-Styrene (ABS) Pipe

ASTM D 2751, with a maximum SDR of 35.

2.1.1.3 Polyvinyl Chloride (PVC) Pipe

ASTM F 758, Type PS 46, ASTM D 3034, ASTM F 949, or AASHTO M 278 with a minimum pipe stiffness of 46 psi.

2.1.1.4 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.

2.1.1.5 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 per linear foot of tubing. Manufacturer's standard perforated pipe which essentially meets these requirements may be used with prior approval of the Contracting Officer.

2.1.2 Fittings

Fittings shall be of compatible materials for pipe, of corresponding weight and quality, and as specified herein.

2.1.3 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.

2.1.4 Sand and Gravel Filter Materials for Foundation Drains

Sand and gravel filter materials shall be [in accordance with Section 02221 EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS] [coarse aggregate conforming to ASTM C 33, size number [8] 4 [____].

2.1.5 Protective Covering for Sand and Gravel Filter Materials

Protective covering shall be [building paper] [or] [fiberglass mat of lime borosilicate glass fibers. Fibers shall be 8 to 12 microns in average diameter, 2 to 4 inches in length, and bonded with phenol formaldehyde resin. Mat shall be roll type, nonperforated, water permeable, with thickness between 1/4 and 1/2 inch and density of 3/4 pcf].

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

3.1.1 Extent

Foundation drainage shall be furnished and installed as a complete system as shown.

3.1.2 Outlet Connections

Foundation pipe shall be terminated as shown.

3.1.3 Drainage Lines

Drainage lines shall be constructed of perforated pipe.

3.1.4 Outlet Lines

Outlet lines shall be constructed of closed-joint nonperforated, nonporous pipe.

3.2 INSTALLATION

3.2.1 Trenching and Excavation

Required trenching and excavation shall be in accordance with Section 02221 EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS. Trenches shall be kept dry during installation of drainage system. Changes in direction of drain lines shall be made with 1/8 bends. Wye fittings shall be used at intersections.

3.2.2 Bedding

Graded bedding, minimum 6 inches in depth, shall be placed in the bottom of trench for its full width and length and 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.

3.2.3 Pipe Laying

Drain lines shall be laid to true grades and alignment with a continuous fall in the direction of flow. Bells of pipe sections shall face upgrade. Interior of pipe shall be cleaned 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.

3.2.4 Jointing

3.2.4.1 Perforated Pipes

Perforated drain pipes shall be laid with closed joints.

3.2.4.2 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.

3.2.4.3 PVC Pipe

PVC pipe joints shall be in accordance with ASTM D 3034, ASTM D 3212, or ASTM F 949.

3.2.4.4 Corrugated Polyethylene

Corrugated polyethylene (PE) pipe joints shall be in accordance with ASTM F 405 or ASTM F 667.

3.2.5 Outlet Lines

The outlet end of drain lines connecting with an open gutter or outfall shall be [covered with a removable wire basket of 16-mesh copper or bronze wire cloth fastened with brass or wire straps] [finished as shown].

3.2.6 Backfilling

After joints and connections have been inspected and approved, the specified pervious backfill material shall be placed [a minimum width of 6 inches on each side of the pipe] [for the full width of the trench and full width between pipe and adjacent walls] and 12 inches above the top of the pipe. When placing the backfill, care shall be taken to prevent displacement of or injury to the pipe. A protective covering, as specified, shall be placed over the pervious backfill for the full width of the trench before regular backfill is placed. Backfill shall be compacted as specified in Section 02221 EXCAVATION, FILLING AND BACKFILLING FOR BUILDINGS.

[3.2.7 Cleanouts

Cleanouts shall be provided in locations indicated. Cleanouts in unpaved areas shall be set in 12-by 12-by 4-inch concrete blocks.]

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SECTION 03300

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SECTION 03300

CONCRETE FOR BUILDING CONSTRUCTION

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1981; Rev 1985) Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	(1984; Rev 1988) Structural Concrete for Buildings
ACI 305R	(1989) Hot Weather Concreting
ACI 318	(1989) Building Code Requirements for Reinforced Concrete
ACI 347	(1988) Concrete Formwork

AMERICAN HARDBOARD ASSOCIATION (AHA)

AHA A135.4 (1982; R 1988) Basic Hardboard

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 615	(1989) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 31	(1988) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1986) Concrete Aggregates
ASTM C 39	(1986) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 42	(1987) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C 78	(1984) Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)
ASTM C 94	(1989b) Ready-Mixed Concrete
ASTM C 143	(1989a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1989) Portland Cement
ASTM C 171	(1969; R 1986) Sheet Materials for Curing Concrete
ASTM C 172	(1982) Sampling Freshly Mixed Concrete
ASTM C 173	(1978) Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C 192	(1988) Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(1989a) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1986) Air-Entraining Admixtures for Concrete
ASTM C 309	(1989) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 330	(1987) Lightweight Aggregates for Structural Concrete
ASTM C 494	(1986) Chemical Admixtures for Concrete
ASTM C 597	(1983) Pulse Velocity Through Concrete
ASTM C 618	(1989) Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 803	(1982; R 1989) Penetration Resistance of Hardened Concrete
ASTM C 805	(1985) Rebound Number of Hardened Concrete
ASTM C 1017	(1985) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM D 1751	(1983) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752 (1984) Preformed Sponge Rubber and Cork

Expansion Joint Fillers for Concrete Paving

and Structural Construction

ASTM E 96 (1990) Water Vapor Transmission of

Materials

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI DA4 (1990; 25th Ed) Manual of Standard

Practice

DEPARTMENT OF COMMERCE (DOC)

DOC PS 1 (1983) Construction and Industrial

Plywood

FEDERAL SPECIFICATIONS (FS)

FS CCC-C-467 (Rev C) Cloth, Burlap, Jute (or Kenaf)

FS SS-S-1401 (Rev C; Notice 1) Sealant, Joint,

Non-Jet-Fuel-Resistant, Hot-Applied, for

Portland Cement and Asphalt Concrete

Pavements

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA-01 (Jan 1984) Quality Control Manual:

Section 3, Plant Certifications Checklist:

Certification of Ready-Mixed Concrete

Production Facilities

NRMCA CPMB-100 (Jan 1986) Concrete Plant Standards

NRMCA TMMB-1 (Jan 1982; 11th Rev) Truck Mixer and

Agitator Standards

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS:

SD-04 Drawings

Concrete Reinforcement System; GA

Detail drawings showing reinforcing steel schedules, sizes, grades, and splicing and bending details. Drawings shall show support details

including types, sizes and spacing.

SD-08 Statements

Proportions of Mix; FIO.

The results of trial mix along with a statement giving the maximum nominal coarse aggregate size and the proportions of all ingredients that will be used in the manufacture of each strength of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate weights shall be based on the saturated surface dry condition. The statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory.

SD-09 Reports

Sampling and Testing; FIO.

Certified copies of laboratory test reports, including all test data, for aggregate, admixtures, cement, pozzolan, joint sealant, and curing compound. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials.

SD-13 Certificates

Cementitious Materials; [____].

Manufacturer's certification of compliance, accompanied by mill test reports attesting that the materials meet the requirements of the specification under which it is furnished, for cement and pozzolan.

Reinforcing Steel; FIO

Certified copies of mill reports attesting that the reinforcing steel furnished meets the requirements specified, prior to the installation of reinforcing steel.

1.4 GENERAL REQUIREMENTS

1.4.1 Strength Requirements

Structural concrete for all work except slabs on-grade shall have a 28-day compressive strength of 4000 pounds per square inch. Concrete slabs on-grade shall have a 28-day flexural strength of 600 pounds per square inch. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type I or II portland cement.

1.4.2 Air Entrainment

Concrete exposed to freeze-thaw cycles shall contain from 5 to 7 percent total air. Other concrete may, at the option of the Contractor, be air

entrained to produce concrete with 3 to 5 percent total air.

1.4.3 Special Properties

Concrete may contain other admixtures, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete, if approved.

1.4.4 Slump

Slump shall be within the following limits:

Structural Element	Slump in Minimum	
Blast and Fragment Resistant Walls	4	6
Foundation walls, substructure walls, footings, pavement, and slab	1	3
Any structural concrete approved for placement by pumping	None	6

*Where use of superplasticizers are approved to produce flowing concrete these slump requirements do not apply.

1.5 PROPORTIONS OF MIX

1.5.1 Mixture Proportioning

Trial batches shall contain materials proposed to be used in the project. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios. Trial mixes shall be proportioned to produce concrete strengths specified. Trial mixtures shall be designed for maximum permitted slump and air content. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192. They shall be tested at 7 and 28 days in accordance with ASTM C 39. From these test results a curve shall be plotted showing the relationship between water-cement ratio and strength.

1.5.2 Average Strength

In meeting the strength requirements specified, the selected mixture proportion shall produce an average compressive strength exceeding the specified strength by the amount indicated below. Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 1000 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made

from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

1.5.2.1 Test Records Exceeding 29

Required average compressive strength used as the basis for selection of concrete proportions shall be the larger of the specified strength plus the standard deviation multiplied by 1.34 or the specified strength plus the standard deviation multiplied by 2.33 minus 500.

1.5.2.2 Test Records Less Than 29

Where a concrete production facility does not have test records meeting the above requirements but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and a modification factor from the following table:

No. of	tests (1)	Modification factor for standard deviation
less than	15	See Note
	15	1.16
	20	1.08
	25	1.03
	30 or more	1.00

(1) Interpolate for intermediate numbers of tests.

When a concrete production facility does not have field strength test records for calculation of standard deviation or the number of tests is less than 15, the required average strength shall be:

- a. The specified strength plus 1000 specified strength of less than 3000 psi.
- b. The specified strength plus 1200 for specified strengths of 3000 to 5000 psi.
- c. The specified strength plus 1400 for specified strengths greater than 5000 psi.

1.6 STORAGE OF MATERIALS

Cement and pozzolan shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Reinforcing bars and accessories shall be stored above the ground on platforms, skids or other supports. Other materials shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than 6 months or which have been subjected to freezing shall not be used unless

retested and proven to meet the specified requirements. Sealants shall be delivered in the manufacturer's original unopened containers. Sealants whose shelf life has expired shall be removed from the site.

1.7 FORM DESIGN

Formwork shall be designed in accordance with methodology of ACI 347 for anticipated loads, lateral pressures, and stresses. Forms shall be capable of producing a surface which meets the requirements of the class of finish specified in Section 03300 CONCRETE FOR BUILDING CONSTRUCTION. Forms shall be capable of withstanding the pressures resulting from placement and vibration of concrete.

PART 2 PRODUCTS

2.1 ADMIXTURES

Admixtures shall conform to the following:

2.1.1 Accelerating Admixture

ASTM C 494, Type C or E.

2.1.2 Air-Entraining Admixture

ASTM C 260.

2.1.3 Flowing Concrete Admixture

ASTM C 1017, Type 1 or 2.

2.1.4 Water-Reducing or Retarding Admixture

ASTM C 494, Type A, B, or D.

2.2 CEMENTITIOUS MATERIALS

Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

2.2.1 Cement

ASTM C 150, Type I or II or III.

2.2.2 Pozzolan

ASTM C 618, Class N.

2.3 AGGREGATES

Aggregates shall conform to ASTM C 33. Maximum size of coarse aggregate shall be 1/2 inch for Blast and Fragment Resistant Walls and 1 inch for all other work.

2.4 CURING MATERIALS

2.4.1 Burlap

FS CCC-C-467.

2.4.2 Impervious Sheets

ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.4.3 Membrane-Forming Compounds

ASTM C 309, Type 1-D, Class A or B.

2.5 EMBEDDED ITEMS

Embedded items shall be of the size and type indicated or as needed for the application.

2.6 FORM MATERIALS

2.6.1 Forms For Class B Finish

Forms for Class B finished surfaces shall be plywood panels conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II. Other form materials or liners may be used provided the smoothness and appearance of concrete produced will be equivalent to that produced by the plywood concrete form panels.

2.6.2 Forms For Class C Finish

Forms for Class C finished surfaces shall be shiplap lumber; plywood conforming to DOC PS 1, Grade B-B concrete form panels, Class I or II; tempered concrete form hardboard conforming to AHA A135.4; other approved concrete form material; or steel, except that steel lining on wood sheathing shall not be used.

2.6.3 Form Ties

Form ties shall be factory-fabricated metal ties, shall be of the removable or internal disconnecting or snap-off type, and shall be of a design that will not permit form deflection and will not spall concrete upon removal. Solid backing shall be provided for each tie. That portion of the tie remaining permanently in the concrete shall not project beyond the surface of the concrete and shall be at least 1 inch back from any concrete surface that will be exposed or dampproofed. Except where removable tie rods are used, ties shall not leave holes in the concrete surface less than 1/4 inch nor more than 1 inch deep and not more than 1 inch in diameter. Removable tie rods shall not be more than 1-1/2 inches in diameter.

2.6.4 Form Releasing Agents

Form releasing agents shall be commercial formulations that will not bond with, stain or adversely affect concrete surfaces. Agents shall not impair

subsequent treatment of concrete surfaces depending upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

2.7 REINFORCING STEEL

Reinforcing steel shall be deformed bars conforming to ASTM A 615 Grade 60, sizes as indicated.

2.8 WIRE TIES

Wire ties shall be 16-gauge or heavier black annealed steel wire.

2.9 SUPPORTS

Bar supports for formed surfaces shall be designed and fabricated in accordance with CRSI DA4 and shall be precast concrete blocks. Precast concrete blocks shall be not less than 4 inches square when supporting reinforcement on ground. Precast concrete block shall have compressive strength equal to that of the surrounding concrete. Concrete supports used in concrete exposed to view shall have the same color and texture as the finish surface. For slabs on grade, supports shall be precast concrete blocks.

2.10 CONTRACTION-JOINT STRIPS

Contraction-joint strips shall be 1/8-inch thick tempered hardboard conforming to AHA A135.4, Class 1.

2.11 EXPANSION-JOINT FILLER

Expansion-joint filler shall be premolded material conforming to ASTM D 1751 or ASTM D 1752. Unless otherwise indicated, filler material shall be 3/8-inch thick and of a width applicable for the joint formed.

2.12 JOINT SEALANT

Joint sealant shall be hot-poured type conforming to FS SS-S 1401.

2.13 VAPOR BARRIER

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 6 mils or other equivalent material having a vapor permeance rating not exceeding 0.5 perms as determined in accordance with ASTM E 96.

2.14 WATER

Water shall be potable. Water for curing shall not contain any substance injurious to concrete, or which causes staining.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACES

Surfaces to receive concrete shall be clean and free from frost, ice, mud, and water. Conduit and other similar items shall be in place and clean of any deleterious substance.

3.1.1 Foundations

Earthwork shall be as specified in Section 02221 EXCAVATION, FILLING, AND BACKFILLING FOR BUILDINGS. Flowing water shall be diverted without washing over freshly deposited concrete. Rock foundations shall be cleaned by high velocity air-water jets, sandblasting, or other approved methods. Debris and loose, semi-detached or unsound fragments shall be removed. Rock surfaces shall be moist but without free water when concrete is placed. Semiporous subgrades for foundations and footings shall be damp when concrete is placed. Pervious subgrades shall be sealed by blending impervious material with the top 6 inches of the in-place pervious material or by covering with an impervious membrane.

3.1.2 Vapor Barrier

Subgrades for slabs in buildings shall be covered with a vapor barrier. Vapor barrier edges shall be lapped at least 4 inches and ends shall be lapped not less than 6 inches. Patches and lapped joints shall be sealed with pressure-sensitive adhesive or tape not less than 2 inches wide and compatible with the membrane.

3.1.3 Preparation of Previously Placed Concrete

Concrete surfaces to which other concrete is to be bonded shall be roughened in an approved manner that will expose sound aggregate uniformly without damaging the concrete. Laitance and loose particles shall be removed. Surfaces shall be moist but without free water when concrete is placed.

3.2 FORMWORK

Forms shall be mortar tight, properly aligned and adequately supported to produce concrete surfaces meeting the surface requirements specified and conforming to construction tolerance given in TABLE 1. Where forms for continuous surfaces are placed in successive units, care shall be taken to fit the forms over the completed surface so as to obtain accurate alignment of the surface and to prevent leakage of mortar. Forms shall not be reused if there is any evidence of surface wear and tear or defects which would impair the quality of the surface. Surfaces of forms to be reused shall be cleaned of mortar from previous concreting and of all other foreign material before reuse. Form ties that are to be completely withdrawn shall be coated with a nonstaining bond breaker.

3.3 CHAMFERING

Except as otherwise shown, external corners that will be exposed shall be chamfered, beveled, or rounded by moldings placed in the forms.

3.4 COATING OF FORMS

Forms for exposed surfaces shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used as recommended in the manufacturer's printed or written instructions. Forms for unexposed surfaces may be wet with water in lieu of coating immediately before placing concrete, except that in cold weather with probable freezing temperatures coating shall be mandatory. Surplus coating on reinforcing steel and construction joints shall be removed before placing concrete.

3.5 REMOVAL OF FORMS

1. Variations from the plumb:

Forms shall be removed in a manner that will prevent injury to the concrete and ensure the complete safety of the structure. Formwork for parts not supporting the weight of concrete may be removed when the concrete has attained sufficient strength to resist damage from the removal operation but not before at least 24 hours has elapsed since concrete placement. Supporting forms and shores shall not be removed until the structural units are strong enough to carry their own weight and any other construction or natural loads. In no case will supporting forms or shores be removed before the concrete strength has reached 70 percent of design strengths as determined by field cured cylinders or other approved methods. strength shall be demonstrated by job-cured test specimens, and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of forming and shoring system. The job-cured test specimens for form removal purposes shall be provided in numbers as directed and shall be in addition to those required for concrete quality control. The specimens shall be removed from molds at the age of 24 hours and shall receive, insofar as possible, the same curing and protection as the structures they represent.

TABLE 1

TOLERANCES FOR FORMED SURFACES

2. Variation from the level or from the grades indicated on the drawings:

Maximum for entire length --- 1 inch

In any 10 feet of length --- 1/4 inch

In any 20 feet of length --- 3/8 inch

the drawings:

In any 10 feet of length ---- 1/4 inch

- a. In slab soffits and ceilings, Maximum for entire length --- 3/4 inch measured before removal of supporting shores

TABLE 1

TOLERANCES FOR FORMED SURFACES

 Variation of the linear building lines from established position in plan 	In any 20 feet 1/2 inch Maximum 1 inch	
4. Variation of distance between walls	1/4 inch per 10 feet of distance, but not more than 1/2 inch in any one bay, and not more than 1 inch total variation	
 Variation in the sizes and locations of wall openings 	Minus 1/4 inch Plus 1/2 inch	
6. Variation in the thickness of slabs and walls	Minus 1/4 inch Plus 1/2 inch	
7. Footings:		
a. Variation of dimensions in plan	Minus 1/2 inch Plus 2 inches when formed or plus 3 inches when placed against unformed excavation	
b. Misplacement of eccentricity	2 percent of the footing width in the direction of misplacement but not more than 2 inches	
c. Reduction in thickness	Minus 5 percent of specified thickness	

3.6 REINFORCEMENT

Reinforcement shall be fabricated to shapes and dimensions shown and shall conform to the requirements of ACI 318. Reinforcement shall be cold bent unless otherwise authorized. Bending may be accomplished in the field or at the mill. Bars shall not be bent after embedment in concrete. Safety caps shall be placed on all exposed ends of vertical concrete reinforcement bars that pose a danger to life safety.

3.6.1 Placement

Reinforcement shall be free from loose rust and scale, dirt, oil, or other deleterious coating that could reduce bond with the concrete.

Reinforcement shall be placed in accordance with ACI 318 at locations shown plus or minus one bar diameter. Reinforcement shall not be continuous through expansion joints. Concrete coverage shall be as indicated or as required by ACI 318. If bars are moved more than one bar diameter to avoid interference with other reinforcement or embedded items, the resulting arrangement of bars, including additional bars

required to meet structural requirements, shall be approved before concrete is placed.

3.6.2 Splicing

Splices of reinforcement shall conform to ACI 318 and shall be made only as required or indicated. Splicing shall be by lapping. Lapped bars shall be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than one-fifth the required length of lap or 6-inches.

3.7 INSTALLATION OF EMBEDDED ITEMS

Embedded items shall be free from oil, loose scale or rust, and paint. Embedded items shall be installed at the locations indicated and required to serve the intended purpose. Voids in sleeves, slots and inserts shall be filled with readily removable material to prevent the entry of concrete.

3.8 BATCHING, MIXING AND TRANSPORTING CONCRETE

Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94, except as otherwise specified. Truck mixers, agitators, and nonagitating units shall comply with NRMCA TMMB-1. Ready-mix plant equipment and facilities shall be certified in accordance with NRMCA-01. Site-mixed concrete shall be mixed in accordance with ACI 301. On-site plant shall conform to the NRMCA CPMB-100.

3.8.1 Admixtures

Admixtures shall be batched within an accuracy of 3 percent. Where two or more admixtures are used in the same batch, they shall be batched separately and must be compatible. Retarding admixture shall be added within one minute after addition of water is complete or in the first quarter of the required mixing time, whichever is first. Superplasticizing admixtures shall be added at the project site, and the concrete with the admixture shall be mixed 4 to 5 minutes before placing. Concrete that shows evidence of total collapse or segregation caused by the use of admixture shall be removed from the site.

3.8.2 Control of Mixing Water

No water from the truck system or elsewhere shall be added after the initial introduction of mixing water for the batch except when on arrival at the jobsite, the slump of the concrete is less than that specified. Water added to bring the slump within the specified range shall not change the total water in the concrete to a point that the approved water-cement ratio is exceeded. The drum shall be turned an additional 30 revolutions, or more, if necessary, until the added water is uniformly mixed into the concrete. Water shall not be added to the batch at any later time.

3.9 SAMPLING AND TESTING

Sampling and Testing is the responsibility of the Contractor and shall be performed by an approved testing agency.

3.9.1 Aggregates

Aggregates for normal weight concrete shall be sampled and tested in accordance with ASTM C 33. Lightweight aggregate shall be sampled and tested in accordance with ASTM C 330. Gradation tests shall be performed on the first day and every other day thereafter during concrete construction.

3.9.2 Sampling of Concrete

Samples of concrete for air, slump, unit weight, and strength tests shall be taken in accordance with ASTM C 172.

3.9.2.1 Air Content

Test for air content shall be performed in accordance with ASTM C 173 or ASTM C 231. A minimum of 1 test per day shall be conducted.

3.9.2.2 Slump

At least 2 slump tests shall be made on randomly selected batches of each mixture of concrete during each day's concrete placement. Tests shall be performed in accordance with ASTM C 143.

3.9.3 Evaluation and Acceptance of Concrete

3.9.3.1 Frequency of Testing

Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 150 cubic yards of concrete, nor less than once for each 5000 square feet of surface area for slabs or walls. If this sampling frequency results in less than 5 strength tests for a given class of concrete, tests shall be made from at least 5 randomly selected trucks or from each truck if fewer than 5 truck loads are used. Field cured specimens for determining form removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.

3.9.3.2 Testing Procedures

Cylinders and beams for acceptance tests shall be molded and cured in accordance with ASTM C 31. Cylinders shall be tested in accordance with ASTM C 39 and beams shall be tested in accordance with ASTM C 78. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days unless otherwise specified or approved.

3.9.3.3 Evaluation of Results

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 required strength by more than 500 pounds per square inch. For flexural strength concrete, the strength level of the concrete will be considered satisfactory if the averages of all sets of five consecutive strength test results equal or exceed the required flexural strength, and not more than 20 percent of the strength test results fall below the required strength by more than 100 pounds per square inch.

3.9.4 Investigation of Low-Strength Test Results

When any strength test of standard-cured test cylinder falls below the specified strength requirement by more than 500 pounds per square inch, or if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803 or ASTM C 805 may be permitted by the Contracting Officer to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the Contracting Officer to least impair the strength of the structure. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 degrees F, relative humidity less than 60 percent) for seven days before testing and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. If the core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318. Concrete work evaluated by structural analysis or by results of a load test and found deficient shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by the Contracting Officer, at the expense of the Contractor.

3.10 CONVEYING CONCRETE

Concrete shall be conveyed from mixer to forms as rapidly as possible and within the time interval specified in paragraph "CONCRETE PLACEMENT" by methods which will prevent segregation or loss of ingredients.

3.10.1 Chutes

When concrete can be placed directly from a truck mixer or other transporting equipment, chutes attached to this equipment may be used. Separate chutes will not be permitted except when specifically approved.

3.10.2 Buckets

Bucket design shall be such that concrete of the required slump can be readily discharged. Bucket gates shall be essentially grout tight when closed. The bucket shall provide means for positive regulations of the amount and rate of deposit of concrete in each dumping position.

3.10.3 Belt Conveyors

Belt conveyors may be used when approved. Belt conveyors shall be designed for conveying concrete and shall be operated to assure a uniform flow of concrete to the final place of deposit without segregation or loss of mortar. Conveyors shall be provided with positive means for preventing segregation of the concrete at transfer points and point of placement.

3.10.4 Pumps

Concrete may be conveyed by positive displacement pumps when approved. The concrete shall be designed for pumping. Pump shall be the piston or squeeze pressure type. Pipeline shall be steel pipe or heavy duty flexible hose. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate. Distance to be pumped shall not exceed the limits recommended by the pump manufacturer. Concrete shall be supplied to the pump continuously. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the concrete in place. After each use, the equipment shall be thoroughly cleaned. Flushing water shall be wasted outside the forms.

3.11 CONCRETE PLACEMENT

Mixed concrete which is transported in truck mixers or agitators or concrete which is truck mixed, shall be discharged within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. These limitations may be waived by the Government if the concrete is of such slump after the 1-1/2 hour time or 300 revolution limit has been reached that it can be placed, without the addition of water to the batch. When the concrete temperature exceeds 85 degrees F, the time shall be reduced to 45 minutes. Concrete shall be placed within 15 minutes after it has been discharged from the truck.

3.11.1 Placing Operation

Concrete shall be handled from mixer to forms in a continuous manner until the approved unit of operation is completed. Adequate scaffolding, ramps and walkways shall be provided so that personnel and equipment are not supported by in-place reinforcement. Placing will not be permitted when

the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing. Concrete shall be deposited as close as possible to its final position in the forms, and there shall be no vertical drop greater than 8 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it will be effectively consolidated in horizontal layers not more than 12 inches thick, except that all slabs shall be placed in a single layer. Concrete to receive other construction shall be screeded to the proper level to avoid excessive shimming or grouting.

3.11.2 Consolidation

Immediately after placing, each layer of concrete shall be consolidated by internal vibrators, except for Blast and Fragment Resistant Walls and slabs 4 inches or less. The vibrators shall at all times be adequate in effectiveness and number to properly consolidate the concrete; a spare vibrator shall be kept at the jobsite during all concrete placing operations. The vibrators shall have a frequency of not less than 8000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mixture being placed. Vibrators shall be inserted vertically at uniform spacing over the area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just-vibrated area by a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer if there is such. Vibrator shall be held stationary until the concrete is consolidated and then withdrawn slowly. Concrete in Blast and Fragment Resistant Walls shall be consolidated by placing manual vibration bars on the outside of the walls or by tapping with a rubber mallet. The use of form vibrators must be specifically approved. Vibrators shall not be used to transport concrete within the forms. Slabs 4 inches and less in thickness shall be consolidated by properly designed vibrating screeds or other approved technique.

3.11.3 Cold Weather Requirements

Special protection measures, approved by the Contracting Officer, shall be used if freezing temperatures are anticipated before the expiration of the specified curing period. The ambient temperature of the air where concrete is to be placed and the temperature of surfaces to receive concrete shall be not less than 40 degrees F. The temperature of the concrete when placed shall be not less than 50 degrees F nor more than 75 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete placing temperature. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, chemical admixture conforming to ASTM C 494 Type C or E may be used.

3.11.4 Warm Weather Requirements

The temperature of the concrete placed during warm weather shall not exceed 85 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. In no case shall the placing temperature exceed 95

3.12 CONSTRUCTION JOINTS

Construction joints shall be located as indicated or approved. Where concrete work is interrupted by weather, end of work shift or other similar type of delay, location and type of construction joint shall be subject to approval of the Contracting Officer except horizontal construction joints shall not be used in Blast and Fragment Resistant walls. Unless otherwise indicated and except for slabs on grade, reinforcing steel shall extend through construction joints. Construction joints in slabs on grade shall be keyed or doweled as shown. Concrete walls shall be in place at least 2 hours, or until the concrete is no longer plastic, before placing concrete for slabs thereon. In walls having door openings, lifts shall terminate at the top and bottom of the opening. Other lifts shall terminate at such levels as to conform to structural requirements or architectural details. Where horizontal construction joints are required, a strip of 1-inch square-edge lumber, bevelled and oiled to facilitate removal, shall be tacked to the inside of the forms at the construction joint. Concrete shall be placed to a point 1 inch above the underside of the strip. The strip shall be removed 1 hour after the concrete has been placed, and any irregularities in the joint line shall be leveled off with a wood float, and all laitance shall be removed. Prior to placing additional concrete, horizontal construction joints shall be prepared as specified in paragraph "PREPARATIONS OF SURFACES."

3.13 FINISHING CONCRETE

3.13.1 Formed Surfaces

3.13.1.1 Repair of Surface Defects

Surface defects shall be repaired within 24 hours after the removal of forms. Honeycombed and other defective areas shall be cut back to solid concrete or to a depth of not less than 1 inch, whichever is greater. Edges shall be cut perpendicular to the surface of the concrete. The prepared areas shall be dampened and brush-coated with neat cement grout. The repair shall be made using mortar consisting of not more than 1 part cement to 2-1/2 parts sand. The mixed mortar shall be allowed to stand to stiffen (approximately 45 minutes), during which time the mortar shall be intermittently remixed without the addition of water. After the mortar has attained the stiffest consistency that will permit placing, the patching mix shall be thoroughly tamped into place by means approved by the Contracting Officer and finished slightly higher than the surrounding surface. For Class B finished surfaces the cement used in the patching mortar shall be a blend of job cement and white cement proportioned to produce a finished repair surface matching, after curing, the color of adjacent surfaces. Holes left after the removal of form ties shall be cleaned and filled with patching mortar. Holes left by the removal of tie rods shall be reamed and filled by dry-packing. Repaired surfaces shall be cured as required for adjacent surfaces. The temperature of concrete, mortar patching material, and ambient air shall be above 50 degrees F while making repairs and during the curing period. Concrete with defects which affect the strength of the member or with excessive honeycombs will be rejected, or the defects shall be corrected as directed.

3.13.1.2 Class B Finish

Class B finish shall be provided for permanently exposed surfaces. All fins shall be removed. Concrete surface shall be smooth with a texture at least equal to that obtained through the use of Grade B-B plywood forms.

3.13.1.3 Class C Finish

Class C finish shall be provided for surfaces that are not permanently exposed. All fins shall be removed. Concrete surfaces shall be relatively smooth with a texture imparted by the forms used.

3.13.2 Unformed Surfaces

In cold weather, the air temperature in areas where concrete is being finished shall not be less than 50 degrees F. In hot windy weather when the rate of evaporation of surface moisture, as determined by methodology presented in ACI 305R, may reasonably be expected to exceed 0.2 pounds per square foot per hour; coverings, windbreaks, or fog sprays shall be provided as necessary to prevent premature setting and drying of the surface. The dusting of surfaces with dry materials or the addition of water during finishing will not be permitted. Finished surfaces shall be plane, with no deviation greater than 1/8 inch when tested with a 10-foot straightedge. Surfaces shall be pitched as indicated.

3.13.2.1 Rough-Slab Finish

Slabs shall be screeded with straightedges immediately after consolidation to bring the surface to the required finish level with no coarse aggregate visible.

3.13.2.2 Float Finish

Floor and roof slabs shall be given a float finish. Screeding shall be followed immediately by darbying or bull floating before bleeding water is present, to bring the surface to a true, even plane. After the concrete has stiffened to permit the operation and the water sheen has disappeared, it shall be wood floated.

3.13.2.3 Trowel Finish

Slabs inside the magazine shall be given a trowel finish immediately following floating. Surfaces shall be trowelled to produce smooth, dense slabs free from blemishes including trowel marks. In lieu of hand finishing, an approved power finishing machine may be used in accordance with the directions of the machine manufacturer. A final hard steel troweling shall be done by hand.

3.13.2.4 Broom Finish

After floating, exterior slabs on grade shall be lightly trowelled, and then broomed with a fiber-bristle brush in a direction transverse to that of the main traffic.

3.14 CURING AND PROTECTION

3.14.1 General

All concrete shall be cured by an approved method for the period of time given below:

Concrete with '	Type	III (cement	:		3	days
Concrete with	Type	I or	Type	II	cement	7	days
Concrete with	Type	I or	Type	II	cement		
blended with	pozz	olan				7	days

Immediately after placement, concrete shall be protected from premature drying extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete shall be maintained at a temperature above 50 degrees F for the first 3 days and at a temperature above 32 degrees F for the remainder of the specified curing period. Exhaust fumes from combustion heating units shall be vented to the outside of the enclosure and heaters and ducts shall be placed and directed so as not to cause areas of overheating and drying of concrete surfaces or to create fire hazards. All materials and equipment needed for adequate curing and protection shall be available and at the site prior to placing concrete. No fire or excessive heat shall be permitted near or in direct contact with the concrete at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved.

3.14.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials used stains or discolors concrete surfaces which are to be permanently exposed, the concrete surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 2-inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene-coated burlap or saturated burlap.

3.14.3 Membrane Curing

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing or flooring specified. Membrane curing compound shall not be used on surfaces that are maintained at curing temperatures with free steam. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Compound shall be applied in a one-coat continuous

operation by mechanical spraying equipment, at a uniform coverage in accordance with the manufacturer's printed instructions. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. On surfaces permanently exposed to view, the surface shall be shaded from direct rays of the sun for the duration of the curing period. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

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SECTION 05315

BLAST AND FRAGMENT RESISTANT WALLS

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 446	(1987) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A 548	(1982) Steel Wire, Carbon, Cold-Heading Quality, for Tapping or Sheet Metal Screws
ASTM A 615	(1989) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement Textile

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with SECTION 01300 SUBMITTALS:

SD-04, Drawings

BFR Wall Layout and Details; GA

Detail drawings shall include dimensions, required type, number, and length of all BFR steel panels, panel connection details, details at wall corners, and details for fabrication of all steel panels. Drawings shall include overall plan layouts and elevations of walls sufficient to show final panel arrangements. Drawings shall also include number, size, type, dimensions and locations of all additional reinforcing steel bars in the walls.

SD-13, Certificates

Steel Panels; FIO

Certificates of compliance stating that all steel facing panels, lacing panels, and miscellaneous steel components of the BFR walls conform to the requirements specified.

SD-20, Construction Methods and Procedures

BFR Wall System; FIO.

Technical description of the materials, equipment, methods, procedures, and construction sequence to be used in constructing the BRF walls, Procedures shall generally conform to those provided by the patent holder.

1.4 STORAGE

BFR steel panels shall be stored on wooden bearers out of contact with the ground with a slope of 1:100 along the sheet length to prevent accumulation of water. The steel panels shall be covered with a waterproof cover to prevent exposure to water but allow air circulation.

PART 2 PRODUCTS

2.1 BLAST AND FRAGMENT RESISTANT (BFR) WALLS

The headwall, side and rear walls of this magazine shall be walls made from the Blast and Fragment Resistant (BFR) wall system. The BFR system is protected by United States Patent Number 4,433,522 and other patents. Walls shown on the drawings as 12 inches thick shall be made of the 300 millimeter thick BFR wall section. Walls shown on the drawings as 10 inches thick shall be made of the 250 millimeter thick BFR wall section.

2.2 STEEL PANELS

Steel facing panels, lacing panels, half panels, and other miscellaneous panels for the BFR walls shall conform to ASTM A 446, Grade B, coating designation G90, non-oiled. Dimensions, gage, and corrugation pattern of these panels shall conform to the requirements of the BFR system as defined by the patent holder.

2.3 CONCRETE

Concrete for infill in the BFR walls shall conform to Section 03300, CONCRETE FOR BUILDING CONSTRUCTION.

2.4 REINFORCING STEEL

Reinforcing steel shall conform to ASTM A 615, Grade 60.

2.5 STEEL SHEET METAL SCREWS

Steel sheet metal screws shall be the self-tapping type, galvanized conforming to ASTM A 548.

PART 3 EXECUTION

3.1 GENERAL

BFR walls shall be constructed according to the methods and procedures generally outlined by the manufacturer and provided in the submittals.

3.2 WORKMANSHIP

Workmanship and manufacturing tolerances of the BFR steel elements shall be such as to insure proper fit when assembled and interchangeability of elements of the same type and size. Panels shall be well formed to shape and size, with sharp lines and true curves. Panels with warped or buckled edges shall not be used in wall construction and shall be removed from the job site.

3.3 PREPARATION OF MATERIALS

Before erection, all BFR steel elements shall be inspected and cleaned of all loose scale, rust, and other deleterious material. Any damage to the galvanized coating shall be repaired using a zinc-rich paint.

3.4 ERECTION OF STEEL PANELS

Erection of steel BFR panels shall not begin until foundations have been completed. Steel panels shall be erected in accordance with the manufacturer's recommended procedure. Steel panels shall be erected plumb and true to lines indicated on the drawings and in conformance with the tolerances listed in Table 1. Joints between steel panels shall be connected with no fewer than two steel sheet metal screws at each end and shall be mortar tight.

3.5 TEMPORARY BRACING

Temporary bracing shall be provided to prevent misalignment and damage to the erected BFR steel panels during construction and bulging and separating of the steel panels during concrete placement. Care shall be taken to prevent the bracing from damaging the galvanized coating on the steel panels. Bracing shall remain in place until the walls are strong enough to carry their own weight and any other construction or natural loads, but not before 24 hours has elapsed since concrete placement. Construction of the roof slab shall not be started until the walls are sufficiently strong to support the roof. In no case shall bracing be removed before the concrete strength has reached 70 percent of design strength as determined by field cured cylinders or other methods.

3.6 PLACING CONCRETE

Concrete shall be placed successively in lifts not exceeding 24 inches, and each lift shall be allowed to partially set before pouring the next lift. Concrete may be placed using buckets or chutes or by pumping. If concrete pumping is used, the rate of pumping shall not exceed 7-1/2 cubic yards per hour. The work shall be visually inspected during the placement of each lift to ensure that all spaces between the steel panels are completely filled with concrete.

3.7 CONSOLIDATION

Immediately after placing, each layer of concrete shall be consolidated. Consolidation shall be by placing manual vibration bars on the outside of walls or by tapping with a rubber mallet. Internal vibrators shall not be used for consolidation of concrete in BFR walls. The use of form vibrators

must be specifically approved.

3.8 CONSTRUCTION JOINTS

Vertical construction joints shall be made using the manufacturer's recommended method. Vertical joints shall be located not less than 6 feet from wall corners. BFR steel facing panels shall be continuous across vertical construction joints. Horizontal construction joints shall not be permitted.

TOLERANCES FOR BFR WALLS

1.	Variations from the plumb	In any 10 feet of length 1/4 inch Maximum for entire length 1 inch
2.	Variation from the level	In any 10 feet of length 1/4 inch Maximum for entire length 3/4 inch
3.	Variation of the linear building lines from established position in plan	In any 20 feet 1/2 inch Maximum 1 inch
4.	Variation of distance between walls	1/4 inch per 10 feet of distance, but not more than 1 inch total variation
5	wastables to the stops and	Minus 1/4 inch
٠.	Variation in the sizes and locations of wall openings	Plus 1/2 inch

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SECTION 05500

DOORS AND MISCELLANEOUS METAL

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC S335	(1989) Specification of Structural		
	Steel Buildings - Allowable Stress Design,		
	Plastic Design		

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	(1989) Structural Steel
ASTM A 53	(1989a) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 123	(1989a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 325	(1986a) High-Strength Bolts for Structural Steel Joints
ASTM A 446	(1989) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality
ASTM A 500	(1989) Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 525	(1987) Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (1988) Structural Welding Code - Steel

MILITARY SPECIFICATIONS (MS)

MIL-H-29181 (18 Aug 1978; Rev 21 Dec 1987) Hasp, High Security, Shrouded, for High and Medium Security Padlock

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS:

SD-04 Drawings

Miscellaneous Metal Items; GA.

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates. Detail drawings shall be submitted for the following items: Doors and Door Frames; Door Operators and Hardware; Louvers and Louver Fragment Shields; Ventilator; and Weatherstripping.

1.4 GENERAL REQUIREMENTS

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123, ASTM A 446, or ASTM A 525, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

1.5 DISSIMILAR MATERIALS

Where dissimilar metals are in contact, the surfaces shall be protected with a coat of bituminous paint or asphalt varnish.

1.6 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

1.7 ANCHORAGE

Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

Structural steel shapes and plates shall conform to ASTM A 36 unless otherwise noted or specified.

2.2 BOLTS

Unless otherwise noted, structural steel bolts, including nuts and washers, shall conform to ASTM A 325.

2.3 SHOP PAINTING

Surfaces of ferrous metal except galvanized surfaces, shall be cleaned and shop coated with the manufacturer's standard protective coating unless otherwise specified. Surfaces of items to be embedded in concrete shall not be painted. Items to be finish painted shall be prepared according to manufacturer's recommendations or as specified.

2.4 LOUVER GUARDS

Louver guards shall be 1/2-inch round bars, spaced not over 8 inches on center horizontally. Bars shall be securely welded to the angle frame. Guards and fasteners shall be galvanized.

2.5 STEEL DOORS

Steel doors shall be constructed of structural steel conforming to ASTM A 36, except the internal square tube stiffeners used in the 10-foot size steel door shall be steel conforming to ASTM A 500, Grade A. Materials and fabrication shall be in accordance with this section and AISC S335. Welding shall be in accordance with AWS D1.1.

2.6 WEATHERSTRIPPING

Weatherstripping for steel doors shall be rubber impregnated canvas belting.

2.7 LOUVERS

Louvers shall be galvanized steel and the standard product of a manufacturer regularly engaged in the manufacture of louvers of the type shown, and the louvers provided shall essentially duplicate louvers that have been in successful operation for a period of at least 5 years. Louvers shall not be removable from the outside of the structure. Louvers shall be provided with 140 degrees F fusible link fire damper mechanism, equipped with suitable spring closing device, and 16 mesh insect screens.

Blades shall be accurately fitted and edges of louver blades shall be folded or beaded for rigidity.

2.8 VENTILATORS

Ventilators shall be of the stationary type, constructed of galvanized ferrous metal sheets, and shall be furnished complete, including insect screens. The ventilators shall be designed to withstand stresses developed by winds up to and including 125 miles per hour, shall be waterproof and stormproof under all operating conditions, and shall be free from backdraft. The design shall be such that the ventilators will be capable of self-cleaning by the action of the elements, with provision for carrying water and normal, wind-transported soil matter to the outside. Ventilators shall be adequately reinforced and will braced, with joints properly formed. Reinforcing members, braces, bolts, and rivets shall be of galvanized ferrous metal of sufficient size to assure rigid and sturdy construction, shall be properly applied and installed in such manner as to avoid corrosion, and shall be secured in an approved manner.

2.9 PIPE GUARDS

Pipe guards shall be heavy duty steel pipe conforming to ASTM A 53, Type E or S, weight STD, black finish.

2.10 STEEL DOOR FRAMES

Steel door frames shall be made of structural steel conforming to ASTM A 36. Steel door frames shall be neatly mitered and securely welded at the corners with all welds ground smooth. Provision shall be made to stiffen the top member for all spans over 3 feet.

2.11 HIGH SECURITY HASPS

High security hasps shall conform to MIL-H-29181, Style NAPEC and 0957-2. High security hasps are Government-furnished, Contractor-installed items.

2.12 MISCELLANEOUS

Miscellaneous plates and shapes for items that do not form a part of the structural steel framework, such as lintels, sill angles, miscellaneous mountings, and frames, shall be provided to complete the work.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

All items shall be installed at the locations shown and according to the manufacturer's recommendations. Item listed below require additional procedures as specified.

3.2 STEEL DOORS

3.2.1 Fabrication

Fabrication of steel doors shall be in accordance with AISC S335 and AWS D1.1. Special care shall be exercised during welding to prevent warping. The surfaces shall be flat, parallel, and plumb after erection. The door assembly shall be properly installed so that operating clearances and bearing surfaces of the erected door conform to the drawing requirements.

3.2.2 Operation

Doors shall be manually operated by a spur gear hand chain operator. Operation shall be by pulling on an endless chain through a stationary gearbox with maximum 18-pound pull to move the door. Gear reduction ratio shall be 4.4 to 1 or less. The door operator shall not include a clutch. The hand chain wheel shall be equipped with a chain quide that will permit operation of the hand chain at an angle 10 degrees out from either side of the chain wheel without stripping or jumping the wheel rim. All load carrying parts of the operator shall resist, without damage or permanent deformation, a load of 400 pounds applied vertically to either side of the hand chain while the door is restrained from moving. The door operator shall be equipped with a manual emergency chain release which will release the door from the drive chain. The drive chain will remain intact with the emergency chain release engaged or disengaged. The emergency chain release shall be located as indicated on the drawing. The door shall be provided with a latching mechanism to secure the release both in the engaged and in the disengaged positions. A bolt and nut type locking mechanism will not be acceptable.

3.2.3 Door Trolleys

Trolleys shall have sealed ball bearings and shall be designed to ensure ease of operation and uniform loading of wheels. Side plates shall be of malleable iron and shall be connected to each other with at least two through-bolts in addition to the yoke connection.

3.2.4 Weatherstripping

Weatherstripping for steel doors shall be installed with slotted holes in such a manner that it can be adjusted to ensure a complete weathertight enclosure.

3.3 PIPE GUARDS

Pipe guards shall be set vertically in concrete piers. Piers shall be constructed of, and the hollow cores of the pipe filled with, concrete specified in SECTION 03300 CONCRETE FOR BUILDING CONSTRUCTION.

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SECTION 07111

ELASTOMERIC MEMBRANE WATERPROOFING

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 297	(1981) Rubber Products
ASTM D 412	(1987) Rubber Properties in Tension
ASTM D 471	(1979) Rubber Property - Effect of Liquids
ASTM D 624	(1986) Rubber Property - Tear Resistance
ASTM D 1004	(1966, R 1988) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 4637	(1987) Vulcanized Rubber Sheet Used in Single-Ply Roof Membrane
ASTM E 96	(1990) Water Vapor Transmission of Materials
ASTM E 154	(1988) Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM G 21	(1970, R 1985) Determining Resistance of Synthetic Polymeric Materials to Fungi

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS:

SD-04 Drawings

Waterproofing System; GA.

Detail drawings showing size of sheets, position of sheets and splices, flashing and termination details, and expansion joint details.

SD-06 Instructions

Installation; GA.

Manufacturer's instructions for installation of the elastomeric membrane, including procedures for preparing the membrane for use, flashing, and splicing. Instructions shall include recommended or required protective covering and procedures for safe handling and use of cleaners, adhesives, and sealants.

SD-13 Certificates

Materials; GA.

Certificates of compliance attesting that the materials meet specification requirements. Certificates may show qualification of the identical compound in the specified test.

1.4 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered to the job site in unopened containers bearing the manufacturer's name, brand name, and description of contents.

Membrane, flashing, and adhesives shall be stored in clean, dry areas.

Storage temperature for adhesives shall be between 60 and 80 degrees F.

Protection board shall be stored flat and off the ground.

PART 2 PRODUCTS

2.1 MATERIALS

All adhesives, mastics, cements, tapes, and primers shall be as recommended by the membrane manufacturer and shall be compatible with the materials to which they are to be bonded.

2.1.1 Performance Requirements

All membranes shall meet the following requirements when tested by the referenced ASTM standards:

Puncture Resistance (ASTM E 154)

40 pounds, minimum

Water Vapor Transmission at 80 degrees F Permeance (ASTM E 96, Procedure B)

0.25 perms (max.)

Resistance to Soil Bacteria or Fungi (ASTM G 21 or ASTM E 154)

No sustained growth or discoloration after 21 days

2.1.1.1 Butyl Rubber

Thickness, plus or minus 10 percent

60 mils

Specific Gravity (ASTM D 297)

1.2 plus or minus 0.05

Tensile Strength (ASTM D 412) 1200 psi (min.)

Elongation (ASTM D 624) 300 percent (min.)

Tear Resistance (ASTM D 624) 125 lb./inch (min.)

Water Absorption (ASTM D 471) plus 2 percent (max.)

158 degrees F, 168 hours

2.1.1.2 Plastic Elastomeric Sheeting

Membrane shall be a minimum of 56 mils thick and shall meet the following requirements:

Tensile Strength (ASTM D 412, Die C) 220 psi (min)

Elongation (ASTM D 412, Die C) 250 percent (min.)

Tear Resistance (ASTM D 1004) 350 lb./inch (min.)

2.1.1.3 Composite Self-Adhering Membrane

Membrane shall be a polymeric sheeting integrally bonded to rubberized asphalt with a minimum thickness of 60 mils.

2.1.1.4 Chlorinated Polyethylene (CPE) Sheeting

Membrane shall be uncured chlorinated polyethylene, synthetic elastomeric sheeting of 40 mils nominal thickness.

2.1.1.5 Chloroprene

Chloroprene membrane shall conform to ASTM D 4637, Type II, Grade 1, Class U, 60 mils minimum thickness.

2.1.1.6 Ethylene Propylene Diene Monomer (EPDM) Membrane

EPDM membrane shall conform to ASTM D 4637, Type I, Grade I, Class U, 60 mils minimum thickness.

2.1.2 Protection Board

Protection board for waterproofing membrane shall be 1/2-inch minimum asphalt plank, 1/2-inch fiberboard or premolded bituminous protection board; 1/8-inch thick for vertical surfaces, and 1/4-inch thick for horizontal surfaces. The membrane and protection board must be compatible.

2.2 ACCESSORIES

Flashing, counterflashing, expansion joint covers and corner fillets shall be as recommended by the membrane manufacturer.

3.1 PREPARATION

Surfaces to which waterproofing is to be applied shall be clean, smooth, and free from deleterious materials and projections. Holes, honeycomb, cracks, or cavities shall be pointed or filled and finished flush with portland cement mortar. Top surfaces of projecting metal or concrete ledges below grade, except footings, shall be beveled. Before waterproofing is applied, the surfaces to be covered shall be swept or brushed carefully to remove all dust and foreign matter. Concrete surfaces to receive elastomeric waterproofing will not be cured with compounds containing wax or oil.

3.2 APPLICATION

Waterproofing shall not be applied to wet surfaces. The ambient and surface temperatures shall be above 40 degrees F during application. Membrane under slabs shall be carried up abutting vertical surfaces to the level of finish of floor or to within 1/2 inch of the top edge of base where base is shown and cemented solid to the substrate. Membrane shall not be continuous through walls, floors, piers, and columns unless otherwise shown. Concrete surfaces shall be primed to receive the membrane. Membranes shall be handled and installed in accordance with the approved installation instructions. All primers, adhesives, and mastics shall be applied in accordance with the membrane manufacturer's printed instructions. Laps shall be oriented so that water will flow over the lap, and not into them. As soon as the mastic is fully set and dry, joints shall be checked. Where any openings or fishmouths appear, joints shall be resealed and rerolled. Wrinkles and buckles shall be avoided in applying membrane and joint reinforcement. Nonadhering membranes shall be unrolled and allowed to remain flat for at least 2 hours before application. Membranes shall be drawn tight during installation without stretching. Self-adhering membrane shall be installed by removing the release sheets on the back of the membrane and applying the tacky surface onto the primed surface. Laps and splices shall be sealed prior to completion of a day's work.

3.2.1 Butyl Rubber

Each sheet shall be lapped at sides and ends a minimum of 6 inches over the preceding sheet. Lap and splice areas of membrane shall be cleaned with heptane, hexane, or white gasoline. Six-inch-wide unvulcanized compounded butyl tape shall be applied between lapped splices so that the tape extends approximately 1/4 inch beyond the exposed sheeting edge. The tape shall be rolled firmly into place as it is applied. Tape backing shall be removed and the lapped sheeting rolled or pressed into place. Splicing adhesive shall be applied to the lapped area 3-1/2 inches on either side of the lapped edge. The splice adhesive shall be allowed to dry thoroughly and the lap reinforced with 6-inch-wide unvulcanized compounded butyl tape. Full contact shall be made for all lap areas. Corner splices and flashing overlaps shall be reinforced with a 12-inch-wide strip of membrane over one layer of butyl tape or with a prefabricated corner of butyl rubber.

3.2.2 Plastic Elastomeric Sheeting

Sheeting shall be applied in sections no longer than 18 feet. Each sheeting shall be lapped at sides and ends a minimum of 6 inches over the preceding sheet. Lap splices shall be reinforced with 12-inch-wide strips of plastic sheeting or as recommended in the approved installation instructions. Lap and splices shall be sealed in a full bed of adhesive at the rate recommended by the manufacturer of the material. Sheeting and joint strips shall be rolled with a 50 to 100 pound roller on horizontal surfaces, and a 6-inch rubber hand roller on vertical surfaces.

3.2.3 Composite Self-Adhering Membrane

On vertical surfaces, membrane shall be applied in lengths up to 8 feet starting at the bottom. Each sheet shall be lapped at edges and ends a minimum of 2-1/2 inches over the preceding sheets. The membrane shall be rolled to adhere with the substrate. Corners and joints shall be double-covered by first applying a 12-inch width of membrane centered along the corner joint. Inside and outside corners shall then be covered with membrane. Exposed termination edges of membrane on horizontal or vertical surfaces shall be finished with a troweled bead of mastic. Mastic shall be applied around termination edges of membrane and around drains and projections. Mastic shall be applied at the termination of each day's work.

3.2.4 Chlorinated Polyethylene (CPE) Sheeting

Sheets shall be lapped at edges and ends a minimum of 2-1/2 inches over the preceding sheet. All horizontal membranes shall overlap vertical surfaces by at least 3 inches.

3.2.5 Chloroprene Rubber Sheeting

Each sheet shall overlap the previously installed sheet by a minimum of 3 inches. Sheet shall be folded lengthwise to expose one half of the underside of the sheet for cleaning the sheet with cleaner recommended by the manufacturer. Adhesive shall be applied to sheet and substrate. Two coats of adhesive are required on the substrate with 1/2-hour between coats. Sheet shall not be bonded to substrate until adhesive does not come off at a dry finger touch. Chalk lines or masking tape shall be used as guides for adhesive application and positioning sheets. After adhesive has dried, sheet shall be folded back onto the substrate or previously applied sheet membrane. Membrane shall be rolled to obtain complete adhesion. The exposed edge of each sheet shall be further sealed with a fillet-shaped bead of adhesive, tooled to obtain positive contact with the surface of both sheets.

3.3 TESTS

When required, and after the system is cured, the membranes on horizontal surfaces shall be tested by flooding the entire waterproofed area with a minimum of 2 inches head of water for a period of 24 hours. There shall be no water added after the start of the period. Measure water level at the beginning and at the end of the 24-hour period. If the water level falls, remove the water and inspect the waterproofing membrane. Leak sites shall

be marked, dried and repaired, and the test shall be repeated.

3.4 PROTECTION

Horizontal applications of membrane shall be protected from traffic during installation. No equipment shall be allowed directly on the membrane. Plywood, or similar material, overlayment shall be provided for wheel-ways. Walkways shall be provided where heavy traffic from other trades is expected. Materials shall not be stored on the membrane. A protective covering shall be installed over the membrane immediately after installation or testing. If membrane is to be exposed, a temporary covering shall be applied to protect the membrane until the protection board is installed.

3.4.1 Projections

Projections passing through membrane shall be flashed as recommended by the manufacturer of the waterproofing membrane.

3.4.2 Counterflashing

Waterproofing connecting with work exposed to the weather shall be counterflashed to form a water-tight connection. Upper edge of membrane waterproofing and protective covering shall be counterflashed.

3.4.3 Expansion Joints and Fillets

Expansion joints and corner fillets shall be installed as recommended by the manufacturer of the waterproofing membrane.

3.4.4 Vertical Membrane Waterproofing

Waterproofing shall be protected with a 1/2-inch minimum fiberboard, 1/2-inch asphalt-impregnated fiberboard or 1/8-inch compatible water-resistant (bitumen type) protection board. Edges of protection shall be butted, and exposed surfaces shall be covered by a coating of bitumen.

3.4.5 Horizontal Membrane Waterproofing

Waterproofing shall be covered with portland cement mortar not less than 3/4 inch thick, uniformly placed and allowed to set before subsequent construction is installed.

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SECTION 07120

FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 208	(1982) Insulating Board (Cellulosic Fiber), Structural and Decorative
ASTM C 726	(1988) Mineral Fiber and Mineral Fiber, Rigid Cellular Polyurethane Composite Roof Insulation Board
ASTM D 412	(1987) Rubber Properties in Tension
ASTM D 471	(1979) Rubber Properties - Effect of Liquids
ASTM D 746	(1987) Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 2240	(1986) Rubber Property - Durometer Hardness
ASTM E 96	(1990) Water Vapor Transmission of Materials

FEDERAL SPECIFICATIONS (FS)

FS TT-S-0027E	(Rev. E; Am. 3) Sealing Compound:
	Elastomeric Type, Multi-Component (for
	Caulking, Sealing, and Glazing in Buildings
	and Other Structures)

1.3 SUBMITTALS

Government Approval is required for submittals with a "GA" designation; submittals having and "FIO: designation are for information only. The following shall be submitted in accordance with SECTION 01300 SUBMITTALS:

SD-06 Instructions

Fluid-Applied Waterproofing; GA.

Manufacturer's instructions for installation of the fluid-applied waterproofing.

SD-13 Certificates

Materials; GA.

Manufacturer's certification of compliance attesting that the materials meet the requirements of the specification under which it is furnished.

SD-14 Samples

Membranes and Flashing Materials; GA.

Sample of membrane material, 8 ounces of each material. Flashing materials, 1 by 1 foot sample.

1.4 DELIVERY AND STORAGE

Materials shall be delivered to the job site in the manufacturer's original, unopened packages, clearly marked with the manufacturer's name, brand name, and description of contents. Membrane and flashing materials shall be stored in clean, dry areas.

PART 2 PRODUCTS

2.1 WATERPROOFING MEMBRANE

Waterproofing membrane shall be one of the following:

2.1.1 One-Component Membrane

A one-component polyurethane rubber based liquid membrane material, self bonding type, compounded specifically for the application methods to be used, not less than 97 percent solids and 6 month shelf life in the uncured state, tested by the manufacturer to comply with the following requirements for the cured membrane:

Tensile Strength (ASTM D 412)	60 psi, minimum
Elongation (ASTM D 412)	400 percent, minimum
Hardness, Shore A (ASTM D 2240)	5 to 30
Water Absorption (ASTM D 471)	maximum 1.0 percent for 21 days at 75 degrees F
Low Temperature Brittleness	-40 degrees F

2.1.2 Two-Component Membrane (Alternate)

(ASTM D 746)

A two-component, bitumen modified, moisture cured urethane waterproofing system, conforming to the following requirements:

Elongation (ASTM D 412)	750 percent, minimum
Tensile Strength (ASTM D 412)	175 psi, minimum
Adhesion Strength, unprimed concrete (FS TT-S-0027)	15 psi
Recovery from 350 Elongation (ASTM D 412)	95 percent
Tear Resistance (ASTM D 412, Die C)	60 psi
Water Absorption (ASTM D 471)	2-5 percent for 6 months at 75 degrees F
Water Vapor Transmission at 100 degrees F (ASTM E 96)	0.01 metric perms * cm
Low Temperature Brittleness (ASTM D 412)	Elongation 500 percent at -20 degrees F
High Temperature Aging, elongation change after 336 hours at 180 degrees F (ASTM D 412)	Decreased from 730 percent to 400 percent
Hardness in 336 hours at 75 degrees F (ASTM D 412)	30 Shore A horizontal 45 Shore A vertical
Service Temperature (ASTM D 2240)	-40 degrees F to +150 degrees F

NOTE: *Metric perms = gm/M (24 hours) (mm Hg)

2.2 PRIMER AND JOINT SEALANT

Primer and joint sealant shall be as recommended by the manufacturer of the fluid-applied waterproofing liquid compound.

2.3 ELASTIC SHEET FLASHING

Elastic sheet flashing shall be as recommended by the manufacturer of the fluid-applied waterproofing liquid compound. The elastic sheeting shall be a black polyvinyl chloride resin alloyed with plasticizers and other modifiers, formed into flexible sheets having 60 to 80 Shore A hardness, 2000 psi strength, 250 percent longation, -20 degrees F brittleness temperature, and shall be a minimum of 50 mils in thickness.

2.4 INSULATION BOARD

ASTM C 208, construction grade, 1/2-inch thick, asphalt saturated and coated; ASTM C 726, 7/16-inch thick; or prefabricated membrane board 1/4-inch thick, consisting of asphalt-saturated felt laminated under pressure to both sides or with felt laminated on the bottom and fiberglass mat laminated on top with a mineral-filled asphalt core.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Surfaces to receive waterproofing shall be cleaned of foreign matter and shall be surface dry at the time waterproofing is applied. Surfaces to receive waterproofing shall be primed only if recommended by the manufacturer.

3.2 APPLICATION

Fluid-applied waterproofing shall be uniformly applied with brushes, serrated squeegees, spray equipment, or trowels to a minimum thickness of 60 mils, in strict accordance with the instructions and recommendations of the manufacturer. Sheet type flashing shall be installed where indicated on the drawings with a rubber base adhesive as recommended by the fluid applied waterproofing manufacturer.

3.3 PROTECTION

Waterproofing against which backfill is to be placed shall be protected by a single thickness of insulation board. The insulation board shall be pressed on the membrane, with edges of the boards brought into moderate contact and joints staggered. Boards shall be carefully and neatly fitted around projections and shall cover the entire surface of the waterproofing. Waterproofing not covered with insulation boards shall be protected as necessary to prevent damage from subsequent building operations.

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SECTION 09900

PAINTING, GENERAL

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

FEDERAL SPECIFICATIONS (FS)

FS TT-E-489	(Rev H) Enamel, Alkyd, Gloss, Low Voc Content
FS TT-P-19	(Rev D) Paint, Latex (Acrylic Emulsion, Exterior Wood and Masonry)
FS TT-P-31	(Rev D) Paint Oil: Iron-Oxide, Ready Mixed, Red and Brown
FS TT-P-37	(Rev D; Am 4) Paint, Alkyd Resin, Exterior Trim, Deep Colors
FS TT-P-38	(Rev E) Paint, Aluminum Ready-Mixed
FS TT-P-102	(Rev E; Int Am 1) Paint, Oil, Alkyd Modified, Exterior, White and Tints
FS TT-P-645	(Rev B) Primer, Paint, Zinc-Chromate, Alkyd Type
FEDERAL STANDARDS (FE	D-STD)
FED-STD 595	(Rev A; Notices 2, 3, 4, 5, 7, 8 & 9; Errata) Colors
MILITARY SPECIFICATIO	ons (MS)
MS MIL-P-26915	(Rev B) Primer Coating, Zinc Dust Pigmented: For Steel Surfaces
STEEL STRUCTURES PAIN	TING COUNCIL (SSPC)
SSPC SP 1	(1982) Solvent Cleaning
SSPC Paint 1	(1982) Red Lead and Raw Linseed Oil Primer
SSPC Paint 5	(1982) Zinc Dust, Zinc Oxide and

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Phenolic Varnish Paint

SSPC Paint 21 (1982) White or Colored Silicone Alkyd Paint

SSPC Paint 25 (1982) Red Iron Oxide, Zinc Oxide,

Raw Linseed Oil and Alkyd Primer (without

Lead and Chromate Pigments)

SSPC Paint 27 (1982) Basic Zinc Chromate-Vinyl

Butyral Wash Primer

1.3 DEFINITION

The term "paint" as used herein includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coat.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS:

SD-01 Data

Materials; GA.

The names, quantity represented, and intended use for the proprietary brands of materials proposed to be substituted for the specified materials when the required quantity of a particular color is 50 gallons or less.

SD-06 Instructions

Mixing and Thinning; FIO. Application; FIO.

Manufacturer's current printed product description, material safety and technical data sheets for all coating systems.

SD-09 Reports

Materials; GA.

A test report showing that the proposed batch to be used meets all specification requirements.

1.5 PACKAGING, LABELING, AND STORAGE

Paints shall be in sealed containers that legibly show the designated name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Emulsion paints shall be stored to prevent freezing.

1.6 COLORS AND TINTS

Colors shall conform to FED-STD 595 and shall be as selected by the Contracting Officer. Tinting of vinyl-type paints shall be done by the manufacturer. The color of the undercoats shall vary slightly from the color of the next coat.

1.7 ENVIRONMENTAL CONDITIONS

Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 45 and 95 degrees F when applying coatings. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch. In no case shall paint be applied to surfaces which have visible frost or ice.

PART 2 PRODUCTS

2.1 MATERIALS

Materials shall conform to the respective specifications listed for use in PART 3 EXECUTION and to the requirements herein except when the required amount of a material of a particular color is 50 gallons or less, in which case an approved first-line proprietary paint material with similar intended usage and color to that specified may be used.

2.1.1 Mixing Liquid

The mixing liquid shall be a factory-prepared acrylic containing 46 to 47 percent solids. The exterior emulsion paint shall be exterior acrylic emulsion paint conforming to FS TT-P-19.

2.1.2 Ferrous-Metal Primer

Ferrous-metal primer shall conform to SSPC Paint 1 and SSPC Paint 5.

2.1.3 International Orange Enamel

Enamel shall conform to FS TT-E-489. Color shall conform to FED-STD 595, Color Number 12197-1.

2.2 HAZARDOUS MATERIALS RESTRICTIONS

Paints and painting practices shall comply with all applicable state and local laws enacted to insure compliance with Federal Clean Air Standards.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Exposed ferrous metals, including nails on or in contact with surfaces to be painted with water-thinned paints, shall be

spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas. All surfaces shall be clean and free of foreign matter before application of paint or surface treatments. Oil and grease shall be removed with clean cloths and cleaning solvents prior to mechanical cleaning. Cleaning solvents shall be of low toxicity with a flashpoint in excess of 100 degrees F. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Items removed prior to painting shall be replaced when painting is completed.

3.1.1 Concrete Surfaces

Surfaces shall be allowed to dry at least 30 days before painting, except concrete slab on grade which shall be allowed to cure 90 days before painting. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting.

3.1.2 Ferrous Surfaces

Ferrous surfaces that have not been shop-coated shall be solvent-cleaned. After cleaning, one coat of ferrous-metal primer shall be applied to all ferrous surfaces to receive paint other than asphalt varnish and vinyl paint. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

3.1.3 Galvanized and Nonferrous Surfaces

Galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous surfaces to be painted shall be solvent-cleaned in accordance with SSPC SP 1 and treated with a vinyl-type wash coat meeting the requirements of SSPC Paint 27.

3.2 MIXING AND THINNING

Unless otherwise recommended by the manufacturer, paints may be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon when necessary to suit conditions of surface, temperature, weather, and application methods. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Paints of different manufacturers shall not be mixed.

3.3 APPLICATION

Paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges, waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of

adjacent painted surfaces. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

3.3.1 Time Between Surface Preparation and Painting

Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface.

3.3.2 Coating Progress

Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Oil-based or oleoresinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause the undercoat to lift or lose adhesion.

3.3.3 Metal Surfaces

First coats other than vinyl paints or vinyl-type wash coats shall be applied by brush. The three-coat paint systems specified for exterior and interior ferrous surfaces shall be applied so that their dry-film thickness at any point shall be not less than 4.0 mils, with the primer having a minimum dry-film thickness of 1.5 mils.

3.4 SURFACES TO BE PAINTED

Surfaces listed in the PAINTING SCHEDULE, other than those listed in paragraphs SURFACES NOT REQUIRING PAINTING and SURFACES FOR WHICH PAINTING IS PROHIBITED, will receive the surface preparation, paints, and number of coats prescribed in the schedule. Surfaces to be painted include all sides of the door and frame and the exterior of the portal wall.

3.5 CLEANING

Cloths, cotton waste and other debris that might constitute a fire hazard shall be placed in closed metal containers and removed at the end of each day. Upon completion of the work, staging, scaffolding, and containers shall be removed from the site or destroyed in an approved manner. Paint and other deposits on adjacent surfaces shall be removed and the entire job left clean and acceptable.

3.6 PAINTING SCHEDULE

The "PAINTING SCHEDULE" at the end of this section prescribes the surfaces to be painted, and the number and types of coats of paint required.

3.6.1 Contractor's Options

The "PAINTING SCHEDULE" provides for Contractor's options as specified by the word "or" between options for one coat and "---or---" between options

for coating systems.

3.6.2 Shop-Painted Items

Surfaces of items finish-painted by the manufacturer, or specified to be finish-painted under other sections of the specifications, are exempted from the requirements for surface preparation and painting. Shop-primed items shall receive surface preparation and finish painting as required by this section.

PAINTING SCHEDULE

Surface	First Coat	Second Coat	Third Coat	
Exterior concrete surfaces.	FS TT-P-19	FS TT-P-19		
Ferrous surfaces, exposed, unless	SSPC Paint 5	FS TT-P-38	FS TT-P-38	
otherwise specified.	SSPC Paint 25	FS TT-E-489, Class A	FS TT-E-489, Class A	
	FS TT-P-645	SSPC Paint 21, Type I	SSPC Paint 21, Type I	
		FS TT-P-102, Type []	FS TT-P-102, Type []	
		FS TT-P-37	FS TT-P-37	
		FS TT-P-31	FS TT-P-31	
Exterior galvanized	SSPC Paint 5	FS TT-P-102	FS TT-P-102	
surfaces.	MS MIL-P-26915, Type I,	Type []	Type []	
	Class A	FS TT-P-37	FS TT-P-37	
		FS TT-P-31	FS TT-P-31	
	FS TT-P-19	FS TT-P-19	FS TT-P-19	
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SECTION 16415

ELECTRICAL WORK, INTERIOR

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C82.4	(1985; C82.4a-1988) Ballasts for
	High-Intensity-Discharge and Low-Pressure
	Sodium Lamps (Multiple Supply Type)

FEDERAL SPECIFICATIONS (FS)

FS L-C-530	(Rev C)	Coating,	Pipe,	Thermoplastic
	Resin			

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 142	(1982) Recommended Practice for Grounding
	of Industrial and Commercial Power Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1985; Rev 1 & 2, ICS 6) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(1986; Rev 1) Molded Case Circuit Breakers and Molded Case Switches
NEMA AB 3	(1984) Molded Case Circuit Breakers and Their Application
NEMA ICS 6	(1988) Enclosures for Industrial Control and Systems
NEMA LE 4	(1987) Recessed Luminaires, Ceiling Compatibility
NEMA OS 1	(1984) Sheet Steel Outlet Boxes, Device Boxes, Covers and Box Supports
NEMA PB 1	(1984; PB 2.1-1986) Panelboards

NEMA RN 1	(1986) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA WD 1	(1983) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements
NATIONAL FIRE PROTECT	ION ASSN (NFPA)
NFPA 70	(1990) National Electrical Code
NFPA 101	(1988) Safety to Life from Fire in Buildings and Structures
UNDERWRITERS LABORATO	RIES, INC (UL)
UL 5	(May 28, 1985; 10th Ed) Surface Metal Raceways and Fittings
UL 6	(Oct 23, 1981; 9th Ed; Rev thru November 22, 1989) Rigid Metal Conduit
UL 20	(Jun 12, 1986; 10th Ed; Errata; Rev thru Sep 23, 1988) General-Use Snap Switches
UL 44	(Aug 29, 1983; 12th Ed; Rev thru Jan 29, 1990) Rubber-Insulated Wires and Cables
UL 50	(Sep 8, 1988; 9th Ed; Rev May 18, 1989) Cabinets and Boxes
UL 67	(Oct 12, 1988, 10th Ed; Rev thru Nov 14, 1989) Panelboards
UL 83	(Sep 26, 1983; 9th Ed; Rev thru Feb 22, 1989) Thermoplastic-Insulated Wires and Cables
UL 98	(Jan 13, 1987; 11th Ed; Rev thru Feb 3, 1988) Enclosed and Dead-Front Switches
UL 467	(Nov 22, 1984; 6th Ed; Rev thru Nov 14, 1986) Grounding and Bonding Equipment
UL 486A	(Nov 24, 1980; 7th Ed; Rev thru Oct 12, 1989) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	(Dec 30, 1983; 1st Ed; Rev thru Oct 12, 1989) Splicing Wire Connectors

UL 489	(Sep 15, 1986; 7th Ed; Rev thru Apr 13, 1988) Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
UL 498	(Nov 3, 1986; 11th Ed; Rev thru Mar 14, 1989) Attachment Plugs and Receptacles
UL 510	(Oct 6, 1986; 6th Ed, Rev Oct 7, 1986) Insulating Tape
UL 514A	(Dec 1, 1983; 7th Ed; Rev thru Jan 22, 1990, Errata, Feb 15, 1990) Metallic Outlet Boxes
UL 514B	(Mar 15, 1989; 2nd Ed Rev Oct 30, 1989) Fittings for Conduit and Outlet Boxes
UL 698	(Jul 6, 1984; 10th Ed; Rev thru Jun 28, 1989) Industrial Control Equipment for Use in Hazardous (Classified) Locations
UL 797	(Oct 10, 1983; 5th Ed) Electrical Metallic Tubing
UL 844	(Nov 29, 1984;, 9th Ed; Rev thru Jan 16, 1989) Electric Lighting Fixtures for Use in Hazardous (Classified) Locations
UL 869A	(Mar 23, 1987; 1st Ed; Rev thru Mar 1, 1989) Service Equipment
UL 877	(Aug 15, 1985; 3rd Ed; Rev thru Mar 23, 1987) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 886	(Jun 12, 1985; 9th Ed; Rev thru Dec 22, 1988) Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations
UL 943	(Sep 11, 1985; 2nd Ed) Ground-Fault Circuit Interrupters
UL 1010	(Feb 24, 1986; 4th Ed; Rev thru Sep 6, 1988) Receptical-Plug Combinations for Use in Hazardous (Classified) Locations
UL 1029	(Dec 1, 1986; 4th Ed; Rev thru Apr 29, 1989) High-Intensity-Discharge Lamp Ballasts
UL 1242	(Oct 10, 1983; 1st Ed; Rev Nov 23, 1989) Intermediate Metal Conduit

UL 1571

(Feb 7, 1984; 2nd Ed; Rev thru Jul 27, 1989) Incandescent Lighting Fixtures

UL 1572

(Dec 10, 1984; 2nd Ed; Rev thru Mar 31, 1989) High Intensity Discharge Lighting Fixtures

1.3 GENERAL

1.3.1 Rules

The installation shall conform to the requirements of NFPA 70 and NFPA 101, unless more stringent requirements are indicated herein or shown.

1.3.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor will become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible. Lighting fixtures, outlets, and other equipment and materials shall be located to avoid interference with mechanical or structural features; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Electrical Contractor shall coordinate the electrical work with other disciplines and electrical drawings and provide all power related wiring even if they are not shown on electrical drawings.

1.3.3 Hazardous Locations

Wiring in locations indicated shall conform to the NFPA 70 for Class I, II Divisions 1 and 2 hazardous locations. Equipment shall be suitable for Groups C and D.

1.3.4 Standard Products

Material and equipment shall be a standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.3.5 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by type or function and specific unit number as indicated. Unless otherwise specified, all identification nameplates shall be made of laminated plastic with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws

or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4-Inch High Letters

Panelboards Safety Switches Equipment Enclosures

Each panel, or similar assemblies shall be provided with a nameplate in addition to nameplates listed above, which shall be provided for individual compartments in the respective assembly, including nameplates which identify "future," "spare," and "dedicated" or "equipped spaces."

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS:

SD-04 Drawings

Electrical Work; GA.

Detail drawings consisting of a complete list of equipment and materials, including manufacturer's descriptive and technical data, catalog cuts, special installation instructions, applicable schematic diagrams, [and] equipment layout and anchorage, and conduit runs, anchorage, and support. Two sets of as-built drawings, within 30 days following the project completion or turnover.

SD-09 Reports

Materials and Equipment; GA.

The label or listing of the Underwriters Laboratories Inc., as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement may be submitted from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the materials and equipment comply with all contract requirements. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer.

1.5 WORKMANSHIP

Materials and equipment shall be installed in accordance with recommendations of the manufacturer and as shown.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section.

2.1.1 Cables and Wires

Conductors in cables shall be annealed copper. Design is based on copper conductors. Cables shall be single-conductor type, unless otherwise indicated. Cables and wires shall conform to UL 44 for rubber-insulated type; UL 83 for the thermoplastic-insulated type.

2.1.1.1 Nonmetallic Sheathed Cables

Type NM or NMC, with ground conductor.

2.1.1.2 Service Entrance Cable

Type USE.

2.1.1.3 Grounding Cables

Grounding cables shall be bare or shall have green low-voltage insulation.

2.1.2 Circuit Breakers

Circuit breakers shall have voltage, current and interrupting ratings as indicated. Fully rated circuit breakers shall be provided to obtain the specified interrupting rating. Fully rated circuit breakers shall be provided as indicated, for specific distribution equipment, to obtain the specified interrupting rating.

2.1.2.1 Molded-Case [and Insulated-Case Circuit Breakers]

NEMA AB 1, NEMA AB 3, and UL 489 for circuit breakers, and UL 877 for circuit breakers and circuit breaker enclosures in hazardous (classified) locations.

a. Molded-Case Circuit Breakers: Single-pole breakers shall be full module size; two poles shall not be installed in a single module. Multipole breakers shall be of the common-trip type having a single operating handle, but for sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multipole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. Breakers coordinated with current-limiting fuses shall have a combined interrupting capacity of 100,000 symmetrical amperes. All poles of associated breakers shall open if any fuse blows.

- b. Insulated-Case, Systems-Type Circuit Breakers: Breakers shall have continuous, short time withstand, and interrupting current ratings and frame sizes as indicated.
- 2.1.2.2 Ground Fault Circuit Interrupters
 - UL 943. Breakers equipped with ground fault interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings as indicated.
- 2.1.3 Conduit and Tubing
- 2.1.3.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)
 UL 797.
- 2.1.3.2 Intermediate Metal Conduit
 UL 1242.
- 2.1.3.3 PVC Coated Rigid Steel Conduit

NEMA RN 1.

2.1.3.4 Rigid Metal Conduit

UL 6.

2.1.3.5 Surface Metal Electrical Raceways and Fittings

UL 5.

- 2.1.4 Conduit and Device Boxes and Fittings
- 2.1.4.1 Boxes, Metallic Outlet

NEMA OS 1 and UL 514A.

- 2.1.4.2 Boxes, Outlet for Use in Hazardous (Classified) Locations
 UL 886.
- 2.1.4.3 Boxes, Switch (Enclosed), Surface-Mounted UL 98.
- 2.1.4.4 Fittings for Conduit and Outlet Boxes
 UL 514B.
- 2.1.4.5 Fittings for Use in Hazardous (Classified) Locations
 UL 886.

2.1.5 Conduit Coatings Plastic Resin System

FS L-C-530 or NEMA RN 1, Type A-40.

- 2.1.6 Connectors, Wire Pressure
- 2.1.6.1 Copper Conductors

UL 486A.

2.1.7 Electrical Grounding and Bonding Equipment

UL 467.

2.1.7.1 Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

2.1.8 Enclosures

NEMA ICS 6 or NEMA 250 or UL 698 for use in hazardous (classified) locations, unless otherwise specified.

2.1.8.1 Cabinets and Boxes

UL 50.

2.1.8.2 Circuit Breaker

UL 489.

2.1.8.3 Circuit Breaker for Use in Hazardous (Classified) Locations
UL 877.

2.1.9 Fixtures, Lighting and Fixture Accessories/Components

Standard Drawing 40-06-04 sheets referenced hereinafter and enclosed as an integral part of these specifications, additional fixtures shown on contract drawings, and UL 844 for fixtures to be installed in hazardous classified locations. Fixtures, accessories and components, including ballasts, lampholders, lamps, starters and starter holders, shall conform to industry standards specified below.

2.1.9.1 Incandescent Fixture

NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1571.

- 2.1.9.2 High-Intensity-Discharge
 - a. Fixture: NEMA LE 4 for ceiling compatibility of recessed fixtures and UL 1572.

- b. Ballasts: ANSI C82.4 for multiple supply types and UL 1029.
- 2.1.10 Panelboards

Dead-front construction, NEMA PB 1 and UL 67.

- 2.1.11 Receptacles
- 2.1.11.1 General Grade

NEMA WD 1.

2.1.11.2 Standard Grade

UL 498.

2.1.11.3 Ground Fault Interrupters

UL 943, Class A or B.

2.1.11.4 Hazardous Classified Locations

UL 1010.

2.1.12 Service Equipment

UL 869A.

2.1.13 Splice, Conductor

UL 486C.

2.1.14 Snap Switches

UL 20.

- 2.1.15 Tapes
- 2.1.15.1 Plastic Tape

UL 510.

2.1.15.2 Rubber Tape

UL 510.

2.1.16 Wiring Devices

NEMA WD 1 for general-purpose wiring devices, and NEMA WD 6 for dimensional requirements of wiring devices.

PART 3 EXECUTION

3.1 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following specifications.

3.1.1 Ground Rods

The maximum resistance measured in accordance with IEEE Std 142 of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, 2 additional rods not less than 6 feet on centers, or if sectional type rods are used, 2 additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

3.1.2 Ground Wire

A green ground wire shall be furnished regardless of the type of conduit.

3.2 WIRING METHODS

3.2.1 General Requirements

Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit, electrical metallic and/ or intermediate metal conduit.

3.2.2 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 1/2 inch. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Penetrations of above grade floor slabs, time-rated partitions and fire walls shall be firestopped. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 6 inches away from parallel runs of flues, steam pipes and hot-water pipes. Raceways shall be concealed within finished walls, ceilings, and floors unless otherwise shown. Raceways crossing structural expansion joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding.

3.2.2.1 Below Slab-on-Grade or in the Ground

All electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel. Rigid steel conduits installed below slab-on-grade or in the earth

shall be field-wrapped with 0.010-inch thick pipe-wrapping plastic tape applied with a 50-percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

3.2.2.2 Installing in Slabs Including Slabs on Grade

Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the Contracting Officer.

3.2.2.3 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations.

3.2.2.4 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed of obstructions or shall be replaced.

3.2.2.5 Supports

Metallic conduits and tubing shall be securely and rigidly fastened in place at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, or ceiling trapeze. C-clamps or beam clamps shall have strap or rod-type retainers. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structures, but no load shall be applied to joist bridging. Fastenings shall be by expansion bolts on concrete; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Holes cut to a depth of more than 1-1/2 inches in reinforced concrete beams or to a depth of more than 3/4-inch in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled. Conduit shall not be supported using wire or nylon ties. Raceways shall be installed as a complete system and be independently supported from the structure. Upper raceways shall not be the support of lower raceways. Conduits shall be fastened to all sheet-metal boxes and cabinets with two locknuts where required by the NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Bushings shall be installed on the ends of all

conduits and shall be of the insulating type where required by the NFPA 70. A pull wire shall be inserted in each empty raceway in which wiring is to be installed by others if the raceway is more than 50 feet in length and contains more than the equivalent of two 90-degree bends, or where the raceway is more than 150 feet in length. The pull wire shall be of No. 14 AWG zinc-coated steel, or of plastic having not less than 200-pound tensile strength. Not less than 10 inches of slack shall be left at each end of the pull wire.

3.2.3 Sizes

Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be No. 10 AWG.

Higher temperature rated conductors shall be permitted to be used, if the size of the conductors is determined on the basis of the 60 degree C ampacity or 75 degree C ampacity within the range of wire sizes for which the terminals are marked and temperature ratings for which the equipment in the circuit is marked.

Conductor sizes for nonlinear loads shall be based on the use of minimum 75 degrees C insulated conductors for branch circuits and feeders.

3.2.3.1 Power Conductor Identification

All phase conductors shall be identified by color-coding. The color of the insulation on the phase conductors of different voltage systems shall be as follows:

120/208 volt, 3-phase: red, black, and blue.

277/480 volt, 3-phase: brown, orange, and yellow.

120/240 volt, single/phase: red and black.

Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of bands of colored electrical tape wrapped around the insulation 3 inches apart for the entire length within the indicated enclosure. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures. Boxes for metallic raceways, 4-inch by 4-inch nominal size and smaller, shall be of the cast-metal hub type when located in normally wet locations, when flush and surface mounted on outside of exterior surfaces,

or when located in hazardous areas. Boxes in other locations shall be sheet steel when permitted by NFPA 70. Boxes for mounting lighting fixtures shall be not less than 4-inches square except smaller boxes may be installed as required by fixture configuration, as approved. Indicated elevations are approximate except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Separate boxes shall be provided for flush or recessed fixtures when required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided. Boxes and supports shall be fastened with bolts and metal expansion shields on concrete and with machine screws or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure. Cast-metal boxes with 3/32-inch wall thickness are acceptable. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4-inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel.

3.3.1 Boxes for Use with Raceway Systems

Boxes for use with raceway systems shall be not less than 1-1/2 inches deep except where shallower boxes required by structural conditions are approved. Sheetmetal boxes for other than lighting fixtures shall be not less than 4 inches square except that 4- by 2-inch boxes may be used where only one raceway enters the outlet. Minimum size boxes for telephone outlets shall be not smaller than 4-1/2 inches square and 3-1/2 inches deep.

3.3.2 Boxes for Use with Cable Systems

Boxes for use with cable systems shall be not less than 3- by 2-inch sectional boxes, 2-inches deep.

3.3.3 Pull Boxes

Pull boxes of not less than the minimum size required by the NFPA 70 shall be constructed of aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified above. Boxes shall be furnished with screw-fastened covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of cast-metal having rounded or beveled edges. Screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Plates shall be installed with all four edges in continuous contact with

cast-metal box. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed and provided with a hinged, gasketed cover, unless otherwise specified. Device plates for telephone and intercommunication outlets shall have a 3/8-inch bushed opening in center.

3.5 RECEPTACLES

3.5.1 Duplex

Duplex ground fault receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be brown. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. Ground fault circuit interrupters shall have the current rating as indicated, and shall be the UL Class A type unless otherwise shown.

3.5.2 Weatherproof

Weatherproof receptacles shown shall be mounted in a box with a gasketed, weatherproof, cast-metal cover plate and gasketed cap over each receptacle opening. The cap [shall be permanently attached to the cover plate by a short length of bead chain.] [shall be provided with a spring-hinged flap.]

3.6 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type. The wall switch handle and switch plate color shall harmonize with the color of the respective wall. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be rated 20-ampere 120/277-volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches shall be red.

3.7 SERVICE EQUIPMENT

Service-disconnecting means shall be of the enclosed molded-case circuit breaker type as indicated with external handle for manual operation. When service disconnecting means is a part of an assembly, the assembly shall be listed as suitable for service entrance equipment. Enclosures shall be sheet metal with hinged cover for surface mounting unless otherwise indicated.

3.8 PANELBOARDS AND LOADCENTERS

3.8.1 Panelboards

Panelboards shall be circuit breaker equipped for lighting and appliance branch circuit.

3.9 UNDERGROUND-SERVICE CONDUITS

Empty conduits for underground electric-service cable shall be installed as indicated. Except where otherwise indicated, conduits shall terminate approximately 5 feet beyond the building wall and 2 feet below finished grade, with the outside ends bushed and plugged or capped.

3.10 LAMPS AND LIGHTING FIXTURES

Fixtures may be provided with No. 18 AWG stranded copper conductors in 3/8-inch flexible metal conduits not over 6 feet long where flexible metal conduits are permitted by NFPA 70. Ballasted fixtures shall have ballasts which are compatible with the specific type and rating of lamps indicated and shall comply with the applicable provisions of the publications referenced.

3.10.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed in the fixtures just prior to the completion of the project.

3.10.1.1 Incandescent

Incandescent lamps shall be for 125-volt operation unless otherwise indicated.

3.10.1.2 High-Intensity-Discharge

High-intensity-discharge lamps shall be the high-pressure-sodium type unless otherwise indicated, shown, or approved.

3.10.2 Fixtures

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on standard Drawing No. 40-06-04, Sheet Nos. 73, which accompany and form a part of this specification for the types indicated. Illustrations shown on these sheets are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light-distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. In suspended acoustical ceilings with fluorescent fixtures, the fluorescent emergency light fixtures shall be furnished with self-contained battery packs.

3.10.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be provided for proper installation.

3.10.2.2 Ceiling Fixtures

Installation and support of fixtures shall be in accordance with the NFPA 70 and manufacturer's recommendations. Where seismic requirements are

specified herein, fixtures shall be supported as shown. Surface-mounted fixtures shall be suitable for fastening to the structural ceiling.

3.11 EQUIPMENT CONNECTIONS

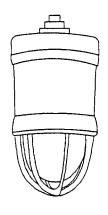
All wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS.

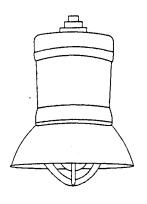
3.12 PAINTING AND FINISHING

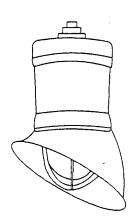
Field-applied paint on exposed surfaces shall be provided under Section 09900 PAINTING, GENERAL.

3.13 TESTS

After the interior-wiring-system installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the Contracting Officer. The Contractor shall furnish all instruments and personnel required for the tests, and the Government will furnish the necessary electric power. No part of the electrical distribution system shall be energized prior to the resistance testing of that systems ground rods and submission of test results to the Contracting Officer. Test reports shall indicate the location of the rod and the resistance and the soil conditions at the time the test was performed.







TYPE 711
Without Reflector

TYPE 712 With Standard DOME Reflector

TYPE 713
With 30 Degree Angle
DOME Reflector

High Intensity Discharge, Mogul Base Industrial Lighting Fixture For Use In NEC Class I, Division 1, Groups C, D, and Class II, Division 1, Groups E, F, and G

First Suffix	Second Suffix	Description
A B C	1 2 3	Rated for/Mounting: 175 watt metal halide lamp 100 watt high pressure sodium lamp 150 watt high pressure sodium lamp Pendant mounted Ceiling mounted Bracket mounted

Fixture shall conform to UL 844 and UL 1572 for use in NEC Division 1 and 2 locations. The fixture shall be integrally ballasted. The conduit entry wiring compartment shall be mechanically sealed from the ballast compartment. The conduit entry compartment shall contain a wireless terminal block which will connect and disconnect the fixture from the power source when the fixture is installed or removed. The fixture shall be prewired and factory sealed. The housing and guard shall be cast aluminum with the manufacturer's standard commercial product protective finish. Lampholder shall be mogul base glazed porcelain. The fixture shall be provided with the type mounting specified or indicated. The globe shall be heat and impact resistant glass, threaded, fluted, ribbed or patterned. The reflector shall be the manufacturer's standard commercial product and finish. Ballast shall be of the high power factor type. The fix-ture ballast shall be lead-peak regulating type for metal hallide lamps, and regulating type for high pressure sodium lamps. Ballast shall be capable of starting and operating the lamp at ambient temperatures ranging from minus 20°F. to 105°F. Fixture shall be prewired.

Fixture types indicated on this sheet shall also conform to requirements specified and indicated in the contract documents.

-- End of Section --

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SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

1.1 SUMMARY (Not Applicable)

1.2 REFERENCES

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

FEDERAL SPECIFICATION (FS)

FS W-S-610

(Rev D; Notice 1) Splice Connectors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70

(1993) National Electrical Code

NFPA 780

(1992) Lightning Protection Code

UNDERWRITERS LABORATORIES (UL)

UL-03	(1990) Electrical Construction
	Materials Directory

UL 96 (Sep 4, 1985; 3rd Ed; Rev thru Dec 5, 1988) Lightning Protection Components

UL 96A (Apr 9, 1982; 9th Ed; Rev thru Jul 6, 1990) Installation Requirements for Lightning Protection Systems

UL 467 (Nov 22, 1984; 6th Ed; Rev thru Nov 14, 1986) Grounding and Bonding Equipment

1.3 GENERAL REQUIREMENTS

1.3.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work. No departures shall be made without the prior approval of the Contracting Officer.

1.3.2 System Requirements

The system furnished under this specification shall consist of the standard products of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest UL approved

2.1.2 Main and Secondary Conductors

Conductors shall be in accordance with NFPA 780 and UL 96 for Class I, or Class II, as applicable.

2.1.2.1 Copper

Copper conductors used on nonmetallic stacks shall weigh not less than 375 pounds per thousand feet, and the size of any wire in the cable shall be not less than No. 15 AWG. The thickness of any web or ribbon used on stacks shall be not less than No. 12 AWG. Counterpoise shall be copper conductors not smaller than No. 1/0 AWG.

2.1.3 Air Terminals

Terminals shall be in accordance with UL 96 and NFPA 78. The tip of air terminals on buildings used for manufacturing, processing, handling, or storing explosives, ammunition, or explosive ingredients shall be a minimum of 2 feet above the ridge parapet, ventilator or perimeter. On open or hooded vents emitting explosive dusts or vapors under natural or forced draft, air terminals shall be a minimum of 5 feet above the opening. On open stacks emitting explosive dusts, gases, or vapor under forced draft, air terminals shall extend a minimum of 15 feet above vent opening. Air terminals more than 24 inches in length shall be supported by a suitable brace, with guides, not less than one-half the height of the terminal.

2.1.4 Ground Rods

Rods made of copper-clad steel shall conform to UL 467. Ground rods shall be not less than 3/4 inch in diameter and 10 feet in length. Ground rods of copper-clad steel shall not be mixed on the job.

2.1.5 Clamp-Type Connectors

Connectors for splicing conductors shall conform to UL 96, class as applicable, and FS W-S-610, Class 2, style and size as required for the installation.

2.1.6 Lightning Protection Components

Lightning protection components, such as bonding plates, air terminal supports, clips, and fasteners shall conform to UL 96, classes as applicable.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

3.1.1 General Requirements

The lightning protection system shall consist of air terminals, roof conductors, down conductors, ground connections, and grounds, electrically interconnected to form the shortest distance to ground without passing through any nonconducting parts of the structure. All conductors on the

equivalent. Conductors placed where there is probability of unusual wear, mechanical injury, or corrosion shall be of greater electrical capacity than would normally be used, or shall be protected. The ground connection to metal doors and door guides shall be by means of mechanical ties under pressure, or equivalent.

3.1.1.5 Ground Connections

Ground connections comprising continuations of down conductors from the structure to the grounding electrode shall securely connect the down conductor and ground in a manner to ensure electrical continuity between the two. All connections shall be of the clamp type. There shall be a ground connection for each down conductor. Ground connections shall be protected from mechanical injury. In making ground connections, advantage shall be taken of all permanently moist places where practicable, although such places shall be avoided if the area is wet with waste water that contains chemical substances, especially those corrosive to metal.

3.1.1.6 Grounding Electrodes

A grounding electrode shall be provided for each down conductor located as shown. A driven ground shall extend into the earth for a distance of not less than 10 feet. Ground rods shall be set not less than 2 feet, nor more than 10 feet, from the structure. The complete installation shall have a total resistance to ground of not more than 10 ohms. A counterpoise shall be of No. 1/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 2-1/2 feet deep at a distance not less than 2 feet nor more than 10 feet from the nearest point of the structure. All connections between ground connectors and grounds or counterpoise, and between counterpoise and grounds shall be electrically continuous. Where so indicated on the drawings, an alternate method for grounding electrodes in shallow soil shall be provided by digging trenches radially from the building. The lower ends of the down conductors are then buried in the trenches.

3.1.2 Magazines

In earth-covered composite steel/concrete magazines, the steel panels and the reinforcing steel shall be made electrically continuous. Electrical continuity may be provided by clipping, brazing, or tying unless a specific method is noted on the drawings. The air terminals and roof conductors shall be securely connected to, and made electrically continuous with, the reinforcing steel. One air terminal shall be located on the top of the front wall and one on or adjacent to the ventilator in the rear. The air terminals shall extend vertically at least 2 feet above the top of the front wall and the highest point on the ventilator. Down conductors and grounding electrodes shall be provided at diagonally opposite corners of the magazine and shall be connected together. Grounding electrodes shall be connected to the horizontal reinforcing rods below the floor line of the wall system. The steel door frame shall be made electrically continuous with the steel panels and the reinforcing steel. The steel door shall be connected to the steel frame by means of a flexible copper strap or cable unless the steel hinges make the door and frame electrically continuous.

SECTION 16670

LIGHTNING PROTECTION SYSTEM

PART 1 GENERAL

SUMMARY (Not Applicable) 1.1

1.2 REFERENCES

UL 467

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

FEDERAL SPECIFICATION (FS)

FS W-S-610 (Rev D; Notice 1) Splice Connectors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1993) National Electrical Code

NFPA 780 (1992) Lightning Protection Code

UNDERWRITERS LABORATORIES (UL)

UL-03	(1990) Electrical Construction Materials Directory
UL 96	(Sep 4, 1985; 3rd Ed; Rev thru Dec 5, 1988) Lightning Protection Components
UL 96A	(Apr 9, 1982; 9th Ed; Rev thru Jul 6, 1990) Installation Requirements for Lightning Protection Systems

GENERAL REQUIREMENTS 1.3

1.3.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work. No departures shall be made without the prior approval of the Contracting Officer.

(Nov 22, 1984; 6th Ed; Rev thru Nov 14, 1986) Grounding and Bonding Equipment

1.3.2 System Requirements

The system furnished under this specification shall consist of the standard products of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest UL approved

design. The lightning protection system shall conform to NFPA 70 and NFPA 78, UL 96 and UL 96A, except where requirements in excess thereof are specified herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS:

SD-04 Drawings

Lightning Protection System; GA.

Detail drawings consisting of a complete list of material, including manufacturer's descriptive and technical literature, catalog cuts, drawings, and installation instructions. Detail drawings shall demonstrate that the system has been coordinated and will function as a unit. Drawings shall show proposed layout and mounting and relationship to other parts of the work.

SD-13 Certificates

Materials and Equipment; GA.

Where material or equipment is specified to comply with requirements of UL, proof of such compliance. The label of or listing in UL-03 will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved nationally recognized testing organization equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters Laboratories may be submitted. A letter of findings, certifying UL inspection of all lightning protection systems provided on buildings used for manufacturing, processing, handling or storing explosives, ammunition, or explosive ingredients.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General Requirements

No combination of materials shall be used that form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist which would cause corrosion of conductors, conductors with protective coatings or oversize conductors shall be used. Where a mechanical hazard is involved, the conductor size shall be increased to compensate for the hazard or the conductors shall be protected by covering them with molding or tubing made of wood or nonmagnetic material. When metallic conduit or tubing is used, the conductor shall be electrically connected at the upper and lower ends.

2.1.2 Main and Secondary Conductors

Conductors shall be in accordance with NFPA 780 and UL 96 for Class I, or Class II, as applicable.

2.1.2.1 Copper

Copper conductors used on nonmetallic stacks shall weigh not less than 375 pounds per thousand feet, and the size of any wire in the cable shall be not less than No. 15 AWG. The thickness of any web or ribbon used on stacks shall be not less than No. 12 AWG. Counterpoise shall be copper conductors not smaller than No. 1/0 AWG.

2.1.3 Air Terminals

Terminals shall be in accordance with UL 96 and NFPA 78. The tip of air terminals on buildings used for manufacturing, processing, handling, or storing explosives, ammunition, or explosive ingredients shall be a minimum of 2 feet above the ridge parapet, ventilator or perimeter. On open or hooded vents emitting explosive dusts or vapors under natural or forced draft, air terminals shall be a minimum of 5 feet above the opening. On open stacks emitting explosive dusts, gases, or vapor under forced draft, air terminals shall extend a minimum of 15 feet above vent opening. Air terminals more than 24 inches in length shall be supported by a suitable brace, with guides, not less than one-half the height of the terminal.

2.1.4 Ground Rods

Rods made of copper-clad steel shall conform to UL 467. Ground rods shall be not less than 3/4 inch in diameter and 10 feet in length. Ground rods of copper-clad steel shall not be mixed on the job.

2.1.5 Clamp-Type Connectors

Connectors for splicing conductors shall conform to UL 96, class as applicable, and FS W-S-610, Class 2, style and size as required for the installation.

2.1.6 Lightning Protection Components

Lightning protection components, such as bonding plates, air terminal supports, clips, and fasteners shall conform to UL 96, classes as applicable.

PART 3 EXECUTION

3.1 INTEGRAL SYSTEM

3.1.1 General Requirements

The lightning protection system shall consist of air terminals, roof conductors, down conductors, ground connections, and grounds, electrically interconnected to form the shortest distance to ground without passing through any nonconducting parts of the structure. All conductors on the

structures shall be exposed except where conductors are in protective sleeves exposed on the outside walls. Secondary conductors shall interconnect with grounded metallic parts within the building. Interconnections made within side-flash distances shall be at or above the level of the grounded metallic parts.

3.1.1.1 Air Terminals

Air terminal design and support shall be in accordance with NFPA 780. Terminals shall be rigidly connected to, and made electrically continuous with, roof conductors by means of pressure connectors or crimped joints of T-shaped malleable metal and connected to the air terminal by a dowel or threaded fitting. Air terminals at the ends of the structure shall be set not more than 2 feet from the ends of the ridge or edges and corners of roofs. Spacing of air terminals 2 feet in height on ridges, parapets, and around the perimeter of buildings with flat roofs shall not exceed 25 feet. In specific instances where it is necessary to exceed this spacing, the specified height of air terminals shall be increased not less than 2 inches for each foot of increase over 25 feet. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure. Where metal ventilators are installed, air terminals shall be mounted thereon, where practicable. Any air terminal erected by necessity adjacent to a metal ventilator shall be bonded to the ventilator near the top and bottom thereof.

3.1.1.2 Roof Conductors

Roof conductors shall be connected directly to the roof or ridge roll. Sharp bends or turns in conductors shall be avoided. Necessary turns shall have a radius of not less than 8 inches. Conductors shall preserve a downward or horizontal course and shall be rigidly fastened every 3 feet along the roof and down the building to ground. Metal ventilators shall be rigidly connected to the roof conductor at three places. All connections shall be electrically continuous. Roof conductors shall be coursed along the contours of flat roofs, ridges, parapets, and edges; and where necessary, over flat surfaces, in such a way as to join each air terminal to all the rest.

3.1.1.3 Down Conductors

Down conductors shall be electrically continuous from air terminals and roof conductors to grounding electrodes. Down conductors shall be coursed over extreme outer portions of the building, such as corners, with consideration given to the location of ground connections and air terminals. Each building or structure shall have not less than two down conductors located as widely separated as practicable, at diagonally opposite corners. Down conductors shall be equally and symmetrically spaced about the perimeter of the structure. Down conductors shall be protected where necessary, to prevent mechanical injury to the conductor.

3.1.1.4 Interconnection of Metallic Parts

Metal doors and door guides shall be connected directly to the grounds or down conductors using not smaller than No. 6 copper conductor, or

equivalent. Conductors placed where there is probability of unusual wear, mechanical injury, or corrosion shall be of greater electrical capacity than would normally be used, or shall be protected. The ground connection to metal doors and door guides shall be by means of mechanical ties under pressure, or equivalent.

3.1.1.5 Ground Connections

Ground connections comprising continuations of down conductors from the structure to the grounding electrode shall securely connect the down conductor and ground in a manner to ensure electrical continuity between the two. All connections shall be of the clamp type. There shall be a ground connection for each down conductor. Ground connections shall be protected from mechanical injury. In making ground connections, advantage shall be taken of all permanently moist places where practicable, although such places shall be avoided if the area is wet with waste water that contains chemical substances, especially those corrosive to metal.

3.1.1.6 Grounding Electrodes

A grounding electrode shall be provided for each down conductor located as shown. A driven ground shall extend into the earth for a distance of not less than 10 feet. Ground rods shall be set not less than 2 feet, nor more than 10 feet, from the structure. The complete installation shall have a total resistance to ground of not more than 10 ohms. A counterpoise shall be of No. 1/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 2-1/2 feet deep at a distance not less than 2 feet nor more than 10 feet from the nearest point of the structure. All connections between ground connectors and grounds or counterpoise, and between counterpoise and grounds shall be electrically continuous. Where so indicated on the drawings, an alternate method for grounding electrodes in shallow soil shall be provided by digging trenches radially from the building. The lower ends of the down conductors are then buried in the trenches.

3.1.2 Magazines

In earth-covered composite steel/concrete magazines, the steel panels and the reinforcing steel shall be made electrically continuous. Electrical continuity may be provided by clipping, brazing, or tying unless a specific method is noted on the drawings. The air terminals and roof conductors shall be securely connected to, and made electrically continuous with, the reinforcing steel. One air terminal shall be located on the top of the front wall and one on or adjacent to the ventilator in the rear. The air terminals shall extend vertically at least 2 feet above the top of the front wall and the highest point on the ventilator. Down conductors and grounding electrodes shall be provided at diagonally opposite corners of the magazine and shall be connected together. Grounding electrodes shall be connected to the horizontal reinforcing rods below the floor line of the wall system. The steel door frame shall be made electrically continuous with the steel panels and the reinforcing steel. The steel door shall be connected to the steel frame by means of a flexible copper strap or cable unless the steel hinges make the door and frame electrically continuous.

3.9 INSPECTION

The lightning protection system will be inspected by the Contracting Officer to determine conformance with the requirements of this specification. No part of the system shall be concealed until so authorized by the Contracting Officer.

-- End of Section --