

U.S. DEPARTMENT OF ENERGY

NEVADA OPERATIONS OFFICE



STANDARD CONSTRUCTION SPECIFICATIONS

JANUARY 1980

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To Attached Distribution


TRANSMITTAL NTS STANDARD CONSTRUCTION SPECIFICATIONS, JANUARY 1980 ISSUE

Transmitted herewith is a copy of the January 1980 issue of the Nevada Test Site (NTS) Standard Construction Specifications.

These Specifications supersede June 1975 Specifications previously issued and establish the basis for design, construction and modifications performed by the Cost Plus Award Fee (CPAF) contractor at NTS. It is recognized that variations to, or departure from these Specifications will be necessary to fulfill unique requirements which will be so noted on the design drawings.

Although specific Occupational Safety and Health Administration (OSHA) Standards are referenced throughout these Specifications, all OSHA Standards are applicable.

Periodic revisions of individual sections will be accomplished as required by Addendum. Questions and/or suggestions concerning these Specifications should be directed to Holmes and Narver, Inc., Engineering Services, NTS, Mercury office, telephone 986-9900.


R. C. Keller, Chief
Logistical Support Branch

Enclosure:
As stated

ONB:051

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FOR THE
NEVADA TEST SITE

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SECTION 1

EARTHWORK FOR BUILDINGS, STRUCTURES, UTILITIES, AND ROADS

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SECTION 1

EARTHWORK FOR BUILDINGS, STRUCTURES, UTILITIES, AND ROADS

1.1 GENERAL.

This section covers the requirements for earthwork for buildings, structures, utilities, and roads, including all site preparation general excavation, trenching, subgrade preparation, embankments, fill, backfill, and related work shown and noted on the drawings and as specified.

1.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

1.2.1 American Association of State Highway Officials (AASHO):

- T 92 Determining the Shrinkage Factors of Soils
- T 93 Determining the Field Moisture Equivalent of Soils
- T 214 Field Determination of Density of Soil In-Place by the
Oil Method
- T 233 Density of Soil In-Place by Block, Chunk, or Core Sampling

1.2.2 American Society for Testing and Materials (ASTM).

- D 423 Liquid Limit of Soils, Test for
- D 424 Plastic Limit and Plasticity Index of Soils, Test for
- D 1194 Bearing Capacity of Soil for Static Load on Spread Footings,
Test for
- D 1452 Soil Investigation and Sampling by Auger Borings, Test
for
- D 1556 Density of Soil In-Place by the Sand-Cone Method, Test
for
- D 1557 Moisture-Density Relations of Soils, Using 10-lb. Rammer
and 18-in. Drop, Tests for
- D 1883 Bearing Ratio of Laboratory-Compacted Soils, Test for
- D 2216 Laboratory Determination of Moisture Content of Soil
- D 2922 Density of Soil and Soil Aggregate In-Place by Nuclear
Methods (Shallow Depth), Determining the

1.2.3 State of Nevada Department of Highways (SNDH)

Standard Specifications for Road and Bridge Construction

Material Manual of Testing Procedures

1.2.4 Occupational Safety and Health Administration (OSHA):

Part 1926, Safety and Health Regulations for Construction

1.2.5 Institute of Makers of Explosives:

American Table of Distances for Storage of Explosives

1.2.6 U.S. Army Material Command (AMC):

Safety Manual, AMCR 385-100

1.2.7 Department of Defense (DOD):

Safety Standards, DOD 4145.27M

1.2.8 U. S. Army Corps of Engineers

General Safety Requirements Manual

1.2.9 Dupont

Blaster's Handbook

1.3 DEFINITIONS

1.3.1 Suitable Materials.

Suitable materials shall comprise all excavated materials free from roots or other organic material, trash, ashes, debris, and frozen material.

1.3.2 Unsuitable Materials.

Unsuitable materials shall comprise excavated materials containing roots, organic material, trash, ashes, debris, frozen material, and such other unsuitable materials as designated by the Contracting Officer's Representative (COR).

1.3.3 Moistening (Wetting) and/or Aerating.

Moistening (wetting) and/or aerating shall include any scarifying and/or mixing required to bring the materials to a desired moisture content.

1.3.4 Roadway.

Roadway is that area included between the outside lines of slopes, ditches, and appurtenant structures and other features necessary to properly drain and protect the roadway.

1.4 SITE PREPARATION

1.4.1 Clearing and Grubbing.

Trees, stumps, subsurface roots larger than 1 1/2 inches in diameter, and matted roots existing within the area bounded by lines 5 feet outside of building or structure foundations and roadway, unless otherwise directed by the COR, shall be removed to a depth of 18 inches and disposed of. Unless further excavation is required, depressions made by clearing and grubbing shall be filled with suitable material and compacted to make the surface conform with the density of the original ground surface. Large rocks and boulders shall be removed and disposed of, unless otherwise directed by the COR.

1.4.2 Removal of Existing Pavement.

In areas where pavement is to be removed, the existing pavement shall be cut in straight lines using a concrete saw or other approved method. Cuts shall be vertical and at least 1/4 the depth of the surfacing. The surfacing and base course shall be removed at least 6 inches beyond the limits of excavation. In areas where straight, neat jointing is not a requirement as determined by the COR, the method of pavement removal shall be at the Constructor's option.

1.4.3 Disposal of Debris.

Cleared material and debris shall be disposed of in an area and in a manner as directed by the COR. Burning will not be permitted.

1.5 EXISTING SERVICE LINES, UTILITIES, STRUCTURES, AND BUILDINGS.

Existing service lines, utilities, structures, and buildings shown on the drawings shall be protected and safeguarded from damage during construction operations in a manner approved by the COR and in accordance with OSHA 1926. When existing utility lines, whether or not shown on the drawings are encountered or damaged, the Constructor shall notify the COR immediately so the necessary measures can be taken to prevent interruption of the service. Repair of utility lines, if required, will be at the discretion of the COR and may be accomplished by others.

1.6 BLASTING.

Blasting will not be permitted without written approval of the COR. Only thoroughly experienced, competent drillers, powdermen, and blasters shall be assigned to the required blasting operations. In addition, blasters must be certified by the State of Nevada. The charges shall be

so proportioned and placed that they will not, when fired, loosen the material outside the excavation lines shown on the drawings or specified herein. Any blasting procedure which results in breaking the material outside the established excavation lines or elevations, or which may be considered dangerous to personnel or property, shall be discontinued immediately and necessary steps taken to correct the procedure. Explosives shall be kept on hand in sufficient quantity to prevent delay of the work and shall be stored aboveground in dry, well-ventilated, fireproof magazines constructed and maintained at the Constructor's expense. A daily record shall be kept, showing the amount of explosives on hand, the quantities received and issued, and the area in which each issue is used in compliance with recommended codes and standards. Unused explosives shall be returned to the magazines in the event they cannot be used immediately. The locations of magazines must be acceptable to the COR and shall comply with the "American Table of Distances for Storage of Explosives" developed by the Institute of Makers of Explosives, AMC 385-100, Blaster's Handbook, and OSHA 1926.

Detonators shall be stored in a separate magazine at a safe distance from other explosives and places of work as designated by the COR. Primers for explosive charges shall be made in an area remote from the working area and shall remain at a safe distance until the drill holes are ready to load.

1.7 GENERAL EXCAVATION.

Excavation shall include the satisfactory removal and disposition of all materials encountered. Excavated material conforming to the requirements specified hereinafter for fills, backfills, or embankments shall be stored for future use or transported to and placed in the fill areas within the limits of the work. All unsuitable materials and any surplus excavated material shall be disposed of in an area and in a manner approved by the COR. Excavation and backfilling operations shall be performed in a manner and sequence that will provide adequate drainage. Materials required for fills or embankments in excess of that produced by excavation shall be obtained from approved borrow areas as specified hereinafter.

1.8 EXCAVATION FOR BUILDINGS, UTILITIES, AND ROADS.

1.8.1 General Requirements.

Excavations shall conform to the lines, grades, and elevations shown on the drawings. Excavations shall extend a sufficient distance from building foundations and utility structures to allow for placing and removal of forms for installation of services, and for inspection, except where concrete for footings and underground walls is deposited directly against the surfaces of the excavations. Undercutting will be permitted only where specifically shown or noted on the drawings. Where suitable bearings for buildings and utility and roadway structures are encountered at elevations above those indicated on the drawings, the excavation shall be carried to an elevation determined by the COR.

Unless so authorized, excavation shall not be carried below the elevations indicated on the drawings, and care shall be taken not to disturb the bottom of the excavation. Where the excavation is made below the elevations indicated on the drawings, the excavations, if under slabs, shall be backfilled to the proper elevation in accordance with the procedure hereinafter specified for backfill, or if under footings, shall be restored to the proper elevation with lean concrete. Lean concrete shall conform to requirements of Paragraph 2.8 - "Proportioning of Concrete." As an alternate, the Constructor may carry the building footings the full depth of the excavation using structural grade concrete specified for footings. Grading in the vicinity of buildings and structures shall be controlled so that the surface of the ground will be properly sloped to prevent water from running into the excavated areas. Any water that accumulates in the excavation shall be removed promptly. Shoring, where required, including sheet piling shall be installed to protect workmen and other personnel, the banks of the excavation, adjacent pavement, buildings, structures, and utilities.

1.8.2 Special Excavation Requirement--Utilities

1.8.2.1 Trench Excavation. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. Such sheeting or shoring shall be placed as may be necessary for the protection of the work and for the safety of personnel in accordance with OSHA 1926. Excavation shall be by open cut and trenches shall be of the necessary width for proper laying of pipe, conduits, and ducts. The banks of trenches shall be as nearly vertical as practicable. Care shall be taken not to over-excavate beyond the requirement for sand bedding as shown on the drawings. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed sand bedding at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints, and as hereinafter specified. Bell holes and depressions for joints shall be dug after the trench bottom has been graded, and, in order that the pipe rest on the prepared bottom for as nearly its full length as practicable, bell holes and depressions shall be only of such length, depth, and width as required for properly making the particular type of joint. Placing pipe on earth mounds will not be permitted. Stones shall be removed as necessary to avoid point bearing. Where rock excavation is required in trenches for pipe, the rock shall be excavated to a minimum overdepth of 4 inches below the trench depths indicated. Except as hereinafter specified for wet or otherwise unstable material, overdepths shall be backfilled with materials specified for backfilling the lower portion of trenches. Whenever wet or otherwise unstable material that is incapable of properly supporting the pipe is encountered in the bottom of the trench, such material shall be removed to the depth required and the trench backfilled to the proper grade with suitable material. Special requirements relating to specific utilities are as follows:

1.8.2.1.1 Sanitary Sewers. The width of the trench at and below the top of the pipe shall be such that the clear space between the barrel of the pipe and the trench wall shall not exceed 8 inches on either side of the pipe. The width of the trench above that level shall be as wide as necessary for sheeting and bracing and the proper performance of the work. The bottom of the trench shall be graded as required and rounded so that at least the bottom quadrant of the pipe shall rest firmly on a sand bed soil for as nearly the full length of the barrel as proper jointing operations will permit.

1.8.2.1.2 Water Supply and Distribution Lines. Unless otherwise indicated on the drawings, trenches shall be graded to avoid high points and the necessity of placing vacuum and relief valves in the waterlines. Trenches shall be of a depth that will provide a minimum cover over the top of the pipe of 3 feet measured from the existing ground surface or the indicated finish grade, whichever is lower, and to avoid interference of waterlines with other utilities.

1.8.3 Special Excavation Requirements--Roads.

1.8.3.1 Excavation. During excavation, grading shall be in conformity with the typical sections indicated on the drawings. Suitable excavated materials shall be transported to and placed in fill or embankment areas within the limits of the work. Unsuitable materials encountered within the limits of the work shall be removed as directed by the COR and replaced with suitable materials. Where solid rock is encountered in excavation for the roadbed, unless otherwise shown on the drawings or directed by the COR, it shall be loosened and broken up between the limits of the shoulder slopes so that no solid ribs, projections, or large fragments will be within 6 inches of the surface of the subgrade. When directed by the COR, the material thus broken up shall be removed and disposed of and the resulting space refilled to the required subgrade elevation with an approved material. The final surface of the rock shall be left so that it will drain adequately, and where pockets are formed which will not drain, the Constructor shall provide drainage by trenching from the pocket or pockets to the bottom of the roadway ditch and backfill both the pocket and trench with a fragmentary rock, gravel, or other suitable granular material. In solid rock excavation, slopes shall be constructed to the average neat lines staked at the direction of the COR. No rock shall project or overhang more than 12 inches from the true slope.

1.8.3.2 Excavation of Ditches, Gutters, and Channel Changes shall be accomplished by cutting accurately to the cross sections, grades, and elevations indicated on the drawings. Care shall be taken not to excavate ditches and gutters below required grades. Excessive open ditch or gutter excavation shall be backfilled with suitable materials and compacted in accordance with Section 1.11 to grades shown. Materials excavated shall be disposed of in an area approved by the COR.

1.8.3.3 Excavation for Drainage Structures shall be made accurately to the lines, grades, and elevations indicated on the drawings. Dimensions

and elevations of footings and foundation excavations shown may be changed, when approved by the COR, to ensure adequate foundation support.

1.8.3.4 Excavation for Appurtenances shall be sufficient to leave at least 2 feet (clearance) between the outer surfaces of the excavation and the appurtenances. Any overdepth excavation below such appurtenances shall be refilled with concrete or as directed by the COR.

1.9 BORROW MATERIALS.

Borrow materials shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used and shall be obtained from authorized borrow areas. Borrow pits and other excavation areas shall be excavated in such manner as will afford adequate drainage. Overburden and other spoil material shall be disposed of or, when suitable, may be used for special purposes. All borrow pits shall be neatly trimmed after the excavation is completed. Banks of pits shall be cut to not steeper than two-to-one slopes to blend with the natural contours.

1.10 COMPACTION

1.10.1 Compaction Control

Tests will be made by the Government; however, the Constructor shall cooperate in obtaining the tests.

1.10.1.1 Laboratory Control.

The moisture density relationship for the materials will be determined and controlled in accordance with the requirements of ASTM D 1557.

1.10.1.2 Field Control. Field density tests will be performed in sufficient number to ensure that the specified density is being obtained. These tests will be made in accordance with AASHTO T 214, AASHTO T 233, ASTM D 1556, or ASTM D 2922.

1.11 GENERAL BACKFILLING.

After completion of foundations, walls for buildings, utility structures, and other construction below the elevation of the final grades, and prior to backfilling, all forms shall be removed and the excavation shall be cleaned of all trash and debris. Material for backfilling shall consist of approved materials (from excavation or bottom). Backfill shall be placed uniformly to prevent eccentric loading upon or against structures. Backfill shall be placed in horizontal layers not in excess of 8 inches in thickness when hand compacted, and shall have the proper moisture content for the required degree of compaction. The relative compaction of each layer of compacted material shall not be less than 95 percent for areas which will be under concrete slabs and roadways, and be not less than 90 percent for all other areas unless otherwise shown on the drawings or approved by the COR.

1.11.1 Special Backfilling Requirements--Utilities.

1.11.1.1 Trenches shall not be backfilled until all required pressure tests are performed and until the utilities systems as installed conforming to the requirements specified in the several sections covering the installation of the various utilities. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Trenches shall be backfilled to the ground surface with selected excavated material or other material that is suitable for the specified compaction and as hereinafter specified. Piping shall have a minimum of 3 inches of sand over the pipe. Trenches improperly backfilled shall be reopened to the depth required for proper compaction, then refilled and compacted as specified, or the condition shall be otherwise corrected as permitted by the COR. The surface shall be restored to its original condition as near as practicable and as hereinafter specified. Pavement and base course disturbed by trenching operations shall be replaced in an acceptable manner with materials equal to the adjacent base course and pavement and shall conform to the requirements as specified or shown on drawings.

1.11.1.2 Lower Portion of Trench. Backfill material shall be deposited in 8-inch layers and compacted with suitable tampers to a relative compaction of not less than 90 percent until there is a cover of not less than 2 feet over the utility lines, unless otherwise shown on the drawings or approved by the COR. The backfill material in this portion of the trench shall consist of sand bedding and/or approved materials as shown on the drawings. Special care shall be taken not to damage the coating or wrapping of pipes.

1.11.1.3 Remainder of Trench. The remainder of the trench shall be backfilled with material that is free from stones larger than 3 inches in any dimension. Backfill material shall be deposited in layers not exceeding the thickness specified, and each layer shall be compacted to a relative compaction of not less than 90 percent, except the top 12 inches shall be compacted to a relative compaction of not less than 95 percent. Compacting by ponding and jetting will not be permitted without prior approval of the COR.

1.11.1.4 Restoration of Paved Surfaces. All existing surfaces which are treated, surfaced, or paved, through which trenching is performed, shall be treated, surfaced, or paved with materials of the same type or approved equal to the materials in the original surfaces. All materials and workmanship shall conform to the requirements as specified and/or as shown on the drawings.

1.11.2 Special Backfilling Requirements--Roads

1.11.2.1 Ground Surface on which backfill is to be placed shall be prepared as specified in the following paragraph. Backfill materials shall be compacted to the density specified hereinafter. Compaction in open areas shall be accomplished by sheepfoot rollers, pneumatic-tired rollers, power rollers, or other suitable compaction equipment. Backfill around structures and culverts shall be moistened and thoroughly tamped

until the compaction is not less than 95 percent of maximum density at optimum moisture content. Compaction of backfill material by ponding or jetting will be permitted only when approved by the COR.

1.12 PREPARATION OF GROUND SURFACE FOR FILL AND EMBANKMENTS

After completion of site preparation as indicated in Paragraph 1.4, areas to receive fill shall be plowed, disced, or harrowed to the depth noted on the drawings; moistened or aerated as necessary; thoroughly mixed; and compacted to a relative compaction of not less than 95 percent. The prepared ground surface shall be scarified, and moistened or aerated as directed by the COR, just prior to placement of fill and embankment materials to ensure adequate bond between fill and embankment material and the prepared ground surface. Where the top of the new subgrade is less than 18 inches of embankment is to be placed over existing pavement, such pavement may be left undisturbed. Sloped ground surfaces steeper than one vertical to four horizontal to receive fill, shall be plowed, stepped, or broken up in such a manner that the fill will bond with the existing surface.

1.13 FILL AND EMBANKMENTS.

Fills, or embankments herein designated as fills, shall be constructed at the locations and to the lines and grades indicated on the drawings. Where applicable, the completed fill shall correspond to the shape of typical sections shown on the drawings. Suitable material shall be material from the excavation or borrow areas which is free from trash, roots, or other organic matter; greater than 3 inches; and which can be readily compacted to the specified density. Rock, clods, or hard lumps of earth from the excavation having a maximum dimension not greater than 6 inches may be incorporated in the fill material, provided such rock is not placed within 12 inches of the finished grade or subgrade, if sufficient fine material is blended with rock to prevent nesting of rocks, and to ensure proper compaction. Rocks, clods, or hard lumps of earth, which cannot be broken readily, may be incorporated into the fill, provided such material is not placed within 3 feet of any finished grade or subgrade, with the approval of, and in a manner directed by the COR. All suitable material removed from the excavation shall be used insofar as practicable in forming necessary fills. No excavated material shall be wasted without authorization of the COR. Fill materials, unless otherwise specified herein, shown on the drawings, or approved by the COR, shall be placed in successive horizontal layers of loose material not exceeding 8 inches in depth when machine compacted and 4 inches when manually tamped. Each layer shall be spread uniformly and shall be moistened or aerated as necessary and compacted to a relative compaction of not less than 95 percent, except the upper 12 inches of fill under footings and under concrete slabs, which shall be compacted to not less than 95 percent of maximum density at optimum moisture content.

Fills may be constructed, with the approval of the COR, for the following two conditions:

- a. Sidehill fills, where the width including bench cuts for bonding existing and new fills is too narrow to accommodate compacting equipment, may be constructed by end dumping until the fill, including benching, is wide enough to permit the use of compacting equipment, after which the remainder of the fill shall be constructed in layers and compacted as specified above.
- b. Where fills are to be constructed across low, swampy ground which will not support the weight of hauling equipment, the lower part of the fill may be constructed by dumping successive loads in a uniformly-distributed layer of a thickness not greater than that necessary to support the equipment while placing subsequent layers, after which the remainder of the fill shall be constructed in layers and compacted as specified above.

Material shall not be placed in the fill when either the material, the foundation, or the fill on which it would be placed is frozen.

X 1.14 SUBGRADE PREPARATION.

Subgrade shall be shaped to line, grade, and cross section, and shall be compacted to a relative compaction of not less than 95 percent. This operation shall include plowing, discing, and any moistening or aerating required to obtain proper compaction. Unsuitable material shall be removed and replaced with suitable excavated material or other approved material. Rock encountered in the cut sections shall be excavated to a depth of 6 inches below finished grade for the subgrade. Low areas resulting from removal of unsuitable material or excavation of rock shall be brought up to required grade with approved materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted to the densities specified for embankments. Subgrade compaction for roads shall extend the full width of the road including shoulders. After rolling, the surface of the subgrade shall not show deviation greater than 3/4 inch in areas to receive a base course, and 3/8 inch in areas to receive pavement without a base course, when tested with a 10-foot straightedge applied both parallel and at right angles to the centerline of the area. The elevations of the subgrade shall conform to the elevations indicated on the drawings in conformance with Paragraph 1.18.

1.15 WATERING.

Watering shall include the application of water for proper compaction of embankment foundation areas, embankments and subgrade, structure backfill, processing subgrade materials, and for controlling dust caused by grading operations and traffic. Equipment used for applying water shall be approved pressure type equipped with a spray system that will ensure uniform application of water at a minimum pressure of 10 pounds per square inch. Water shall be applied in the amounts and on the areas as determined by the Constructor to attain the compaction in those materials

requiring a specified density. Excavation areas and borrow pits may be watered prior to excavating material. After the water has been applied to an area to be compacted, the material shall be processed by approved equipment until the layer is uniformly wet. Care shall be taken to avoid disturbing layers which have been previously placed and compacted.

1.16 CHEMICAL ADDITIVES.

If the Constructor elects to do so he may use chemical additives in water used for compaction. The right is reserved by the COR to prohibit the use of a particular type of additive, to designate the locations where a particular type of additive may not be used, or to limit the amount of a particular type of additive to be used at certain locations.

1.17 SHOULDER CONSTRUCTION.

Shoulders shall be constructed of suitable excavated or borrow materials. Shoulders shall be constructed as soon as possible after adjacent paving is complete. The entire shoulder area shall be compacted to at least the percentage of maximum density as specified for embankment. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, power rollers, or other approved equipment. Shoulder construction shall be done in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. The completed shoulders shall be true to alignment grade and shaped to drain in conformity with the required cross section.

1.18 FINISHING.

The surface of all excavations, embankments, and subgrades shall be finished to a reasonably smooth and compact surface in accordance with the required lines, grades, and cross sections or elevations. The degree of finish for all graded areas, except subgrades for pavements, shall be that ordinarily obtainable from blade-grader operations. Gutters and ditches shall be finished in a manner that will provide adequate drainage. The finished surface of embankments or excavated areas shall not vary from the established grade or approved cross section as follows:

- a. Not more than 0.15 foot in areas on which no base course or pavement is to be placed;
- b. Not more than 0.10 foot in areas on which base course is to be placed; and
- c. Not more than 0.05 foot in areas on which pavement is to be placed without a base course.

X 1.19 SUBGRADE AND EMBANKMENT PROTECTION.

The finished subgrade and embankment shall not be disturbed by traffic or other operations and shall be protected and maintained in a satisfactory

condition until the base course or pavement is placed. No base course or pavement shall be laid until the subgrade has been checked and approved.

1.20 RESHAPING ROADWAY.

X 1.20.1 Reshaping.

Reshaping of roadway shall include the restoration and preparation of the roadway where the subgrade work and embankments have been previously and substantially completed. This work shall include all excavation and embankment necessary to restore or repair the previously prepared roadway to the required grade, line, and section to receive an initial base course, and the finishing, trimming, and dressing of the shoulder to ditch slopes, cut slopes, and all parts of the roadway disturbed by the elements.

1.20.2 Construction.

All slides shall be removed and the roadway ditches shall be cut to the required lines and grades. Materials removed from the slides or ditches shall be used to widen uniformly, build up the low places in the embankment, or shall be disposed of. Slopes and ditches shall be brought to grade lines by scarifying, plowing, moving, and shaping, and compacting the earth to accomplish the desired section. All material shall have the required moisture content and shall be compacted as specified herein. Grading of the surface shall be continuous during the rolling operations to provide a well-shaped roadbed with the required cross section and crown.

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SECTION 2
CONCRETE WORK

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SECTION 2

CONCRETE WORK

2.1 GENERAL.

This section covers plain and reinforced concrete work for buildings, structures, utility structures, concrete pavement and all miscellaneous concrete work shown and noted on the drawings.

2.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

2.2.1 American Concrete Institute (ACI) Publication:

- ACI 311 Manual of Concrete Inspection
- ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures
- ACI 318 Building Code Requirements for Reinforced Concrete
- ACI 347 Recommended Practice for Concrete Formwork
- ACI 605 Recommended Practice for Hot Weather Concreting

2.2.2 American Society for Testing and Materials (ASTM) Specifications:

- A 82 Cold-Drawn Steel Wire for Concrete Reinforcement
- A 184 Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
- A 185 Welded Steel Wire Fabric for Concrete Reinforcement
- A 615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- A 616 Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
- C 33 Concrete Aggregates
- C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C 94 Ready-Mixed Concrete

- C 150 Portland Cement
- C 171 Sheet Materials for Curing Concrete
- C 226 Air-Entraining Additions for Use in the Manufacture of Air-Entraining Portland Cement
- C 260 Air-Entraining Admixtures for Concrete
- C 309 Liquid Membrane-Forming Compounds for Curing Concrete
- C 494 Chemical Admixtures for Concrete
- C 595 Blended Hydraulic Cements
- C 618 Fly Ash and Raw or Calcined Natural Pozzolans for Use in Portland Cement Concrete
- D 98 Calcium Chloride
- D 1190 Concrete Joint Sealer, Hot-Poured Elastic Type
- D 1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- D 1850 Concrete Joint Sealer, Cold-Application Type

2.2.3 International Conference of Building Officials:

Uniform Building Code (UBC)

2.3 EXAMINATION OF DRAWINGS.

The Constructor shall thoroughly examine all drawings to establish locations of embedment and anchorage items. Templates or instructions furnished with equipment shall be made available at the construction site by the Constructor. The ACI Building Code shall govern except as otherwise noted.

2.4 ADMIXTURES, HARDENERS, AND ACCELERATING OR RETARDING AGENTS.

Admixtures, hardeners, and accelerating or retarding agents may be used only when specifically approved by the Contracting Officer's Representative (COR).

2.5 AIR ENTRAINMENT.

The use of air-entrainment, either as air-entraining cement or as an air-entraining agent, may be used in concrete mixes when approved by the COR.

2.6 FORMS.

Forms, complete with centering, cores, and molds, shall be constructed to conform to the shape, form, line, and grade required and shall be maintained sufficiently rigid to adequately support the load.

2.6.1 Design.

Joints shall be tight and leakproof and shall be arranged vertically or horizontally to conform to the pattern of the design. Where forms are placed in successive units for continuous surfaces, they shall be fitted to accurate alignment so that the completed surface will be smooth and free from irregularities. In long spans, where intermediate supports are not possible, the anticipated deflection in the forms due to the weight of the fresh concrete shall be accurately figured and taken into account in the design of the forms, so that the finished concrete members will have true surfaces conforming to the desired lines, planes, and elevations, as shown on the drawings, and within the tolerances specified for finished concrete in ACI Standard 347. If adequate foundation for shoring roofs or floors cannot be secured, trussed supports shall be provided. Temporary openings shall be arranged in wall and column forms and where otherwise required, to facilitate cleaning and inspection. Lumber once used in forms shall have the nails withdrawn, and the surfaces to be exposed to concrete carefully cleaned before reuse. All forms shall be so constructed that they can be removed readily without hammering or prying against the concrete.

2.6.2 Form Ties.

Form ties shall be of suitable design and adequate strength to restrain concrete emplacement loads. Wire ties will not be permitted where appearance of the finished surface will be compromised. Bolts and rods which are to be completely withdrawn shall be coated with grease.

2.6.3 Joints.

Corners of columns, beams and other exposed joints, unless otherwise indicated on the drawings or directed, shall be beveled, rounded, or chamfered by moldings placed in the forms.

2.6.4 Coating.

Forms for exposed surfaces shall have a commercial, nonstraining oil coating applied before reinforcement is placed. Forms shall not be oiled when the concrete is to be painted. Surplus coating on form surfaces shall be removed prior to placing concrete. Forms for surfaces not exposed to view may be thoroughly wet with water (in lieu of oil coating) immediately before placing of concrete, when ambient temperature is 40° F. or above and rising.

2.6.5 Removal.

Forms shall be removed only with approval of the COR and in a manner to ensure complete safety of the structure. Supporting forms or shoring

shall not be removed until members have acquired sufficient strength to support their own weight safely and any construction loads to which they may be subjected (where concreting is sequenced and one emplacement must develop a specified strength before the next phase is started, the constraints will be specified on the drawings) but in no case shall they be removed prior to the time directed by the COR. Forms used for curing shall not be removed before expiration of curing period except as provided hereinafter under Paragraph 2.21. Voids shall be completely filled with cement mortar as forms are removed and voids are accessible.

2.6.6 Clamps.

Tie rod clamps to be entirely removed from the wall shall be loosened 24 hours after concrete is placed. Form ties may be removed at that time. Ties wholly withdrawn from wall shall be pulled toward the inside face.

2.6.7 Filling Tie Rod or Bolt Holes.

Holes left by bolts or tie rods shall be completely filled with cement mortar while concrete is green. The patching mortar shall be a mixture of one part Portland cement, two and one-half parts sand by weight and water in required quantity to provide proper workability of the mortar. Holes passing entirely through the wall shall be filled from inside face with a device that will force the mortar through to outside face, using a stop held at the outside wall surface to ensure complete filling. Holes which do not pass entirely through walls shall be packed full. Excess mortar at the face of filled holes shall be struck off flush.

2.7 REINFORCING STEEL.

2.7.1 General.

Reinforcing fabricated to the dimensions and shapes shown, shall be placed where indicated on drawings. Before placement, all reinforcement shall be cleaned of dirt, form oil, or non-metallic coating, including ice, which could reduce or destroy the bond. Rust and mill scale shall be considered satisfactory if the provisions of ACI 318, Section 7.2, are met. Following any substantial delay in the work, in-place reinforcement shall be inspected and cleaned. Reinforcement shall not be bent or straightened in a manner that will injure the material. Bars with kinks or with bends not shown on the drawings, or appreciably reduced in section (deteriorated), shall not be placed in the work. The heating of reinforcement for bending or straightening will be permitted only if the entire operation is approved by the COR.

Shop drawings for details and placement of all reinforcement, when required, shall be furnished for the approval of the COR. Unless otherwise indicated, the details of reinforcing steel shall conform to ACI 315. Splices, not indicated on the drawings, shall conform to the provisions of ACI 318, Sections 7.5 through 7.10, and shall be subject to the approval of the COR.

Mill certificates of tests on bar steel conforming to ASTM A 615 shall be submitted to the COR for approval.

2.7.2 Design.

Reinforcing details shown on the drawings shall govern the furnishing, fabrication, and placing of reinforcement. Except as otherwise shown on the drawings, construction shall conform to the following requirements:

2.7.2.1 Concrete Covering Over Steel Reinforcement, unless otherwise specified, shall be not less than the following thicknesses:

	Minimum Cover, In.
Cast against and permanently exposed to earth	3
Exposed to earth or weather:	
#6 through #18 bars.	2
#5 bars, 5/8 in. wire, and smaller.	1 1/2
Not exposed to weather in contact with the ground:	
Slabs, walls, joists:	
#14 and #18 bars	1 1/2
#11 and smaller.	3/4
Beams, girders, columns:	
Principal reinforcement, ties, stirrups or spirals.	1 1/2
Shells and folded plate members:	
#6 bars and larger	3/4
#5 bars, 5/8 in. wire, and smaller.	1/2

2.7.2.2 Minimum Bar Size. Unless otherwise shown on the drawings, bars less than No. 3 shall not be used in the work, except for stirrups, ties, spirals, and other placement aids.

2.7.3 Supports.

Reinforcement shall be accurately placed and securely tied at all intersections and splices with 18-gage, minimum, black annealed wire, and shall be supported rigidly in accurate position during the placing of concrete by spacers, chairs, or other supports approved by the COR.

Wire tie ends shall point away from the nearest form. Reinforcement in the top of slabs, either straight or bent bars, shall be supported on not less than No. 5 bars, carried on high chairs spaced not over 4 feet on centers. These bars shall be provided on the two opposite sides of the panels when the principal reinforcement is in one direction only, and on all four sides when the principal reinforcement is in two directions. For reinforcement in the bottoms of slabs and beams, the supports shall be sufficiently heavy and sufficient in number to properly carry the steel reinforcement.

2.8 PROPORTIONING OF CONCRETE.

Prior to the start of concrete work, the Constructor shall submit his intended mix design to the COR for laboratory tests, analysis, and approval. Design of concrete mixes shall conform to the UBC, Section 2604 or ACI 318, Part 3, Chapter 4. The design of concrete shall be in accordance with the strength requirements specified by the drawings. Cement (to be specified in mix design) shall be Type II, low-alkali, or Type III. Lean concrete used for fill or earth reinforcement, as specified in Section 1, Paragraph 1.8.1 - "General Requirements," shall conform to the requirements of these specifications, or as directed by the COR to correct faulty soil conditions encountered in the field, and shall have a minimum compressive strength of 1500 psi in 28 days.

2.8.1 Measurements.

2.8.1.1 Cement. A 94-pound bag of Portland cement will be considered to contain a volume of 1 cubic foot for computing yield.

2.8.1.2 Water. One gallon of water will be considered as 8.33 pounds. No increase in the maximum water content as determined in the approved trial mixes will be permitted. Water content specified is inclusive of surface water contained in the aggregate.

2.8.1.3 Aggregates. The source of all aggregates used in the work shall be approved by the COR. All tests in connection with coarse and fine aggregates will be the responsibility of the Government. Coarse aggregate shall be used in the greatest amount consistent with the required workability, and shall be of the largest size suitable for the work. Fine aggregate shall consist of clean, sharp particles well graded from coarse to fine. Gradation of all aggregates shall be as specified herein or as otherwise directed by the COR.

2.8.1.4 Gradation of Government-Furnished Aggregate, will be as follows:

Fine Aggregate

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
3/8-Inch	100
No. 4 (4760 Micron)	95-100
No. 8 (2380 Micron)	80-100
No. 16 (1190 Micron)	50-85
No. 30 (590 Micron)	25-60
No. 50 (297 Micron)	10-30
No. 100 (149 Micron)	2-10

Coarse Aggregate

No. 4 to 3/4-Inch

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
1-Inch	100
3/4-Inch	90-100
3/8-Inch	20-55
No. 4 (4760 Micron)	0-10

3/4-Inch to 1 1/2 Inches

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
2-Inch	100
1 1/2-Inch	90-100
1-Inch	20-55
3/4-Inch	0-15

2.8.2 Concrete Proportions.

The exact proportions of all material entering into the concrete shall be as determined in the approved trial mixes. All necessary equipment shall be provided to determine and control the actual amounts of materials entering into each concrete mix. The proportions will be changed whenever, in the opinion of the COR, such changes become necessary to overcome deficiencies and to assure development of the specified strength, the desired durability, density, workability, or consistency.

2.8.3 Corrective Additions.

To remedy deficiencies in the aggregate gradations, corrective additions may be used, subject to approval by the COR.

2.8.4 Correction of Proportions.

2.8.4.1 Workability. If during the progress of the work it is found impossible to obtain concrete of the required workability with the mix design proportions, the COR may allow such changes in proportions as are deemed necessary to secure the desired workability, provided that in no case shall the ratio of water to cement be greater than is shown on the approved mix design for the strength of the concrete specified on the drawings.

2.8.4.2 Slump. The slump shall fall within the following tabulation provided the requisite strength is obtained:

	Slump in Inches			
	For Concrete Without an Air-Entraining Admixture		For Concrete Containing an Air-Entraining Admixture	
	Minimum	Maximum	Minimum	Maximum
Heavy mass construction and slabs on the ground	1 1/2	4	1 1/2	3 1/4
Slabs, beams, or walls	3	5	2	4
Thin walls and columns,	3 1/2	5	3	5

2.9 BATCHING AND MIXING CONCRETE.

Concrete shall be mixed by a mechanical batch-type mixing plant which is in good working condition, and has been approved by the COR. Mixers shall be provided with adequate facilities for accurate measurement and control of each of the materials entering the mixer, and for changing the proportions to conform to varying conditions of the work. The mixing-plant assembly shall include adequate provision for the inspection of operations at all times. Scales and meters are to be certified and sealed by state inspectors and checked at regular intervals and after each move.

2.9.1 Batching Unit.

Each batching unit shall be supplied with the following items:

2.9.1.1 Weighing Unit. A weighing unit shall be provided for each type of material to indicate the scale load at convenient stages of the weighing operation. The weighing units shall be maintained calibrated.

2.9.1.2 Water Mechanism. The water mechanism shall be tight with interlocked valves such that the discharge valves cannot be opened before the filling valve is fully closed. This mechanism shall be fitted with a graduated gage.

2.9.1.3 Discharge Gate. The batcher discharge gate shall control the mix to produce a smooth ribboning and mixing of the cement with the aggregate. Delivery of materials from the batching equipment to the mixer shall be accurate within the following limits:

<u>Material</u>	<u>Percent by Weight</u>
Cement	1/2
Water	1/2
Fine aggregate	1
Coarse aggregate	2

2.9.2 Mixing Unit.

2.9.2.1 Operations. Mixers shall not be charged in excess of the rated capacity, nor be operated in excess of the rated speed. Excessive mixing, requiring the addition of water to preserve the required consistency, will not be permitted. The entire batch shall be discharged before recharging.

2.9.2.2 Mixing Time shall be measured from the time the water is introduced into the drum containing all solids. All mixing water shall be introduced before one-quarter of the mixing time has elapsed. Mixing time for mixer of 1 cubic yard or less shall be 1 1/4 minutes after all material is in the drum; for mixes larger than 1 cubic yard, the mixing time shall be increased 15 seconds for each additional half cubic yard or fraction thereof. Mixing time, where an air entraining agent is used, shall be adjusted as required to provide the specified air content.

2.9.2.3 Discharge Lock. Unless waived by the COR, a lock shall be provided on each mixer to secure the discharge mechanism until the required mixing time has elapsed.

2.9.2.4 Operating Condition. Plant equipment shall be maintained in accordance with manufacturer's recommendations and approved maintenance instructions. Excessive blade wear (greater than 10 percent) or evidence of water leakage shall be reported to the cognizant COR.

2.10 READY-MIXED CONCRETE.

Ready-mixed concrete shall be plant-mixed or transit-mixed as specified below. The temperature of the concrete when delivered shall be not less than 60° F. for ordinary structures and average environment conditions. Placement temperature for massive structures or involving hot and cold

weather extremes may be adjusted with approval of the COR. The storing, weighing, batching, and mixing requirements specified herein for storing, batching, and mixing at the site, except as hereinafter modified, shall apply to ready-mixed concrete.

2.10.1 Plant-Mixed Concrete.

The plant shall be equipped for the accurate proportioning, mixing, and delivery of the concrete and have sufficient capacity and transportation facilities to deliver the concrete at the rate required. Concrete shall have an initial mixing at the plant of not less than 1 minute after all materials are in the mixer. The time elapsing between the discharge of the concrete from the mixer to its final position shall not exceed the time limit specified under Paragraph 2.16, "Placing Concrete." Transportation of concrete from the plant to the job shall be in clean, watertight receptacles equipped with an agitation device which shall operate until the concrete is discharged. Maximum size of batch carried shall be not more than 70 percent of the rated capacity of the container (for agitation) and the agitating speed shall not be less than 2 revolutions per minute or more than 6 revolutions per minute of the drum or revolving agitating device.

2.10.2 Transit-Mixed Concrete.

Materials shall be batched and discharged into the truck mixer and agitator which shall be capable of transporting and mixing the separate ingredients into a thoroughly mixed and uniform mass, while in transit. The quality and characteristics of the mix shall conform in every respect to the requirements for concrete after the addition of mixing water. The rate of revolution of the drum shall be not less than 4 revolutions per minute nor greater than a peripheral velocity designated by the manufacturer of the transit mixer. Additional revolutions of the mixer beyond that which is found to produce the desired uniformity of the mix shall be at a speed designated by the COR. The agitating speed for any type of transit mixer shall be not less than 2 nor more than 6 revolutions per minute. Truck mixers generally shall be operated within the limits of the capacity and speed of rotation designated by the manufacturer of the truck mixer.

2.10.2.1 Recording Device. The transit mixer shall be equipped with a device for recording the number of revolutions made by the drum between time of charging with material and delivery of the concrete at the site.

2.10.2.2 Water Measurement. The mixing and flushing waters in truck mixers shall be in separate compartments arranged so that the drum cannot be flushed until the mix has been dumped. The mixing water compartment shall be equipped with a calibrated glass gage.

2.10.2.3 Operating Condition. Transit mix equipment shall be maintained in accordance with manufacturer's recommendations and approved maintenance instructions. Excessive blade wear (greater than 10 percent) or evidence of water leakage shall be reported to the COR.

2.11 CONSTRUCTION JOINTS.

Except for emergency cold joints, construction joints shall be as shown on the drawings. Concrete shall be placed continuously so that the unit will be monolithic in construction. Construction joints shall be constructed as detailed. Joints in columns shall be made at the underside of the floor or roof slab. Columns, piers, or walls of ordinary height shall be placed at least 2 hours before any overhead work is placed thereon. Joints not shown or specified shall be located so as not to impair strength and appearance of the structure and shall be subjected to the approval of the COR. Except when indicated on the drawings, no jointing shall be made in footings or foundation work without approval of the COR. Placement of concrete shall be at such rate that surfaces of concrete not carried to joint levels will not have attained initial set before additional concrete is placed thereon. Lifts shall terminate at such levels as are indicated on the drawings. Provision shall be made for jointing successive pours as detailed on drawings or as required. To ensure a level, straight joint in exposed vertical surfaces, a strip of dressed lumber may be tacked to the inside of the forms at the construction joint. The 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 leveled off with a wood float, and all laitance removed.

2.12 EXPANSION JOINTS.

Joints between concrete slabs placed on earth and which abut against vertical surfaces, and where indicated at other locations, shall have premolded expansion joint filler strips of thickness indicated on the drawings and for the full depth of the slab except where joint sealing is indicated. Edges of joints shall be finished slightly rounded.

2.12.1 Expansion Joint Filler.

Expansion joint filler shall be preformed joint filler strips conforming to ASTM D 1751.

2.12.2 Joint Sealer.

Joint sealer, unless otherwise specified on the drawings, shall be Thiokol Polysulfide, or approved equal, and shall conform to ASTM D 1850.

2.13 CONTROL JOINTS.

Control joints shall be located as shown on the drawings. Unless otherwise specified, this joint may consist of either a 1/8- to 1/4-inch wide sawcut, approximately 1/4 the thickness of the wall or slab in depth, or be preformed using a wood strip of these same dimensions. The joint shall be sealed as specified on the drawings. No control joints shall be placed in the work unless indicated on the drawings or approved by the COR.

2.14 WATERSTOP JOINTS.

Waterstops shall be located as shown on the drawings, in either construction, expansion, or contraction joints. The waterstop shall be installed as detailed on the drawings, and should provide a completely moisture-proof joint. In the case of an expansion joint, the premolded joint filler shall be placed on both sides of the waterstop unless otherwise specified. At splice points, waterstops shall be joined in a manner so as to ensure a moisture-proof connection.

2.15 PREPARATION FOR PLACING.

Water shall be removed from excavation before concrete is placed. Any flow of water shall be diverted through proper side drains and shall be removed without eroding freshly placed concrete. Hardened concrete, debris, and foreign materials shall be removed from interior of forms and from inner surfaces of mixing and conveying equipment. Reinforcement shall be secured in position, inspected, and approved before placing concrete. Runways shall be provided for wheeled concrete-handling equipment; such equipment shall not be wheeled over reinforcement nor shall runways be supported on reinforcement. The subgrade shall be finished to the exact section of the bottom of the floor slab and shall be maintained in a smooth, compacted condition until the concrete is in place. The subgrade shall be thoroughly moistened, but not muddy or frozen, at the time the concrete is placed.

2.16 PLACING CONCRETE.

Concrete shall be handled from the mixer or transport vehicle to its final position in a continuous manner, and as rapidly as practicable, until the given unit of operation is completed. Concrete shall be delivered to the construction site and discharge shall be completed within 1 1/2 hours or before the drum has been revolved 300 revolutions, whichever comes first, after introduction of the mixing water. The concrete shall be placed in the forms as nearly as practicable in its final position, so as to avoid rehandling. Special care shall be exercised to prevent damage to the forms or reinforcing in advance of placing. As new concrete is placed, earlier concrete shall be agitated in a manner that will force out all air pockets and work the mixture into corners, around reinforcement and inserts, and prevent the formation of voids. New concrete shall not be placed on hardened concrete which will cause the formation of seams and planes of weakness within the section. Concrete shall not be allowed to drop freely more than 4 feet in unexposed work nor more than 3 feet in exposed work. Where greater drops are required, a tremie or other method shall be employed. The discharge of the tremie shall be controlled so that the concrete may be effectively compacted into horizontal layers not exceeding 12 inches in thickness with a minimum of lateral movement.

2.16.1 Cold-Weather Placement.

Concrete shall be mixed and placed only when the ambient temperature is at least 40° F. and rising, unless permission to place is obtained from the COR, in which event all material shall be heated and otherwise properly prepared so that batching and mixing can proceed in full accord with the provisions of this specification. Suitable means shall be provided for maintaining the concrete at a temperature of at least 50° F. for a period of 72 hours after placing, except that where high-early-strength cement is used, this period may be reduced 24 hours. Salt, chemicals, or other materials, unless otherwise approved, shall not be mixed with the concrete for the purpose of preventing freezing. Accelerating agents shall not be used except when approved by the COR.

2.16.2 Hot-Weather Placement.

When the ambient temperature is in excess of 100° F., or is expected to be in excess of 100° F. during placement of concrete, materials for concrete shall be shaded from the sun and the water-cooled in order that the temperature of the concrete will not exceed 90° F. An approved retarder shall be used in the concrete mix whenever the temperature is sufficiently high to cause "flashset" or any problem in achieving specified finish. In addition, concrete placed in hot weather shall be subject to ACI 605.

2.16.3 Earth Footing and Foundation Placement.

Concrete for footings shall be placed upon undisturbed or compacted, clean surfaces which are free from frost, ice, mud, and water. When the foundation is on dry soil, the earth surfaces to receive the concrete shall be lightly sprinkled with water, immediately before placement of the concrete, unless otherwise noted on the drawings or directed by the COR.

2.16.4 Rock Foundation Placement.

Rock surfaces upon which concrete is to be placed shall be approximately level, free from objectionable coatings, water, mud, debris, and or loose fragments, and shall be sufficiently rough to assure satisfactory bond with the concrete.

2.16.5 Chute Placement.

When concrete is conveyed by chutes, the plant and equipment shall be of such size and design as will ensure a continuous flow of concrete in the chute. The chute shall be of metal and the different parts shall be set at approximately the same slope, which shall be not less than 1 vertical to 3 horizontal, nor more than 1 vertical to 2 horizontal. The discharge end of the chute shall be provided with a baffle to prevent segregation. If the height of the discharge end of the chute is more than 3 times the thickness of the concrete layer to be placed, but not more than 5 feet above the surface of the concrete in the forms, a spout shall be used,

and the lower end maintained as near the surface of placement as practicable. When the placing operation is intermittent, the chute shall discharge into a hopper. The chute and hopper shall be thoroughly cleaned before and after each run. All waste material and the flushing water shall be discharged outside of the forms.

2.16.6 Pneumatic Placement.

Where concrete is conveyed and placed by pneumatic means, the equipment shall be located as close as uniformly spaced points not farther apart than the visible effectiveness of the machine. Where hand-tamping is used, there shall be not less than one man for each 2 yards of concrete placed per hour, whose time shall be used in tamping ONLY.

2.18 BONDING AND GROUTING.

Before placing new concrete on or against concrete which has set, the existing surfaces shall be thoroughly roughened and cleaned of all laitance, foreign matter, and loose particles. Forms shall be retightened and the existing concrete surfaces slushed with a grout coat of neat cement. Grout for horizontal construction joints shall be of cement and fine aggregate in the same proportions as the concrete to be placed, and shall be from 1/2 to 1 inch thick. Grout for setting metal items shall be composed of equal parts of sand and cement, with water sufficient to produce the required consistency.

2.19 SLABS ON GRADE.

Prior to construction of concrete slabs on grade all pipes under concrete floors on earth shall have been subjected to the required tests. The earth fill shall be tamped and any fill required under the slabs on earth shall be deposited and compacted by rolling or tamping. Before compacting the subgrade, any unsuitable material shall be removed and replaced with suitable material. The subgrade shall be brought to grade, and compacted to 95 percent of maximum density at optimum moisture content, and shall be screeded level or to the required grades.

2.20 CONCRETE FLOOR AND ROOF-SLAB FINISHES.

Concrete slabs shall be finished as hereinafter described. The dusting of wearing surfaces with dry materials will not be permitted. In preparation for finishing, floor slabs shall be struck off true to the required level at the elevation or grade of the finished floors, as shown on the drawings. Floors shall be level with a tolerance of 1/8 inch in 10 feet except where drains occur, in which case, the floors shall be pitched to the drains as indicated on the drawings or as directed. Unless otherwise specified on the drawings, the Constructor may use either of the following methods of finishing:

2.20.1 Monolithic Finish.

Floors shall be compacted and finished by screeding and floating with straightedges to bring the surface to the required finish level shown on the drawings. While the concrete is still green but sufficiently hardened, it shall be wood-floated to a true even plane with no coarse aggregate visible. Sufficient pressure shall be used on the wood-floats to bring moisture to the surface. Any water brought to the surface by the float should be allowed to evaporate before the surface is again floated or hand troweled. The concrete shall then be hand troweled to produce a smooth impervious surface free from trowel marks. An additional troweling shall be given the surface for the purpose of burnishing. The final troweling shall produce a ringing sound from the trowel. Roof slabs shall be finished as specified above, except that the second troweling shall be omitted.

2.20.2 Power-Machine Finishing.

In lieu of hand finishing, the Constructor may use an approved power machine for finishing concrete slabs in accordance with the directions of the machine manufacturer. The preparation of concrete surfaces for finishing by machine shall in general be as hereinbefore required for hand finishing.

2.21 PROTECTION AND CURING.

2.21.1 Curing.

Immediately after placing or finishing, concrete surface not covered by forms shall be protected against moisture loss for not less than 7 days when an unblended Portland or a blended cement has been used, or 3 days when a high-early-strength Portland cement has been used. Curing shall be accomplished by one of the following methods or combination thereof, as approved by the COR.

2.21.1.1 Moist Curing. Unformed surfaces shall be covered with burlap, cotton, or other approved fabric mats kept in intimate contact with the surface, or with sand, and shall be kept continually wet. Where formed surfaces are cured in the forms, the forms shall be kept continually wet. If the forms are removed before the end of the curing period, curing shall be continued as on unformed surfaces, using suitable material.

2.21.1.2 Waterproof Paper Curing. Surfaces shall be covered with waterproof paper lapped 4 inches at edges and ends, and sealed with mastic or pressure-sensitive tape not less than 1 1/2 inches wide. Paper shall be weighted to prevent displacement, and tears or holes appearing during the curing period shall be immediately repaired by patching. Plastic sheeting, 6 mils thick, may be substituted for the paper.

2.21.1.3 Membrane-Forming Curing. Compound shall be applied by power spraying equipment using a spray nozzle equipped with a wind guard. The

compound shall be applied in a two-coat, continuous operation at a coverage of not more than 200 square feet per gallon for each coat. When application is made by hand sprayers, the second coat shall be applied in a direction approximately at right angles to the direction of the first coat. The compound shall form a uniform, continuous, adherent film that shall not check, crack, or peel, and shall be free from pinholes or other imperfections. Surfaces after compound has been applied, or surfaces damaged by subsequent construction operations within the curing period shall be resprayed at the rate specified above. Membrane curing compound shall not be used on surfaces that are to receive bituminous membrane waterproofing, adhesive for application of other material, concrete fill or setting beds, nor on surfaces that are to be painted or receive epoxy coatings. Where membrane forming curing compounds are permitted, permanently exposed surfaces shall be cured by use of a clear-type membrane-forming curing compound containing a fugitive dye.

2.21.1.4 Water Flood Curing. When shown or noted on the drawings, slabs shall be cured by flooding with water. The perimeter of slabs shall be dammed or sealed against leakage in a manner approved by the COR to provide for a depth of water of approximately 2 1/2 inches at the highest slab elevation. Water shall be maintained at that level for the 7-day or 3-day period specified under Paragraph 2.21.1.

2.21.1.5 Protection. The completed structure shall be protected from damage until accepted. The Constructor shall repair and clean, at his own expense, all concrete damaged or discolored during construction.

2.22 SAMPLING AND TESTING.

2.22.1 General.

Testing of end items is the responsibility of the Government. Concrete samples for test purposes will be taken and stored by the Government. Concrete for test samples shall be furnished by the Contractor. The Contractor shall afford access to work and cooperate with the Government in the preparation of concrete samples for testing.

2.22.2 Concrete Cylinders.

The Government will take for test purposes, a minimum of three test cylinders from each day's placement of concrete (if less than 50 cubic yards) which is placed, with an additional minimum of three test cylinders for each 50 cubic yard increment. The test cylinders will be tested in accordance with ASTM C 39. The test results shall be the average of the strengths of the test cylinders for each day's pour and not more than 20 percent of the strength tests shall have values less than the specified strength. If the test results of the cylinders fall below the minimum allowable strength, the Contracting Officer may require such changes in the proportions of the concrete mix as will be necessary to obtain the required strength, and all deficient concrete shall be removed and replaced with new concrete by the Contractor.

* * * * *

SECTION 3

REINFORCED CONCRETE MASONRY

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SECTION 3
REINFORCED CONCRETE MASONRY

3.1 GENERAL.

The work covered by this section includes reinforced concrete masonry requirements for buildings, structures, walls, and other construction shown or noted on the drawings.

3.2 APPLICABLE PUBLICATIONS.

The following publications, including revisions and amendments of the issues as of the date of award of this contract, form a part of this specification:

3.2.1 American Society for Testing and Materials (ASTM)

- A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- A 615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- C 33 Specification for Concrete Aggregates
- C 90 Hollow Load-Bearing Concrete Masonry Units
- C 144 Specification for Aggregate for Masonry Mortar
- C 150 Portland Cement
- C 331 Lightweight Aggregate for Concrete Masonry Units
- C 404 Specification for Aggregates for Masonry Grout
- C 426 Testing of Concrete Masonry Units
- C 427 Moisture Condition of Hardened Concrete
- C 476 Mortar and Grout for Reinforced Masonry

3.2.2 Federal Specifications:

- QQ-W-461 Wire, Steel, Carbon (Round, Bare, and Coated)
- QQ-S-632 Steel Bar Reinforcing (for Concrete)

3.2.3 International Conference of Building Officials:

Uniform Building Code (UBC)

3.2.4 American Concrete Institute (ACI):

ACI Standard 318-71; Building Code Requirements for Reinforced Concrete

ACI Standard 315-74; Manual of Standard Practice for Detailed Reinforced Concrete Structures

3.3 SHOP DRAWINGS.

The Constructor shall submit shop drawings showing details and placing dimensions for all masonry reinforcing steel to the Contracting Officer's Representative (COR) for approval. The COR will retain three (3) copies of each drawing and return the remainder of the copies to the Constructor. Dowels or bars extending from concrete for lapping with masonry reinforcement will be furnished and installed under Section 2, "Concrete Work." Shop drawings for masonry reinforcing steel shall be coordinated with concrete reinforcing steel and approved prior to placement of concrete. The shop drawings shall clearly indicate special masonry shapes, shape numbers, applicable dimensions, and methods of anchoring and reinforcing the wall back of hung fixtures. Materials for the installation shall not be delivered to the site prior to approval of shop drawings.

3.4 MATERIALS

3.4.1 Anchors and Ties.

Anchors and ties, where applicable, shall be as shown on the approved design drawings and, except as otherwise specified herein, shall be zinc-coated ferrous metal of the types noted below. Zinc coating of anchors and ties shall conform to ASTM Standard A 153, Class B-1, B-2, or B-3, as required.

3.4.1.1 Supports and Fastenings for fixtures and equipment are specified in Section No. 21, entitled "Plumbing."

3.4.1.2 Centering-Clips and Caging Devices for positive positioning reinforcing bars shall conform to FS QQ-W-461, Composition 1006, 1010, or 1015, Finish 5, Class 1, hard, and shall be of standard manufacture of a design as approved by the COR.

3.4.2 Aggregates

3.4.2.1 Aggregate for Masonry Units. Aggregates used in making concrete masonry units shall conform to ASTM Standard C 33.

3.4.2.2 Aggregate for Masonry Mortar shall conform to ASTM Standard C 144.

3.4.2.3 Aggregate for Masonry grout shall conform to ASTM Standard C 404, Table 1, fine aggregate, Size No. 2.

3.4.2.4 Aggregate for Low-Lift and High-Lift Grout shall conform to ASTM Standard C 404, Table 1, coarse aggregate Size No. 8, except that the coarse aggregate shall be graded with 100 percent passing the 3/8-inch sieve and not more than 5 percent passing the No. 8 sieve.

3.4.3 Cement.

Portland Cement shall conform to ASTM C 150, Type II, low alkali.

3.4.4 Concrete Masonry Units.

Concrete masonry units shall be two-core units of modular dimensions and shall include all closers, jamb units, lintels, and special shapes of the required sizes to complete the work as indicated. Units shall conform to ASTM Standard C 90, Type I, Grade N-I or S-I. Units shall be delivered to the jobsite in air-dry condition and shall conform to linear shrinkage potential tests as stipulated in ASTM C426. Grade N-I shall be used for exterior walls; either Grade N-I or S-I, at the option of the Constructor, shall be used for all other work. Exposed-to-view or painted units in any one building shall be of the same appearance, and shall be cured by the same process. Units shall be free of any deleterious matter that will stain plaster or corrode metal and shall weigh not less than 105 pounds per cubic foot.

3.4.5 Grout.

Grout shall conform to ASTM Standard C 476 except as modified hereinafter. Grout shall be classified as fine; low-lift, or high-lift type. The aggregate shall be as specified in the Paragraph 3.4.2. Grout shall attain a minimum ultimate compressive strength in 28 days of 2,000 pounds per square inch. When used in the work, grout shall be mixed in the laboratory-established proportions which shall include the water content necessary to obtain the consistency required for use in the work. The low-lift grout mixtures shall be designed to have water content which shall give a pouring consistency with a slump of approximately 5 inches, without segregation of the constituents. When placement is by the high-lift method, the grout shall be mixed in the laboratory-established proportions which shall include fluidifier and water content necessary to obtain a slump of approximately 11 inches, suitable for pumping without segregation of the constituents. Adjustments in the cement content shall be made to ensure that the grout meets the minimum ultimate compressive strength. Prior to use the Constructor shall furnish a certified copy of the laboratory-established proportions and tests for approval as evidence that the grout used in the work meets the requirements specified herein. No change in the laboratory-established proportions shall be made nor shall materials with different physical or chemical characteristics be utilized in grout used in the construction unless the Constructor furnishes additional evidence that such grout meets the requirements as specified herein and receives permission to use by the COR.

3.4.6 Mortar.

Mortar shall conform to ASTM Standard C 476 except as modified herein-after. The aggregate shall be as specified in Paragraph 3.4.2. When tested for compressive strength, the water-retention requirements for mortar stipulated in ASTM C 476 shall apply. The mortar shall obtain a minimum ultimate compressive strength in 28 days of 2,000 pounds per square inch. When used in the work, mortar shall be mixed in the laboratory-established proportions with water as may be necessary to produce the workability desired regardless of initial flow. Prior to use the Constructor shall furnish a certified copy of the laboratory-established proportions and tests for approval as evidence that the mortar used in the work meets the requirements as specified herein. No change in the laboratory-established proportions shall be made nor shall materials with different physical or chemical characteristics be utilized in mortar used in the work unless the Constructor furnishes additional evidence that such mortar meets the requirements as specified herein.

3.4.7 Precast Concrete Trim Items.

Precast concrete trim items, unless otherwise shown on drawings, shall consist of 3,000 psi concrete using a 1/2 inch to No. 4 nominal size coarse aggregate and reinforced with not less than two No. 4 bars. Precast units shall have beds and joints at right angles to the face with sharp true arrises, and shall have drip grooves on underside where units overhang the walls. Copings and sills shall have drips cut on the undersides. Sills shall be cast with necessary anchors and/or openings for anchorage of sash. Sills for windows having mullions shall be cast in sections with head joints at mullions and 1/4-inch allowance for mortar joints. The ends, except a 3/4-inch wide margin at exposed surfaces, shall be roughened for bond. Exposed-to-view surfaces shall have smooth finish, free of pits, honeycomb, aggregate pockets, or other blemishes. Unless precast-trim items have been subjected during manufacture to saturated-steam pressure of 120 pounds or more per square inch for 5 hours or more, the trim items shall, after casting, be either damp-cured for a minimum of 24 hours or steam-treated and shall then be aged under cover for a minimum of 28 days. Prior to use, each trim item shall be wetted and inspected for crazing. Trim items that show evidence of dusting, excessive crazing, or having surfaces treated with silicone or other protective coating will be rejected. Precast concrete members weighing over 80 pounds shall have built-in loops of galvanized wire or other approved provisions for lifting and anchoring. Subject to approval by the COR, salvaged window sills may be reused.

3.4.8 Reinforcing Steel Bars.

Reinforcing steel bars shall conform to ASTM A 615, Grade 40 or Grade 60 as indicated on the drawing. All bars shall be deformed unless otherwise shown on the drawing.

3.4.9 Waterstops.

Waterstops for control joints may be composed of natural rubber, a suitable synthetic rubber, a blend of natural and synthetic rubber, or of polyvinylchloride and shall be of the shape and dimension shown on the drawings. Splices in the continuity of rubber waterstops shall be vulcanized and in runs of polyvinylchloride splices shall be performed by heat sealing.

3.5 HANDLING AND STORAGE.

Masonry materials shall be stored in a manner that will protect them to avoid chipping, breakage, etc., and from contact with soil and exposure to the elements.

3.6 ERECTION

3.6.1 General.

Masonry shall not be erected when the ambient temperature is below 40° F. except by written permission of the COR. No frozen work shall be built upon. No masonry unit having a film of water or frost on its surface shall be laid in the walls. Masonry shall be protected from freezing for 48 hours after being laid. Masonry erected during arid weather when the ambient temperature is more than 99° F. in the shade and the relative humidity is less than 50 percent shall be protected from direct exposure to wind and sun for 48 hours after installation. Masonry shall be laid plumb, true to line, with level courses accurately spaced and, unless otherwise shown, with all courses laid with the vertical joints of one course falling midway between those of adjacent courses. Vertical cells to be filled with grout shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical core. Each unit may be adjusted to its final position in the wall while mortar is still soft and plastic. Any unit which is disturbed after mortar has stiffened shall be removed and relaid with fresh mortar. Bond pattern shall be kept plumb throughout. Corners and reveals shall be plumb and true. Vertical joints shall be of the same width except for inconspicuous variations required to maintain the bond pattern. The sizes of any two adjacent units shall be selected within permitted tolerances so that the difference between the vertical faces of such units in exposed-to-view or painted walls or partitions as installed in habitable rooms and spaces shall not exceed 1/8-inch. The controlling alignment shall be on the exterior side of exterior walls and on the corridor side of corridor walls. Units in exposed-to-view or painted walls or partitions shall be free from chipped edges or other imperfections detracting from the appearance of the finished work.

3.6.1.1 Wetting Masonry Units. Concrete masonry units shall not be wetted before laying.

3.6.1.2 Protection. Surfaces of masonry not being worked on shall be properly protected at all times during construction operations. At such

time as rain or snow is imminent and the work is discontinued, the tops of exposed masonry walls shall be covered with a strong waterproof membrane well secured in place. Adequate provisions shall be made during construction to prevent damage from wind and freezing.

3.6.1.3 Mortar that has stiffened because of chemical reaction of hydration shall not be used or retempered for use. Mortar shall be used and placed in final position within 2 1/2 hours after mixing. Mortar not used within this time interval shall be discarded.

3.6.1.4 Unfinished Work shall be stepped back for joining with new work; toothing may be resorted to only when approved by the COR. Before new work is started, all loose mortar shall be removed and the exposed joint shall be thoroughly cleaned.

3.6.1.5 Embedded Items. Spaces around metal door frames and other built-in items shall be solidly filled with grout or mortar. Anchors, wall plugs, accessories, reglets, flashings, and other items required to be built in with masonry shall be built in as the masonry work progresses. Cutting and fitting of masonry required to accommodate the work of others shall be done by qualified craftsmen with masonry saws. Anchor bolts, bearing plates, and other anchors shall be built into the walls at all points and in the manner indicated on the design or shop drawings. Cells which receive anchor bolts or support bearing plates shall be reinforced as shown on design drawings and filled solidly with grout.

3.6.1.6 Sills and Lintels shall be set with faces plumb and true in a full bed of mortar except that sills with lugs shall have mortar beds under the ends of the sill only. Sills shall be leveled and tapped into place on these beds. Upon completion of the walls, the remainder of the bed joint shall be filled solidly with mortar from front to back, and the exterior face of the mortar tooled smooth.

3.6.1.7 Mortar Joints on the weather side of exterior walls and on all exposed-to-view or painted interior walls and partition surfaces, except control joints, shall be tooled slightly concave with a device of as long as practicable and so that the mortar will be thoroughly compacted and pressed against the edges of the units. Tooling shall not be done until after the mortar has taken its initial set. All other face joints, except control joints, shall be cut off flush and not tooled. Chases and raked-out joints shall be kept free from mortar or other debris. The following joints on the weather side of exterior masonry walls shall be raked out 3/4-inch and left ready for calking: control joints, joints between metal frames and masonry, horizontal and vertical faces of joints where so indicated. Exposed mortar head and bed joints in masonry work shall have a thickness equal to the difference between the actual and nominal dimensions of the masonry in either height or length; but in no case shall the average width of any three adjacent joints vary by more than 1/8-inch. The width of all exposed mortar joints shall be approximately 3/8-inch.

3.6.1.8 Control Joints shall be provided in concrete-masonry construction in strict accordance with design details shown on the drawings. Control joints shall be constructed by using either special control-joint units, sash units, or open-end stretcher units, at the option of the Constructor, unless otherwise noted. Control joints shall be provided at the locations shown on the drawings. Structural bond beam at roof level shall not be broken at control joints. Dummy joints shall be formed in the continuous structural bond beams at control joint locations. On the exterior face of the wall, the control joint and dummy joint in bond beam should be raked to a depth of 3/4-inch and left ready for calking. Control joints and dummy bond beam joints on exposed-to-view or painted interior walls shall be raked to a depth of 1/4 inch and shall not be calked. Calking of control joints is specified under Section 7.

3.6.1.9 Placement of Reinforcing Steel. Bars, fabricated to shapes and dimensions shown on design drawings, shall be placed where indicated on the drawings or where required to carry out the intent of the drawings and these specifications. All reinforcement shall be, when surrounding grout is placed, free from loose, flaky rust and scale, and free from oil, grease, mortar, or other coating which might destroy or reduce its bond with the grout. Shop drawings for all reinforcing steel, when requested on the design drawings or by the COR, shall be furnished for approval of the COR. Unless otherwise indicated, the details of reinforcing steel shall conform to ACI 315. Reinforcing steel shall not be bent or straightened in a manner injurious to the steel. Bars with kinks or bends not shown on drawings shall not be used. The use of heat to bend or straighten reinforcing steel or welding of bars will be permitted only if the entire operation is approved by the COR. Placement of reinforcement shall be inspected and approval received from the COR prior to placing grout.

Bars shall be lapped a minimum of 40 diameters or 2 feet, whichever is greater. Lapped ends of bar shall be placed in contact and securely wired together with 18-gage black annealed wire. Splices shall be located as shown on approved shop drawings. Reinforcing steel shall not be spliced at points of maximum stress. At points of critical stress, splices in adjacent bars shall be staggered.

Reinforcing steel shall be accurately centered in the masonry cells and securely held in place by means of metal or concrete supports, centering-clips, spacers, ties, or caging-devices adequate to prevent displacement during the course of construction. Such supports shall be of sufficient strength to maintain the reinforcement in place throughout the grouting operation. Dowels or bars extending from concrete shall be positioned to locate vertical wall reinforcement on center line of wall, unless otherwise indicated. Vertical bars shall be fixed in position at the top and bottom, and at intermediate intervals not exceeding 160 diameters of the bar. The minimum clearance distance between parallel bars shall be not less than 1 1/2 times the diameter of the bar. The minimum clear distance between masonry units and reinforcing bars shall be 1/2 inch. Column and pilaster ties shall be wired in position around the vertical steel; laying ties in mortar joints will not be allowed. The position of bars

shall be as shown on the approved design or shop drawings within tolerances shown in the following table:

CONSTRUCTION TOLERANCE FOR PLACING WALL REINFORCEMENT

(1) Variation in transverse position	1/2-inch
(2) Variation from longitudinal position	2-inch
(3) Variation from vertical position	1-inch

Bond beams shall be reinforced with two No. 4 bars, unless otherwise indicated on the design or shop drawings. Bars shall be continuous in exterior wall bond beams at roof level; bar splices shall be staggered. Bars in intermediate bond beams shall be discontinuous at control joints. Bond beam at roof level shall be anchored to roof construction as indicated on the drawings.

Lintels shall be reinforced with two No. 4 bars when span of lintel is less than 6 feet or two No. 5 bars where span exceeds 6 feet unless otherwise indicated on drawings. Bars shall extend 40-bar diameters or 2 feet, whichever is greater, beyond each face of opening. Steel stirrups shall be provided when indicated on the approved design or shop drawing.

All walls and partitions shall be reinforced with both vertical and horizontal bars. Reinforcement shall be as shown on the shop drawing. When not shown, minimum vertical reinforcement shall be one No. 5 at 32 inches o.c. As part of the minimum reinforcement, vertical reinforcements shall be provided at corners, anchored intersections, and control joints. All vertical bars shall extend floor to roof levels.

Provide two No. 4 bars or one No. 5, on all sides of every opening which measures 2 feet in either direction. Such extra perimeter bars shall extend not less than 40-bar diameters or 24 inches, whichever is greater, beyond the corners of the opening. Where opening exceeds 6 feet horizontally or 8 feet vertically, reinforcement shall be two No. 5 bars and shall extend from floor to roof level. The bars required above shall be in addition to minimum reinforcement except over openings where the total combined depth of lintel and bond beam is not less than 16 inches (i.e., where a bond beam is immediately above a lintel). The additional perimeter reinforcement at openings shall be located in the nearest cavity that does not contain other required reinforcement.

Additional vertical reinforcement shall be installed at corners, anchored intersections, control joints, and end of wall panels. Provide vertical reinforcement so that a total of at least two reinforced cells are adjacent to external corners, on each side of control joints, at the end of each wall panel, and at the junction of an intersected wall which is anchored to the intersecting wall. The vertical reinforcement at each location shall be one deformed No. 5 bar, and shall extend from floor to roof level.

3.6.1.10 Bond and Anchorage. Unless otherwise indicated, each tier of masonry unit shall be laid in straight, even courses with the joints in

the successive course above breaking halfway between the joints of the next course below. Each course shall be masonry bonded at corners. Intersecting walls and partitions shall be anchored by continuous reinforcing bars, except where otherwise indicated.

3.6.1.11 Bond Beams in Grouted Core Hollow Unit Masonry Construction shall consist of bond beam units filled with grout and reinforced as indicated. When open-bottom bond beam units are used, wire mesh, small mesh expanded metal lath, or other approved material shall be placed in the mortar joint immediately under each bond beam course, except at vertical cores which are to be grouted, in order to cover and prevent filling of the unreinforced vertical cores below.

3.6.1.12 Lintel Beams in hollow unit masonry construction, unless otherwise indicated, shall be constructed of U-shaped units, reinforced as indicated and filled solidly with grout. Lintels shall extend at least 24 inches beyond each face of the opening with open-bottom cells over reinforced vertical cells. Lintels shall be of a depth equal to the wall thickness, unless otherwise indicated, but not less than 8 inches in depth.

3.6.1.13 Concrete Surfaces which are to receive or to be in contact with masonry shall be clean and damp, the laitance removed by sandblasting if necessary.

3.6.1.14 Cleanout Holes shall be provided at bottom of grout pours when in-place masonry exceeds 40 inches in height. Spacing of openings shall not exceed spacing of vertical reinforcement. Cleanout openings shall be of sufficient size and located to allow flushing away any mortar droppings and debris and for wiring bars lapped with dowels when vertical bars are placed after masonry is laid. In hollow-masonry construction, cleanout openings shall be a 4- by 4-inch cut from one face shell of each reinforced vertical core, or at the option of Constructor, an approved manufacturer's standard cleanout unit. Where all cells are to be grouted, the cleanout course shall be constructed with open-bottom bond beam units, inverted, to permit cleaning of all cells by flushing. Cleanout holes shall not be plugged until the masonry work, reinforcement, and final cleaning of grout spaces have been approved by the COR. Cleanout holes shall be plugged with material to match the surrounding masonry. A new series of cleanouts shall be established if grouting operations are stopped for a period longer than 4 hours.

3.6.1.15 Placement of Grout. Before commencing grouting operations, the Constructor shall notify the COR. Reinforcing bars shall be secured in position, inspected, and approved by the COR before grouting. Grout shall be poured by hand bucket, concrete hopper, or through a grout pump in such a manner as to completely fill the grout spaces without segregation of the ingredients. Immediately after deposit, the grout shall be thoroughly compacted by agitating in a manner approved by the COR. Tapping or other external vibration of the masonry or reinforcement will not be permitted.

The use of belt conveyers, chutes, or other similar equipment will not be permitted without written approval by the COR. Grout shall be handled from mixer to transport vehicle to place of final deposit in a continuous

manner, as rapidly as practicable, and without segregation or loss of ingredients until the approved unit of operation is completed. Where grout is conveyed and placed by pumping, the pump shall be such that a continuous stream of grout without air pockets is produced. When pumping is completed, grout to be used remaining in pipeline shall be ejected without contamination of grout or separation of ingredients. Each lift or pour shall be compacted by hand-spading and rodding with 1- by 2-inch wood tamping poles unless otherwise directed by the COR. Before each run, hardened grout, debris, and foreign materials shall be removed from inner surfaces of mixing and conveying equipment. After each run, equipment shall be thoroughly cleaned and waste material, debris, and flushing water shall be discharged outside the masonry.

Grout placed as laying of masonry progresses is classified as low-lift grouting. Height of any ungrouted masonry shall not exceed 24 inches. Grout shall be placed while mortar joints are still soft and plastic or the grout spaces shall be cleaned of mortar dropping and protruding mortar joints removed.

Grout placed after wall is laid higher than 24 inches is classified as high-lift grouting. Cleanout holes shall be provided at bottom of each grout lift. Placement of a grout lift shall be made at such rate that successive lifts (layers) in an individual pour unit shall be placed and consolidated while the preceding lift is still soft and plastic. The height of grout lift shall not exceed 4 feet.

The grout shall be handled from the mixer to the final place of deposit as rapidly as practicable. Grout shall be placed and consolidated before it has stiffened because of chemical reaction of hydration. Grout not used within time interval of 1 1/2 hours from time of water addition shall be discarded.

High-lift grouting shall not be poured until the mortar of the masonry work has been allowed to set for a minimum of 3 days in hot weather or 5 days in cold, damp weather, as determined by the COR. Grout shall first be poured to a height of one lift and rodded to thoroughly fill all voids, spaces, and interstices. After a waiting period, a second lift shall be poured to the same depth and all spaces again rodded. When consolidating the upper lift, permit the tamping poles to penetrate into the preceding lift 12- to 18 inches to reconsolidate and make the two lifts monolithic. The waiting period between placement of lifts, 15 to 60 minutes, will depend upon type of construction, type of units, spacing of wall ties, height of lifts, and weather conditions. The rate of lift placement shall be controlled within limits which will avoid either hydrostatic blowouts or formation of cold joints. Repeat the waiting, pouring, and rodding steps until the top of the wall is reached. The top lift shall also be reconsolidated after a waiting period. At end of each workday, the grout shall be stopped 1 1/2-inch (+ 1/2-inch) below top of uppermost in-place masonry unit, except lift at top of wall shall be carried to top of masonry units. Pours in columns, pilasters, grouted cores, or other vertical members shall terminate at the underside of the

deepest horizontal member framing thereto. For keying, the grout pour shall be stopped at least 1 1/2 inches below top of upper masonry course. Vertical members shall be poured at least 2 hours before any horizontal overhead work is placed thereon. Grout in bond beams, lintels, and other grouted horizontal spaces shall be placed continuously so that pour of the member will be monolithic. Spacing of vertical construction joints in continuous members shall not exceed 50 feet or control-joint spacing, whichever is less, unless approved by the COR. At least 48 hours shall elapse between the pouring of adjoining sections, unless this requirement is waived by the COR. Reinforcing bars splashed with grout shall be recleaned in advance of placing subsequent grout pours. Placement of grout will not be permitted when the sun, heat, wind, or limitations of facilities furnished by the Constructor prevent proper placement and curing of the grout.

Walls shall be braced against wind and other forces during construction. If blowouts, misalignment, or cracking of face-shells should occur during construction, the wall shall be torn down and rebuilt. The high-lift grouting of any section of wall between lateral flow barriers shall be completed to the top in one working day unless a new series of cleanout holes are established and the resulting horizontal construction joint cleaned.

3.6.1.16 Cleaning of Wall Surfaces. Immediately after the grout work is completed, the exposed masonry faces shall be washed down thoroughly with a pressure stream of water through a jet nozzle to remove any scum or stains. Subsequent cleaning may be necessary as the curing takes place.

3.6.1.17 Curing. Attention shall be given to proper curing of the mortar joints as well as the grout. The masonry work and top of grout pour shall be protected from freezing and direct exposure to drying effects of sun and wind for 48 hours after installation.

3.7 CERTIFICATES.

The Constructor shall furnish certificates in accordance with the requirements of the design drawing, prior to delivery of the materials to the project site. Each certificate shall be signed by an authorized officer of the manufacturing company and shall contain the name and address of the Constructor, the project location, and the quantity, the quality, and date or dates of shipment or delivery of the material to which the certificate applies. Concrete masonry units shall be certified for compliance with all specification requirements. Aggregate for concrete masonry units shall be certified for compliance with specification requirements for nonstaining and popout properties. Mill certificates of test on bar steel shall be provided.

3.8 TESTS.

3.8.1 For Drying Shrinkage.

Sampling and testing to determine the linear shrinkage potential of concrete masonry units shall be done at the expense of the Constructor by an approved commercial testing laboratory not more than three months nor less than two weeks before delivery of units to the project site. Three copies of such tests shall be signed by the testing laboratory and counter-signed by the Contractor and shall be submitted to the COR at least 10 days before delivery of units to the project site. No change in manufacturing processes and techniques or in drying and curing procedures shall be made nor shall materials with different physical or chemical characteristics be used in units delivered to the project site unless the Contractor verifies the linear shrinkage potential by additional signed test reports.

3.8.2 Samples for Testing.

A sample of five individual and whole units representative of the manufacturer's product whose units are proposed for use shall be selected after cooling and/or curing at the point of manufacture. Sample units shall prove under test to be free from cracks or other structural defects, and to have been manufactured with the same type and quality of aggregate, and cured and dried by the same procedures as those to be employed in producing units for use in the work. Units previously subjected to tests involving temperatures exceeding 150° F. shall not be used in dryingshrinkage tests. Testing shall be done in accordance with ASTM Standard C 426.

SECTION 4

STRUCTURAL STEEL AND MISCELLANEOUS METALWORK

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SECTION 4

STRUCTURAL STEEL AND MISCELLANEOUS METALWORK

4.1 GENERAL.

The work covered in this section includes structural steel and miscellaneous metalwork requirements for buildings and structures as shown and noted on the drawings.

4.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

4.2.1 American Institute of Steel Construction (AISC):

Code of Standard Practice for Steel Buildings and Bridges

Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings

4.2.2 American Society for Testing and Materials (ASTM):

A 36	Standard Specifications for Structural Steel
A 48	Gray Iron Castings
A 242	High-Strength Low-Alloy Structural Steel
A 283	Low and Intermediate Tensile Strength Carbon-Steel Plates of Structural Quality
A 663	Merchant Quality Hot-Rolled Carbon Steel Bars subject to Mechanical Property Requirements
A 307	Carbon Steel Externally and Internally Threaded Standard Fasteners
A 325 or A490	High Strength Bolts for Structural Steel Joints Including Suitable Nuts and Plain Hardened Washers
A 354	Quenched and Tempered Alloy Steel Bolts, Studs and other Externally Threaded Fasteners
A 440	High-Strength Structural Steel
A 441	High-Strength Low-Alloy Structural Manganese Vanadium Steel

- A 502 Steel Strucutural Rivets
- A 537 Pressure Vessel Plates, Heat Treated, Carbon-Manganese-Silicon
- B 209 Aluminum-Alloy Sheet and Plate
- B 308 Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded

4.2.3 American Welding Society (AWS):

- D1.1 Structural Welding Code in Building Construction

4.2.4 American National Standards Institute (ANSI):

- B27.2 Plain Washers

4.2.5 International Conference of Building Officials:

Uniform Building Code (UBC)

4.2.6 Military Specifications:

MIL-S-16216H Steel Plate (HY-80, HY-100)

MIL-S-8699A Steel Bars (4330)

4.3 DESIGN.

The design of members and connections for any portions of the structures or miscellaneous metalwork not indicated on the drawings shall be submitted by the Constructor for the approval of the Contracting Officer's Representative (COR), before any material is fabricated. Such design shall conform to the requirements of the current issue of the "Specification for the Design, Fabrication, and Erection of Structural Steel Buildings" of the AISC. Drawings showing such designs shall be comparable in extent of information and detail to the project drawings. No changes or modifications shall be made without prior approval of the COR.

4.4 WORKMANSHIP.

The current rules and practices set forth in the latest edition of the "Code of Standard Practice for Steel Buildings and Bridges" and the "Specifications for the Design, Fabrication, and Erection of Structural Steel Buildings" of the AISC shall govern this work, except as otherwise noted on the drawings or as otherwise specified. Welding shall be in accordance with D1.1 "Structural Code for Welding in Building Construction" of the AWS.

4.4.1 Shop Drawings.

The Constructor shall submit shop drawings prior to procurement to the COR. The COR will retain three copies of each drawing submitted and return the remainder of the copies to the Constructor. Fabrication of structural steelwork and miscellaneous metalwork shall not be started prior to receipt by the Constructor of the approved shop drawings.

4.4.2 Mill Reports.

The Constructor, when required to provide for material traceability, shall furnish two certified copies of all mill reports covering the chemical and physical properties of the steel to be used in the work shown on the drawings.

4.4.3 Substitutions.

Substitutions of sections, or modifications of details, or both, shall be made only when approved by the COR.

4.4.4 Templates.

The Constructor shall have available at the site of the work all necessary templates and instructions for the setting of anchors, bearing plates, and other items, and shall ascertain that the items are properly set during the progress of the work. Shop drawings which effect anchor patterns shall be approved prior to concreting anchors in place.

4.4.5 Connections.

Connections shall be as shown on the drawings. When details are not shown, the connections shall conform to the requirements for applicable AISC standard connections. One-sided or other types of eccentric connections will not be permitted unless shown in detail on the drawings.

4.4.5.1 Field Connections. Unless otherwise indicated on the drawings, field connections shall be in accordance with the requirements of the AISC specification. No combination of rivets and bolts and/or welds shall be used in the same face of any connection.

4.4.5.2 Welded Connections will be permitted only as indicated on the drawings or as specifically authorized by the COR.

4.4.6 Holes.

Holes shall not be made or enlarged by burning, nor will the burning of unfair holes in the shop or field be acceptable. Holes shall be provided in members to permit connecting of other work to the structure, as shown on the drawings or approved by the COR.

4.4.7 Column Bases.

Column bases shall conform to the AISC specifications unless otherwise indicated on drawings or authorized by the COR.

4.4.8 Camber.

Camber shall conform to the AISC specifications unless otherwise noted on drawings or authorized by the COR.

4.4.9 Draw.

Allowance shall be made for draw in all tension bracing.

4.5 MATERIALS.

Materials, including structural steel, steel plate, metal pipe, bolts, nuts, rivets, washers, weld metal, and other items to be used in the work shall be of the type, grade, class, and sizes shown on the drawings and shall meet the requirements of the applicable publications included above.

4.6 ERECTION.

4.6.1 Driftpins.

Driftpins may be used only to bring together the several parts; they shall not be used in such manner as to distort or damage the metal.

4.6.2 Gas Cutting.

The use of a gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Its use will be permitted on secondary members when the member is not under stress and then only with the approval of the COR.

4.6.3 Base Plates and Bearing Plates.

Column base plates and large bearing plates shall be supported on steel wedges, anchor bolt nuts, or shims until the supported members have been plumbed following which the entire bearing area shall be grouted solid with grout containing equal parts of Portland cement and sand, or a commercial product approved by the COR.

4.6.4 Torque Wrenches.

Torque wrenches shall be calibrated when high-strength bolts are used or where specified torque limits are specified.

4.7 PAINING.

Unless otherwise noted on the drawings, steel for structures and miscellaneous metalwork shall be shop primed with one coat of zinc chromate base paint, or approved equal.

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SECTION 5
PREFABRICATED METAL BUILDINGS

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SECTION 5

PREFABRICATED METAL BUILDINGS

5.1 GENERAL.

The work covered in this section includes the design, fabrication, and erection of preengineered, prefabricated metal buildings as shown and noted on the drawings.

5.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

5.2.1 American Institute of Steel Construction (AISC):

Code of Standard Practice for Steel Buildings and Bridges

Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings

5.2.2 American Iron and Steel Institute (AISI):

Specifications for the Design of Light Gage Cold-Formed Steel Structural Members

5.2.3 American National Standards Institute (ANSI):

B18.2.1 Square and Hex Bolts and Screws, Including Hex Cap Screws and Lag Screws

B18.2.2 Square and Hex Nuts

5.2.4 American Society for Testing and Materials (ASTM):

A 36 Structural Steel

A 283 Low and Intermediate Tensile Strength Carbon-Steel Plates of Structural Quality

A 663 Merchant Quality Hot-Rolled Carbon Steel Bars subject to Mechanical Property Requirements

A 675 Quenched and Tempered Alloy Steel Bolts, Studs and other Externally Threaded Fasteners

B 209 Aluminum-Alloy Sheet and Plate

E 84 Surface Burning Characteristics of Building Materials, Tests for

5.2.5 American Welding Society (AWS):

D1.1 Structural Welding Code

5.2.6 Factory Mutual Engineering Corporation (FM):

Approval Guide

5.2.7 Federal Specifications (FS):

QQ-S-775 Steel Sheets, Carbon, Zinc Coated

5.2.8 International Conference of Building Officials:

Uniform Building Code (UBC)

5.2.9 Underwriters' Laboratories, Inc., Publications (UL):

Building Materials Directory

5.2.10 National Fire Protection Association Standards (NFPA):

Standard 220 Standard Types of Building Construction

Standard 255 Method of Test of Surface Burning Characteristics of Building Materials.

5.2.11 U.S. Department of Labor

OSHA General Industry Standards Part 1910

OSHA Construction Standards Part 1926

5.3 SHOP DRAWINGS.

The Constructor shall submit shop drawings to the Contracting Officer's Representative (COR). The COR will retain three (3) copies of each drawing submitted, and return the remainder of the copies to the Constructor. Shop drawings shall include all design data, calculations, structural details, template requirements, and erection layout. No portion of the building shall be fabricated, nor shall any portion of the building be delivered to jobsite prior to approval of the shop drawings.

5.4 WORKMANSHIP.

The current rules and practices set forth in the "Code of Standard Practice for Steel Buildings and Bridges" and the "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings" of the AISC, and the "Specifications for the Design of Light Gage Cold-Formed Steel Structural Members" of the AISI shall govern this work, except as otherwise noted on the drawings or as otherwise specified. Welding shall be accomplished by the electric arc welding methods conforming to the requirements of D1.1 of the "Standard Code for Welding in Building Construction" of the AWS.

5.4.1 Substitutions.

Substitutions of structural members or modifications of details, or both, shall be made only approved by the COR.

5.4.2 Templates.

Templates, where required, shall be obtained by the Constructor in accordance with the shop drawings. The Constructor shall ascertain that the embedded items are properly set during the progress of the work.

5.4.3 Holes.

Holes shall not be made or enlarged by burning, nor will the burning of unfair holes in the shop be acceptable. Holes in base or bearing plates, if required, shall be drilled or gang-punched. Bolts and nuts shall be provided with washers.

5.5 MATERIALS.

Structural steel, aluminum structural shapes, sheet and plate, corrugated or fluted steel and aluminum roofing and siding, and other materials and supplies required in the work shall conform to the applicable standards and specifications listed above.

5.6 PREFABRICATED BUILDINGS.

Prefabricated buildings shall be of the nominal size, type, and of the materials indicated on the drawings, and shall be the standard product of the manufacturer. The buildings shall be designed to withstand the loading indicated on the drawings. The buildings furnished shall include all glazed windows, doors, complete hardware, and all connections and fasteners as required for a complete installation unless otherwise shown or noted on the drawings. Foundation concrete and anchors will not be placed until building designs have been approved.

5.6.1 Rigid Frames.

Rigid frames, where required, shall consist of steel columns and roof beams; complete with necessary splice members and plates for bolted field assembly.

5.6.1.1 All Base Plates, cap plates, splice plates, stiffener plates, and similar items as required, shall be shop-welded in place and shall have the proper bolt connection holes shop fabricated.

5.6.1.2 Columns and Roof Beams shall be shop-fabricated, complete with all necessary holes in webs and flanges for the attachment of secondary structural members and bracing in proper locations.

5.6.2 Corrugated or Fluted Sheet Coverings.

5.6.2.1 Aluminum Sheets. All exterior roof and wall sheathing below, shall be minimum .032-inch thickness. Sheets shall be a clad or prefinished alloy, of manufacturer's standard corrugated or fluted aluminum sheets (preference is in the order given). Sheets shall be accurately cut to proper size and shape.

5.6.2.2 Steel Sheets shall be the manufacturer's standard corrugated or fluted type of standard design to withstand wind load, and shall be tight-galvanized with not less than 3/4-ounce zinc coating per square foot on each side of sheets. Sheets shall be not less than 24-gage for roofing and siding.

5.6.3 Insulated Sandwich Panels.

Insulated sandwich panels, where required by the drawings, shall be installed on roof and walls of the building. Unfinished panels when specified shall be either galvanized steel or clad alloy aluminum. Prefinish panels, when specified, shall be cold-rolled steel, or aluminum with baked enamel finish, or primed if field-applied special finishes are specified on drawings. Interior and exterior faces of panels shall be not less than 24 gage for steel, not less than .032-inch thickness of aluminum. Panels shall be of the interlocking type and shall be furnished with a full-length gasket system to provide water- and dust-tight joints. All accessory items and fastening devices shall be provided with the panels. In addition to the above, all panels shall meet the following minimum requirements for the NTS:

5.6.3.1 Thermal Resistance. All panels used as building walls without additional insulating/finish materials shall have a minimum thermal resistance (R) values of $R=11$ expressed in BTU/HR/FT²/Degree F. All panels used as building roofs without additional insulation/finish materials shall have a minimum of $R=19$.

Panels having lesser thermal resistance may be used in conjunction with additional insulating and/or finishing materials as an assembly to satisfy above thermal resistance requirements, when calculated from air-to-air through wall section.

5.6.3.2 Fire Resistance General. All panels shall have been tested according to the "Method of Test of Surface Burning Characteristics", ASTM E-84.

Test shall have been performed by an approved nationally recognized testing laboratory and material shall have a flame spread rating not greater than 25, a fuel contributed rating not greater than 50 and a smoke developed rating not greater than 50.

5.6.3.3 Foam Plastic Sandwich Panels. In addition to the above tests all foam plastic sandwich wall or roof panels used in construction on the NTS must satisfy all requirements of headquarters, DOE Memo dated 12-6-76 titled "USE OF FOAMED PLASTICS IN CONSTRUCTION".

5.6.3.4 Available Panels. Metal faced panels insulated with both fiberglass and mineral (perlite) are available to satisfy all of the above requirements. No foam plastic panels to satisfy all of the above requirements have been identified as of this edition of these specifications.

5.6.4 Accessories for Sheet Coverings.

5.6.4.1 Flashings, closers, fillers, and similar items required to assure a water- and dust-tight installation shall be used with the sheets. Accessories shall be of the same basic materials as the sheets, shaped or formed as standard and recommended by the manufacturer of the sheets. Filler strips may be either premolded neoprene or rubber. Weather sealing compound shall be an extruded bead of nondrying, nontoxic, synthetic resin base and inert inorganic extenders. Sealing compound shall be provided on all lap connections at roof panels to ensure a weathertight and dust-resistant seal, and at all connections between dissimilar metals, and shall be applied in accordance with the manufacturer's written instructions.

5.6.4.2 Fasteners for Sheets shall be of the type designed for attachment of sheets to the structural members and shall be used in sufficient quantity to withstand the design load. Automatic end-welded steel fasteners or slot-steel threaded studs may be used at the option of the Constructor. All fasteners exposed to the weather shall be provided with combination metal and neoprene washers. Sheets may be welded directly to framing members where the COR has approved the construction procedure.

5.6.4.3 Wall and Roof Insulation, where required by the drawings, shall be flexible glass fiber, blanket-type insulation having a R-factor of 11.0 for walls, 19.0 for roofs, minimum. The insulation shall have a vapor barrier consisting of open mesh glass fiber scrim, reinforced aluminum foil, and kraft paper for enclosed attics or areas which are sheathed or similarly protected, or vinyl/scrim/foil for exposed surfaces or areas which may be subjected to moisture build-up. The vapor barrier shall face toward the interior of the building. Insulation shall be applied in accordance with the manufacturer's instructions. Insulation shall be UL-listed and/or FM-approved. Material shall have been tested according to the "Method of Test of Surface Burning Characteristics of Building Materials, ASTM No. E 84" (aka NFPA No. 255) (aka U.L. 723). Test shall have been performed by an approved nationally recognized testing laboratory and material shall have a flame spread rating not greater than 25, a fuel contributed rating not greater than 50, and a smoke developed rating not greater than 50. Exposed insulation in shop areas or in areas where damage may occur shall be protected as shown on the drawings.

5.6.5 Doors.

Doors shall be of the types and sizes indicated on the drawing and shall be provided with all operating and locking hardware standard of the

building manufacturer. Doors shall be fabricated from aluminum or galvanized steel flat sheet and extruded or rolled shapes. Doors, including swing doors, shall have dust- and weathertight closures at bottoms, and a complete system of weatherstripping. Weatherstrip and closures shall be of the heaviest duty commercial grade available as either a standard or an option of the manufacturer. Flashing shall be provided over door tracks and at other critical locations to assist in preventing wind-driven rain and dust from entering the building.

5.6.6 Shop Painting.

Unless otherwise noted on the drawings, steel framing and miscellaneous metalwork shall be shop-coated with zinc chromate primer prior to delivery to project. After erection, scarred areas, including welds, weld scars, bruises, and rust spots, shall be wire brushed and touch-up painted. Primer coated decking shall be touched up with galvanizing repair paint.

5.6.7 Shop Assembly.

The Constructor may be required to direct the manufacturer to demonstrate the accuracy of fabrication by pre-erection, without use of drifting or reaming, before acceptance. Shop assembly may be waived if the manufacturer can show evidence of trouble-free field erection of an identical structure fabricated with the use of existing jigs and templates.

5.7 ERECTION.

Shall be accomplished in accordance with the approved shop drawings and design drawings.

5.7.1 Framing.

Separate base and bearing plates shall be securely supported on wedges, anchor bolt nuts, shims, or other means and grouted to proper elevation before erecting the supported members. Attached base and bearing plates shall be supported on wedges or shims until the supported members have been plumbed or otherwise properly positioned, and then shall be grouted in place. Wrenches used for tightening high-strength bolts used for framing connections shall be checked daily for proper calibration to avoid tightening beyond yield points. Calibration of wrenches shall be in accordance with "Specifications for Assembly of Structural Joints Using High-Strength Steel Bolts," as approved by the Research Council on Riveted and Bolted Structural Joints Using High-Strength Steel Bolts.

5.7.2 Sheets.

Minimum end laps on all sheets shall be 6 inches and side laps shall be 1 1/2 corrugations. All sheathing shall be secured to structural framework with power actuated studs or approved fasteners at each third corrugation, using the Ramset stud welding method or approved equal. Where aluminum sheathing makes contact with the steel frame, provide protection for the aluminum sheets as specified under Section "Sheet Metalwork." Framing

members of the building framework such as girts and purlins that will support the fasteners for the roof and siding sheets shall be of sufficient thickness and strength to permit satisfactory welding of the powder actuated studs.

5.7.3 Wall Panels.

Wall panels at gable ends of the building shall be shop or field cut to match the slope of the roof. Cutting shall be accomplished by use of power saw or other approved means that will preclude damage to the wall panels. Wall panels at eaves and gables shall be sealed against the weather using premolded filler strips, flashing, and/or sealant. All joints and abutments shall be proven watertight when subjected to the water test specified below.

5.8 WATER TEST.

All exterior joints, laps, and door perimeters shall be water tested upon completion of building erection. Tests shall be accomplished by use of a hose with nozzle, similar to a fire hose with water pressure of between 40 and 60 psi. Leaks, if any, resulting from water tests, shall be repaired and made watertight in an approved manner and each repaired area shall be retested.

5.9 INSPECTION AT SITE.

Upon delivery to the site, the roof and wall sheets shall be closely inspected, and all damaged sheets shall be properly repaired, using materials and methods prescribed by the manufacturer of the sheets. Where, in the opinion of the COR, the damage is too extensive for satisfactory repair, the sheets shall be rejected. Rejected sheets shall be removed from the site and replaced with new sheets at no additional cost to the Government.

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SECTION 6

ROOFING

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SECTION 6

ROOFING

6.1 GENERAL.

The work covered in this section includes all labor, equipment and material necessary to install built-up asphalt roofing, Elastomeric-coated roofing, mineral-surfaced roofing, flashings, angle nosings, pitch pockets, and other items shown or noted on the drawings.

The use of polthrethane will be allowed only on approval by the Contracting Officer's Representative (COR).

6.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

6.2.1 American Society for Testing and Materials (ASTM):

- | | |
|------------------|---|
| A 525 | Steel Sheets, Zinc-Coated (Galvanized) |
| A 153 | Zinc-Coating (Hot-Dip) on Iron and Steel Hardware |
| A 177 | Chromium-Nickel Steel Sheet and Strip, High-Strength |
| C 208
Class C | Insulating Board (Cellulosic Fiber), Structural and Decorative,
Specification for |
| C 209 | Insulating Board (Cellulosic Fiber), Structural and Decorative,
Testing |
| C 610 | Expanded Perlite Block and Pipe Thermal Insulation |
| C 165 | Test for Compressive Strength of Preformed Block-Type Thermal
Insulation |
| D 41 | Primer for Use with Asphalt in Dampproofing and Waterproofing |
| D 224 | Smooth-Surfaced Asphalt Roll Roofing (Organic Felt), Specification
for |
| D 226 | Asphalt-Saturated Roofing Felt for Use in Waterproofing and
Constructing Built-Up Roofs |
| D 250 | Asphalt-Saturated Asbestos Felts for Use in Waterproofing and
in Constructing Built-Up Roofs |
| D 312 | Asphalt for Use in Constructing Built-Up Roof Coverings |

- D 412 Rubber Properties in Tension, Tests for
- D 471 Rubber Property-Effect of Liquids, Test for
- D 491 Asphalt Mastic for Use in Waterproofing
- D 1084 Tests for Viscosity of Adhesives
- D 1149 Test for Accelerated Ozone Cracking of Vulcanized Rubber
- D 1227 Asphalt-Base Emulsions for Use as Protective Coatings for Built-up Roofs
- D 2240 Rubber Property-Durometer Hardness, Test for
- E 96 Test for Water Vapor Transmission of Materials in Sheet Form
- E 108 Fire Test of Roof Coverings

6.2.2 Federal Specifications (FS):

- HH-I-526 Insulation Board, Thermal-Acoustical Mineral Wool (for Roofs)
- HH-I-551 Insulation Block, Pipe Covering, and Boards, Thermal (Cellular Glass)
- LLL-I-535 Insulation Board, Thermal, and Insulation Block; Thermal
- SS-C-153 Type I, Asphalt Plastic Cement (to perform without sag at 180° F. and with Quick drying solvents or plasticizers)
- TT-W-571 Wood Preservation - Treating Practices
- TT-W-572 Wood Preservatives - Water Repellent

6.2.3 Occupational Safety and Health Administration (OSHA):

Part 1910, Occupational Safety and Health Standards

6.2.4 Factory Mutual Engineering Corporation (FM):

Approval Guide - Loss Prevention Data

6.2.5 Underwriters' Laboratories (UL):

Building Materials Directory w/Supplements

6.3 PREPARATION OF SURFACES.

The roof-deck surface shall be dry, clean, and free from any projections. Vents and other items penetrating the roof shall be secured in position and prepared for flashing, and the entire roof deck completed before roofing is started.

6.4 BUILT-UP ROOFING.

6.4.1 General.

The Constructor shall have a competent foreman, on the job at all times, to directly supervise the roofing work. Rolls of roofing shall be delivered and stored on end, in properly protected piles and maintained at a temperature of not less than 50° F. for not less than 24 hours prior to laying. Properly protect insulation and other materials. The ambient temperature shall be at least 55° F. and rising prior to starting roofing.

Asphalt heating kettles, used by the Constructor, shall be equipped with suitable thermometers for determining the temperature of the asphalt. The 190° F. melt temperature asphalt shall be heated to the proper temperature, not to exceed 500° F. and shall be applied at a temperature up to 450° F. but not lower than 400° F. Workmen shall not walk on mopped surface when bitumen is in a sticky condition.

6.4.2 Materials.

6.4.2.1 Vapor Barrier - Metal Deck. A nonflammable membrane vapor barrier consisting of two layers of nonflammable special heavy-duty kraft paper, Grade 600, laminated together and reinforced with glass fibers shall be attached to the metal deck with a nonflammable, chlorinated solvent, rubber-base adhesive, Sisal Kraft - Division of St. Regis Paper Co. or an approved equal. The vapor barrier and adhesive are to be Underwriters' Laboratories (UL)- or Factory Mutual (FM)-approved, installed in accordance with manufacturer's recommendations for UL Construction No. 1 assembly. Install vapor barrier in a solid bed of adhesive as wide as the flutes and lapping edges and ends 4 inches. Lap on solid bearing surfaces and seal all laps. The vapor barrier membrane shall be extended 9 inches up or beyond eaves, rakes, and where joining existing insulation. This extension shall be turned back and over the insulation and sealed with the rubber-base adhesive.

6.4.2.2 Vapor Barrier - Concrete Deck. A vapor barrier shall be applied on the concrete deck. Prime concrete deck with asphalt primer applied at the rate of one gallon per square (100 square feet) and allow to dry twenty-four (24) hours minimum. Then apply a solid mopping of 25 pounds per square of hot asphalt and embed two plies of 15 pound asphalt-saturated felt. Lap each sheet 19 inches and solid mop each sheet and broom to assure complete embedment. The bottom layer of felt shall be extended 9 inches beyond eaves. This extension shall be turned back and over the board insulation and solidly mopped in hot asphalt.

6.4.2.3 Insulation. The insulation shall be a rigid board type, meeting all requirements of Factory Mutual Laboratories for Class I Roof Construction, thickness as shown on drawings, and minimum compressive strength of 35 psi. Insulation maybe expanded Perlite Roof Insulation, or J-M Fesco Board conforming to ASTM C610 of approved equal. On metal decks the insulation shall be attached to the vapor barrier by applying a 1/2-inch bead of the above adhesive at 6 inches O.C. in the opposite direction

to the deck flutes and at a rate of 1/2 gallon per square. Where insulation is applied over concrete deck set insulation in a mopping of 30 pounds per square of hot asphalt. Lay insulation boards in adhesive or asphalt and parallel with eave line, with joints broken, in moderate contact with the adjoining units without forcing, and cut to fit neatly against adjoining surfaces. Joints between insulation units shall not occur over the fluted openings in the steel deck. Cut insulation at vertical surfaces to allow not over 1/2-inch clearance. If necessary, use tapered edge strips to reduce height of roofing at eave edge. The insulation shall be kept dry at all times and shall be laid just before application of the roofing felts. No more insulation shall be laid than can be covered in one day. During inclement weather and at the end of each day's work exposed edges of the insulation shall be protected by cutoffs. Cutoffs shall be two layers of felt hot-mopped not less than 4 inches on completed work and extending out not less than 6 inches on the deck. Cutoffs shall be removed when work is resumed.

6.4.2.4 Base Sheet. Over insulation, a 15- or 20-pound asphalt-saturated and coated felt-base sheet will be used. Starting at the eave of the roof, mop a continuous coating of approximately 30 pounds per square of hot asphalt, into which, while hot, embed the base sheet.

Lap each ply 4 inches over preceding ply. Lap ends 6 inches and seal all laps with hot asphalt. Firmly broom each ply to assure complete embedment, immediately back of the roll or machine, while asphalt is still hot.

At the eaves and expansion joints and between insulated roof and roof deck extend the base sheet 11 inches. After built-up roofing is installed turn the base sheet back and hot mop the top layer of felt.

6.4.2.5 Asphalt Felt. Three plies of 15- or 20-pound asphalt felts shall be laid shingle fashion immediately behind the mop coat and shall be free of all wrinkles or buckles. The three layers of felt shall be lapped 24 1/2 inches leaving 11 1/2-inch exposure. The ends shall be lapped 4 inches with the end laps broken not less than three feet apart. The sheets shall be firmly pressed into the asphalt by brooming the felt surface with a stiff broom. Each layer shall be mopped solid and even with asphalt using not less than 25 pounds of asphalt per square for each layer, so that in no place shall felt touch felt. Each layer of felt shall be carried up cant strips or abutting vertical surfaces to bottom of reglet or a minimum of 4 inches above insulation, trimmed and secured by hot mopping. Nail top edge with concrete nails and tin caps 8 inches O.C. and seal nails and top edge of felts with a heavy coat of plastic cement.

Where new roofing ties into existing roofing the felts shall be lapped 30 inches until 18 inches of existing roofing has been covered.

No wrinkles, fishmouths, blisters, or nonadhered felts will be permitted.

6.4.2.6 Sheet Neoprene. The neoprene is to be either gray or black, field-cured, 1/16-inch thick, homogeneous, free from defects, containing no crude rubber or other synthetic or reclaimed rubber. Tensile strength 1800 psi minimum per ASTM D 412; elongation 450 percent minimum per ASTM D412; water absorption 3.5 percent maximum per ASTM D 471; Shore A durometer hardness 55 plus or minus 5 percent per ASTM D 2240; brittleness temperature minus 40° F. Ozone test shall be for 100 hours at 100° F. with 10 pphm Ozone in air and shall show no cracks per ASTM D 1149. "Gaco-flex Countourflash" or an approved equal.

6.4.2.7 Neoprene Adhesive, Flashing Compound, Thinner, Cleaners, and Tools: As recommended by the neoprene manufacturer.

6.4.2.8 Hypalon. Tensile strength 900 psi minimum per ASTM D 412; elongation 400 percent per ASTM D 412; water absorption by weight 4 percent maximum per ASTM D 471; moisture vapor transmission maximum 1 perm per ASTM E 96, solids content by weight 35 percent minimum per ASTM D 1084.

6.4.3 Cant Strips.

Install 4-inch fiber cant strips along all walls and equipment curbs. Set in a solid mopping of hot asphalt.

6.4.4 Expansion Joints.

An expansion joint shall be formed at all locations where indicated on the drawings. On each side of the expansion joint the bottom felt shall be turned back and solid mopped to the top sheet. Centered over the joint, install a 12-inch wide sheet of 1/16-inch thick neoprene in a full mopping of hot asphalt. Reinforce with two plies of 15-pound asphalt felt strips 8 and 10 inches wide solidly mopped over the neoprene edges. Lap ends of neoprene joints 6 inches and seal with neoprene adhesive. Apply a 1/4-inch filler of neoprene flashing compound along all lap edges. No wrinkles, fishmouths, blisters, or nonadhered felts will be permitted.

6.4.5 Neoprene Flashing or Counterflashing.

Sheet neoprene flashing or counterflashing shall be installed around all equipment curbs, duct penetrations, and along walls and parapets unless otherwise shown on the drawings.

6.4.5.1 Surface Preparation. All concrete surfaces to be covered with sheet neoprene are to be sandblasted or wire-brushed as required to remove paint, asphalt, or other deleterious materials to provide a smooth clean surface suitable to receive the sheet neoprene. Scrub the vertical wall surface with a stiff-bristle brush and the neoprene manufacturer's recommended detergent to remove any laitance or efflorescence. Flush the detergent from the surface and allow to dry.

At wall surfaces covered with corrugated metal siding the sheet neoprene is to be attached to the metal counterflashing at the base of the siding. The metal must be thoroughly cleaned or sandblasted to remove all paint and other deleterious materials. The metal is then to be cleaned and etched with the neoprene manufacturer's recommended mixture of detergent and acid chemical cleaner.

6.4.5.2 Application. Coat the concrete or metal surfaces, at least 5 inches above the top of the felts and the sheet neoprene, in the area to be cemented, with neoprene adhesive in a quantity to show good visible coverage. Allow both adhesive surfaces to dry a minimum of one hour and with no tacky surface to the touch of the back of the hand. Carefully and without stretching, install the sheet neoprene in a straight line parallel to the roof deck on the concrete wall or metal wall. Immediately use a "Stitcher" and "Roller" to assure positive adhesion. Lap ends of neoprene joints 6 inches. Seal with neoprene adhesive. Install a 1/4-inch fillet of neoprene flashing compound at the vertical raw edges of the sheet material and continuously along the top of the sheet at the wall. Allow sheet neoprene to extend down wall, over cant strip, and out onto the roof surface a minimum of 6 inches. Lift sheet neoprene and solidly mop roofing with 25 pounds per square of hot asphalt and firmly embed the neoprene. Reinforce the roof surface edge of the neoprene with two plies of 15-pound asphalt felts, 8 and 10 inches wide, embedded in solid mopping of hot asphalt and firmly and smoothly pressed into place.

6.4.5.3 Hypalon Coating. All exposed sheet neoprene, including that along the metal fascia, is to be painted with two coats of liquid hypalon applied at the rate of 3/4 gallon per square per coat.

6.4.6 Pitch Pockets.

Pitch pockets shall be installed around all equipment or duct supports, conduit penetrations, pipe supports, vents, or any other roof penetration unless roof jacks are indicated. Pitch pockets are to be fabricated of 24-gage galvanized metal with a 4-inch wide flange, a 3-inch high curb and to allow 2-inch clearance all around, all joints and corners to be fully soldered. Set flanges, in 1/8-inch thick layer of plastic cement and cover with two plies of 15-pound asbestos felts 8 and 10 inches wide and sealed with asphalt plastic cement onto the built-up roof. Fill pitch pockets with 1 inch of asphalt flashing compound "Asbestile" or approved equal. Fill balance of pockets with coal-tar plastic cement in accordance with FS SS-C-153, Type I.

6.4.7 Metal Eave Fascia or Metal Angle Nosings.

Cut metal as required to fit neatly around any penetrations. Metal fascia shall be secured over roofing to wood fascia or wood nailer with No. 8 x 3/4-inch sheet metal screws 2 inches above drip edge. Set flange of fascia or nosing in 1/8-inch thick layer of asphalt plastic cement. Lap ends 3 inches and seal laps with 1/4-inch thick layer of trowel grade neoprene flashing cement. Nail flange to wood nailer with 1 1/2-inch long annular threaded nails, "Stronghold" or approved equal.

Fully cement one layer of 1/16-inch thick sheet neoprene 8 inches wide onto metal flange with neoprene adhesive. Lap ends of neoprene joints 6 inches. Seal with neoprene adhesive. Lift sheet neoprene and solidly mop roofing with 25 pounds per square of hot asphalt and firmly embed neoprene. Reinforce back edge of neoprene with two plies of 15-pound asbestos felt 8 and 10 inches wide solidly mopped with 190° F asphalt.

6.4.8 Asphalt Emulsion Coating.

After all roofing and flashing is complete, coat the plies of clean felt with a prime coat of fibered clay type asphalt emulsion ASTM D 1227 thinned 20 percent with water at the rate of 1 gallon per square. Allow to dry and then to the same areas apply two coats (one in each direction) of full strength fibered clay type asphalt emulsion at the rate of 3 gallons per square per coat.

6.5 REFLECTIVE ROOF COATING.

Approximately eight months after completion of the built-up roof, apply Goodyear Flex-A-Roof with a roller in accordance with the manufacturer's recommendations. After four additional months wash (hose) down and brush all water and dust off roof. When dry apply Goodyear Triple Duty Aluminum coat with a roller in accordance with manufacturer's recommendations unless otherwise approved by the COR.

6.6 ELASTOMERIC ROOF COATING SYSTEM - CONCRETE OR PLYWOOD DECKS.

6.6.1 General.

The applicator must be thoroughly experienced in the application of elastomeric roofing and be approved by the elastomeric manufacturer or must have a manufacturer's representative on the job during the application.

6.6.2 Preparation.

The surface of the concrete or plywood roof deck shall be dry and free from grease, oil, paint, asphalt, projections, depressions, loose scale, cement laitances, sand, curing compounds and other foreign deposits. Construction work on the roof shall be completed and drains, ducts and other roof penetrations installed.

After concrete has cured, the deck shall be allowed to dry for 2 to 4 weeks before coating. If rain occurs after the drying period and prior to application of the primer, allow at least two days of good drying weather. Work will not be started when precipitation threatens or when the temperature is under 40° F.

6.6.3 URETHANE RUBBER COATING SYSTEM

6.6.3.1 Materials.

6.6.3.1.1 Primer-Sealer. Plywood surfaces do not require a primer. Metal surfaces shall be primed with Gacoflex E-5320 Primer, and concrete surfaces shall be sealed with Gacoflex E-5321 except under conditions of heavy traffic or standing water E-5320 will be substituted.

6.6.3.1.2 Urethane. Liquid Urethane rubber coatings shall meet the requirements for Class A rating on noncombustible substrates when tested under ASTM E-108. The Urethane coating shall be Gacoflex U-66 Series.

6.6.3.1.3 Sheet Neoprene. Same as paragraph 6.4.2.6.

6.6.3.1.4 Other Materials. Thinner and cleaner, expansion joint covers, reinforcing materials, caulking and flashing compounds as required shall be supplied by Gaco Western Inc. or approved equal.

6.6.3.2 Application.

6.6.3.2.1 General. Materials shall be stored until time of mixing at temperature above 50° F. to maintain a consistency suitable for mixing. Prior to and during application, all dirt and dust shall be removed from surfaces either by vacuuming, sweeping, blowing with compressed air, or similar methods. All materials shall be mixed, thinned, modified, and applied in accordance with those specifications and the manufacturer's recommendations.

6.6.3.2.2 Primer-Sealer. Apply one coat of Gacoflex E-5321 Primer-Sealer to concrete surface at the rate of 3/4 gallon per 100 square feet. The primer-sealer coat shall be applied by roller or spray application. The normal minimum surface temperature for application of E-5321 is 55° F. Surface temperature is more important than air temperature. When the surface is cooler than 55° F., follow recommended manufacturer's instructions. Allow the following time for cure of primer-sealer before over coating:

Maximum daily temperature

70° F. and above	2 days
60° F.	4 days
50° F.	7 days

6.6.3.2.3 Sheet Neoprene Flashing (Gacoflex Contour Flash or Equal). Install a minimum 12 inch wide strip of 1/16 inch black Contourflash at all junctions of roof deck and walls, protrusions, vents, drains, skylights etc.. All flashing shall extend a minimum of 6 inches above the finished roof elevation. Lap joints in flashings shall be a minimum of 6 inches. Coat both the curb wall and the roof surface, where the flashing is to be installed, with neoprene adhesive in a quantity to show good visible coverage. Also coat the neoprene with the adhesive. Allow both adhesive surfaces to dry a minimum of one hour and with no tacky surface to the touch of the back of the hand. Carefully position the Contourflash, pressing firmly into place, and working it neatly and uniformly at the junction of vertical surface and roof deck, corners, curbs etc., without stretching in any direction. Do not move Contourflash after initial contact is made. Roll and stitch the Contourflash to obtain positive contact to the substrate and to remove any air bubbles or fishmouths that might be present. The exposed edge of all flashing shall be sealed after installation with a 1/4 inch fillet bead of Gacoflex AS-3 sealant.

Around the base of all roof penetrations, handrails, and pipe conduits, concrete anchors, anchor bolts, etc., install a 1/4-inch thick layer of neoprene flashing compound. Allow compound to cure and shrink and then recoat to assure a complete covering at these critical joints.

6.6.3.2.4 Construction Joints Centered over the joints, install a 12-inch wide sheet of 1/16-inch thick neoprene. Coat a 6-inch wide strip of deck on each side of the construction joint with neoprene adhesive in a quantity to show good visible coverage. Also coat the sheet neoprene with the adhesive. Allow adhesive surfaces to dry a minimum of one hour and with no tacky surface to the touch of the back of the hand. Carefully and without stretching install the sheet neoprene in a straight line parallel to the construction joint. Immediately use a "Stitcher" and "Roller" to assure positive adhesion unless otherwise shown on the drawings. Lap ends of neoprene joints 6 inches. Seal with neoprene adhesive. Install a 1/4-inch fillet of trowel grade neoprene flashing compound along all edges and at all laps of sheet neoprene.

6.6.3.2.5 Urethane Coating. Apply Urethane coating in two coats (alternate colors-white and gray) to secure a coverage of 1 gallon per 100 square feet per coat (16 mils wet film thickness each). The minimum over-all dry film thickness of the completed roof membrane will be not less than 18 mils with an average thickness of approximately 20 mils.

6.6.4 NEOPRENE-HYPALON COATING SYSTEM.

6.6.4.1 Materials.

6.6.4.1.1 Sheet Neoprene. Same as Paragraph 6.4.2.6.

6.6.4.1.2 Neoprene Roof Coating shall be Gacoflex N-100 Series. Use alternating colors.

6.6.4.1.3 Hypalon Roof Coating shall be Gacoflex H-22 Series.

6.6.4.1.4 Other Material. Primer, thinner and cleaner, expansion joint covers, reinforcing materials, granules, caulking and flashing compounds as required shall be supplied by Gaco Western Inc. or approved equal.

6.6.4.2 Application.

6.6.4.2.1 General. All materials shall be mixed, thinned, modified, and applied in accordance with these specifications and the manufacturer's recommendations.

6.6.4.2.2 Priming. Concrete surfaces shall be primed and sealed with Gacoflex E-5320 Primer-Sealer applied per Paragraph 6.6.3.2.2. Plywood surfaces shall be primed with Gacoflex N-1105 and galvanized metal shall be primed with Gacoflex N-11R. All primers shall be applied per manufacturer's instructions.

6.6.4.2.3 Sheet Neoprene Flashing. Same as paragraph 6.6.3.2.3 except Contourflash shall be gray in color and in addition all Contourflash shall be top coated with two coats of liquid Hypalon color coat at the same time as the remaining roof area is coated.

6.6.4.2.4 Construction Joints. Same as Paragraph 6.6.3.2.4.

6.6.4.2.5 Neoprene Coating. Apply neoprene coating in sufficient coats to secure a total minimum coverage of 3 gallons per 100 square feet (Total wet film thickness-48 mils). The total dry film thickness will be not less than 11 mils and will average not less than 12 mils.

6.6.4.2.6 Hypalon Coatings. Apply Hypalon coating in two coats in a wet film thickness of 16 mils per coat. Use not less than 1 gallon per 100 square feet for each coat. The minimum over-all dry film thickness of the completed roof membrane will be not less than 18 mils with an average thickness of approximately 20 mils.

6.7 SMOOTH SURFACE ROOL ROOFING (WOOD DECKS ONLY):

Material shall consist of asphalt roofing, 36 inches wide, composed of roofing felt saturated and coated on both sides with asphalt and surfaced on the weather side with powdered talc or mica. Field-applied gravel surfacing will not be acceptable. Unless otherwise indicated on the drawings, material shall be 90 pounds per square. Rolls shall be either 108 or 216 square feet. Lap cement shall be asphalt mastic. Nails shall be annular thread, galvanized roofing nails. Application to roof decks shall be in accordance with the manufacturer's instructions.

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SECTION 7
CALKING AND SEALING

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SECTION 7

CALKING AND SEALING

7.1 GENERAL.

This section covers calking and sealing applied in exterior joints around frames built into exterior walls, control, construction, and expansion joints in concrete or masonry, and wherever else indicated on the drawings or required to make a tight joint between materials.

7.2 APPLICABLE PUBLICATIONS.

The latest issue of the following publication, including revisions and amendments, form a part of this specification:

Federal Specifications (FS);

TT-S-00230 Sealing Compound: Elastomeric Type, Single Component.

7.3 MATERIALS.

7.3.1 Calking Compound.

Calking compound shall be a one-part polysulfide base (Thiokol) calking compound, of standard gray color, heavy type for vertical application, type "PRC Rubber Calk 5000" as manufactured by Products Research Company, Tremco "Mono-Lasta-Meri-," or approved equal. Calking compound shall be used as packaged by the manufacturer for calking gun application.

7.3.2 Primer.

Primer shall be "PRC Primer No. 1," or approved equal, used in accordance with manufacturer's written instructions.

7.4 PREPARATION.

All surfaces to receive calking compound shall be dry and thoroughly clean of all loose particles, dirt, loose paint, foreign matter, and curing compound. Surfaces shall then be primed with one coat of Primer No. 1 applied by brush in a thin coat to avoid running and to obtain 100 percent surface coverage. Allow primer to dry at least 15 minutes before applying calking compound.

7.5 APPLICATION.

Calking compound shall be applied with gun, using a nozzle of proper size to fit the joint width, and shall be forced into joints with sufficient pressure to expel all air and fill the joints solidly to a minimum depth of 3/8 inch. Calking shall be uniformly smooth and free of wrinkles, and unless otherwise noted, shall be left sufficiently convex to result

in a flush joint when dry. Calking around openings shall include the entire perimeter of each opening. Do not apply calking compound unless the ambient temperature is above 40^o F. and rising.

7.6 SPECIAL REQUIREMENTS.

For special calking and sealing requirements, see other section of these specifications and the drawings.

7.7 CLEANING.

Upon completion of calking, all smears resulting from calking operations shall be removed using solvents as recommended by calking manufacturers, or approved equal.

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SECTION 8
SHEET METALWORK

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SECTION 8

SHEET METALWORK

8.1 GENERAL.

This section covers sheet metalwork requirements for roofing items and miscellaneous items shown and noted on the drawings. Ductwork is included under Section 22.

8.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

8.2.1 American Society for Testing and Materials (ASTM);

A 153	Zinc coating (Hot Dip) on Iron and Steel Hardware
A 177	High-Strength Stainless and Heat Resisting Chromium-Nickel Steel Sheet and Strip
A 366	Steel, Carbon, Cold-Rolled Sheet, Commercial Quality
A 569	Steel, Carbon (0.15 Maximum Percent) Hot-Rolled Sheet and Strip, Commercial Quality
B 209	Aluminum-Alloy Sheet and Plate
B 370	Copper Sheet and Strip for Building Construction

8.2.2 Federal Specifications (FS):

O-F-506	Flux, Soldering; Paste and Liquid
QQ-S-571	Solder: Tin Alloy; Lead-Tin Alloy, and Lead Alloy
RR-W-360	Wire Fabric, Industrial
RR-W-270	Wire Fabric, Steel, Hot-Dipped Galvanized

8.2.3 Sheet Metal and Air-Condition Contractors National Association, Inc. (SMACCNA):

Architectural Sheet Metal Standards

Low and High Velocity Duct Construction Standards

8.3 SPECIAL REQUIREMENTS.

Surfaces to which sheet metal is to be applied shall be even, smooth, sound, thoroughly clean and dry, and free from all defects that might affect the application. All cutting, fitting, drilling, soldering, and other operations in connection with sheet metal required to accomodate the work of other trades, shall be performed under this section. Fastenings other than nails shall be as required and shall be of a type, design, and material that will not support galvanic action. Where sheet metal abuts or members into adjacent materials, the juncture shall be executed as indicated on the drawings or in a manner satisfactory to the Contracting Officer's Representative (COR). Sheet metal items shall be fabricated and installed in accordance with the details or not covered by detailed specifications shall be as set forth in the applicable publications listed in Paragraph 8.2.3 - Sheet Metal and Air Conditioning Contractors National Association, Inc.

8.4 MATERIALS.

Materials shall be of the types, gages, alloys, and thicknesses shown or noted on the drawings and shall conform to the publications listed above, as applicable. All materials used in the work shall be new and free of defects.

8.5 PROTECTION OF ALUMINUM.

Aluminum that will be in contact with steel, copper, wet or green wood, mortar, masonry, concrete, or other absorbent materials shall be protected against galvanic or corrosive action by one of the following methods:

8.5.1 Paint.

Aluminum surfaces shall be given a coat of bituminous paint or shall be given a coat of zinc-chromate primer and one coat of aluminum paint. Aluminum paint shall consist of aluminum paste, thinner compatible with the varnish, and spar varnish mixed in the proportion of 2 pounds of paste to not more than 1 pint of thinner to 1 gallon of varnish. The paste, thinner, and vehicle shall be field mixed.

8.5.2 Nonabsorptive Tape or Gasket.

Nonabsorptive tape or gasket shall be placed between the adjoining surfaces.

8.6 FASTENING.

8.6.1 Nailing of Sheet Metal.

Nailing of sheet metal shall be confined generally to sheet metal having a width of less than 12 inches. Nailing of flashings shall be confined to one edge only. Where two edges are to be secured, such as returns under overhangs, the roof flange shall be fabricated with 1/8-inch by

1/2-inch longitudinal slotted holes 6 inches on center to receive nails. Nails shall be evenly spaced not over 6 inches on centers unless otherwise specified or indicated on the drawings. Where sheet metal is applied to other than wood surfaces, detailed shop drawings shall be provided to establish locations for sleepers and nailing strips required to properly secure the work.

8.6.2 Cleats.

Cleats shall be provided where required and shall be evenly spaced not over 12 inches on centers unless otherwise specified or indicated on the drawings, or approved by the OCR. Cleats shall be not less than 2 inches wide by 3 inches long and shall be of the same material and weight as the sheet metal being installed. One end of the cleat shall be secured with two nails and the cleat folded back over the nailheads. The other end shall be locked into the seam. Cleats for soldered seams shall be pretinned.

8.6.3 Bolts, Rivets, and Screws.

Bolts, rivets, and screws shall be installed where indicated on the drawings, one the standard details referenced, or, as approved by the COR.

8.7 SOLDERING, WELDING, AND SEAMING.

8.7.1 Soldering and Welding.

Edges of sheet metal except aluminum shall be pretinned before soldering is begun. Soldering shall be done slowly with well-heated coppers so as to thoroughly heat the seams and completely sweat the solder through the full width of the seam. Edges of lead-coated copper to be soldered shall be scraped or wire-brushed to produce a bright surface, and seams shall have a liberal amount of flux brushed in before soldering is begun. Edges of corrosion-resisting steel to be soldered shall be treated with a 50 percent solution of hydrochloric acid in water followed, after five minutes and without washing, by soldering flux. Soldering shall follow immediately after application of the flux. Upon completion of soldering, the acid shall be neutralized, and the surfaces shall be thoroughly cleaned. Joints in aluminum sheets thinner than 0.040 inch shall be made mechanically and sealed with a sealing material recommended by the manufacturer. Joints in thicker sheets shall be of the inert-gas shielded-arc type unless resistance spot or other types of welding are indicated on the standard details referenced, or shown on the drawings. Aluminum shall not be soldered.

8.7.2 Seams.

Seams shall conform to the following requirements:

8.7.2.1 Flat-Lock Seams shall finish a minimum of 3/4 inch wide.

8.7.2.2 Soldered-Lap Seams shall finish a minimum of 1 inch wide.

8.7.2.3 Unsoldered Plain-Lap Seams shall lap not less than 4 inches unless otherwise specified.

8.7.2.4 Flat Seams shall be made in the direction of the flow.

8.8 HANDLING AND STORAGE.

Sheet metal items shall be carefully handled to prevent personal injury or damage to the surfaces, edges, and ends, and shall be stored, tied down, or secured at the site above the ground in a covered, dry location. Damaged items that cannot be restored to like-new condition shall not be used.

8.9 DOWNSPOUTS.

Downspouts shall be of the type shown on the drawings. Downspouts of the rectangular type shall be factory corrugated longitudinally. All downspouts shall be provided in sections approximately 10 feet long with flat-lock seams. Downspouts shall be set plumb and shall be firmly secured to the supporting construction by 2-inch wide straps attached to or made integrally with the downspout. Transverse downspout joints shall be telescoped 1 1/2 inches. Two straps shall be provided for each section of downspout. The strap at the top of the section shall be fixed. The strap at the bottom of the section shall be loose fitting to permit not less than 1/2 inch movement for each 10 feet of downspout. Elbows and offsets shall be provided where indicated on the drawings and elsewhere if required to clear interferences discovered in field. Basket strainers shall be set in loosely at gutter openings into downspouts.

8.9.1 Downspout Heads.

Downspout heads used in conjunction with scuppers shall be closed at the top with removable wire bird screens that are securely attached to the heads.

8.9.2 Scupper Linings.

The interior of the scupper opening shall be completely lined with sheet metal. The lining shall extend through and project outside of the wall to form a spout with a drip on the bottom edge and shall be formed to return not less than 1 inch against both faces of the wall or parapet with the outside edges folded under 1/2 inch on the top and sides. The perimeter of the lining shall be approximately 1/2 inch less than the perimeter of the scupper. The top and sides of scuppers on the roof-deck side shall be of sufficient length to fold over and be lapped and attached to base flashings. The bottom edge shall also be lapped and attached to the flashing, or shall be of sufficient length to extend not less than 4 inches into the roofing and, where required, shall be formed with a ridge to act as a gravel stop around the scupper inlet. Surfaces to receive the lining shall be coated with plastic cement. Each scupper

shall be provided on the roof side with a strainer formed of 2 by 2 mesh, 16-gage wire of material that is electrolytically compatible with lining material.

8.10 GUTTERS.

Gutters shall be fabricated in sections not less than 8 feet long except at ends of runs where shorter lengths are required. The rear side of the gutter shall be not less than 1 1/2 inches higher than the opposite side. Openings in gutters at downspouts shall be the same size and shape as the downspouts. Gutters shall be of the type shown on the drawings and shall be hung with high points equidistant from downspouts. Joints, except for expansion joints, shall be lapped at least 1 inch in the direction of flow and shall be made mechanically, soldered, or sealed as specified in Paragraph 8.7 "Soldering, Welding, and Seaming." Gutters shall be secured by brackets spaced not more than 30 inches on centers. Brackets shall be attached to wood nailer or fascia by at least two screws and shall be secured to the gutter in a manner that will allow free movement of the gutter. Gutter braces, where required, shall be installed at the midpoints between brackets. Gutter runs between expansion joints shall not be over 60 feet in length.

8.10.1 Other than Aluminum.

Top gutter support shall be secured to front of bracket by bolts and shall be attached to the roof by screws. Any straps shall be let in flush with top of wood nailers.

8.10.2 Aluminum.

The rear side of the gutter shall be hooked over a continuous cleat attached to the roof by 1 1/4-inch screw shank roofing nails spaced not more than 12 inches on centers.

8.10.3 Gutter Expansion Joints.

Gutter expansion joints shall provide a space between end baffles of gutters which shall be not less than the allowance shown in the SMACNA standard for the material specified, space shall be closed with a cover plate. Galvanized steel cover plates shall be soldered to one gutter section, aluminum cover plates shall be secured to the gutter section by a loose-locked slip joint conforming to the manufacturer's recommendations.

8.11 FLASHING.

Metal flashing, shall be installed as indicated on the drawings, at all intersections of roofs with vertical surfaces, any projection through the roof, roof openings, overall base flashings, and elsewhere as shown on the drawings or required. Exposed edges of all flashings shall be folded back 1/2 inch to provide stiffness.

8.12 GRAVEL STOPS AND FASCIA.

Gravel stops and fascia shall be installed where shown on the drawings. Metal shall be of the type and gages indicated. All end laps shall be sealed with neoprene flashing cement 1/4 inch thick.

8.13 MISCELLANEOUS ITEMS.

Miscellaneous items of sheet metal shown on the drawings, but not specified herein, shall be furnished and installed in accordance with the details shown on the drawings.

8.14 PAINTING.

All prefabricated, purchased, galvanized sheet metal components which are to be painted, shall have a factory applied bond coat coating suitable for painting. When required by the COR, a factory certification shall be submitted stating that the galvanized metal has a bond coat.

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SECTION 9

ROLLING, SLIDING, AND OVERHEAD METAL DOORS

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SECTION 9

ROLLING, SLIDING, AND OVERHEAD METAL DOORS

9.1 GENERAL.

This section covers requirements for the design, fabrication and installation of metal rolling, sliding, and overhead doors as shown and noted on the drawings.

9.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

9.2.1 Publications listed under Section "Structural Steel and Miscellaneous Metalwork," as applicable.

9.2.2 Federal Specifications (FS):

FF-B-571	Bolts, nuts, studs and tap rivets (and material for same)
FF-B-575	Bolts, hexagon and square
FF-S-92	Screws, machine: Slotted, cross-recessed or hexagon head
HH-L-529	Insulation board, thermal, (mineral aggregate)
HH-I-530	Insulation board, thermal (urethane)
QQ-S-775	Steel sheets, carbon, zinc-coated
TT-C-490	Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings
TT-P-641	Primer Coating, Zinc Dust-Zinc Oxide (for Galvanized Surfaces)
TT-P-645	Primer, Paint, Zinc-Chromate, Alkyd Type

9.2.3 Military Specifications (MIL):

MIL-P-6883	Paint, Blended Type, Coal-Tar-Pitch Base, Bituminous
MIL-P-14504	Primer Coating, Pretreatment, One-Package Wash Primer (for Steel, Aluminum, and Magnesium)
MIL-P-15328	Primer, Pretreatment (Formula No. 117 for Metals)

9.2.4 Underwriters' Laboratories, Inc., Publications (UL).

Building Materials Directory

9.2.5 National Electrical Manufacturers' Association (NEMA):

MG-1 Motors and Generators

ICS Industrial Controls and Systems

9.3 SHOP DRAWINGS.

The Constructor shall submit shop drawings or catalog data prior to procurement to the Contracting Officer's Representative (COR). The COR will retain three (3) copies of each drawings, catalog data, or descriptive material submitted, and return the remainder of the copies to the Constructor. Doors shall not be delivered to jobsite prior to approval of the shop drawings, which shall indicate elevations of each door type; details of construction; method of assembling sections; location and installation of hardware; size, shape, and thickness of materials; joints and connections, field wiring diagrams for operator assembly, and details of tracks, rollers, fittings, and other attachments.

9.4 ROLLING STEEL DOORS.

9.4.1 Operation.

Doors shall be either manually operated, by means of chain or crank, or electric power operated with auxiliary manual operation as indicated on the drawings. Doors shall be mounted as shown on the drawings.

9.4.2 Curtains.

Curtains shall be formed of interlocking steel slats rolled into easy curves to produce sufficient stiffness to resist a wind pressure of 20 pounds per square foot. Slat for doors less than 12 feet wide shall be not lighter than 22 gage; slats for doors 12 feet wide and less than 18 feet wide shall not be lighter than 20 gage; and slats for doors 18 feet wide and over shall be not lighter than 18 gage. Curtain shall roll up on a drum supported on brackets and be balanced by helical springs. Fenestration standard with manufacturer shall be provided where indicated.

9.4.2.1 End Locks and Wind Locks. The end of each slat for exterior doors and each alternate slat for interior doors shall have malleable iron ends locks of manufacturer's stock design. In addition to end locks, exterior doors more than 20 feet wide or having an area greater than 340 square feet shall have wind locks of manufacturer's standard design at ends of each fourth or fifth slat.

9.4.2.2 Bottom Rail. The curtain shall have a rolled-steel bottom bar consisting of two angles of equal weight, one on each side, fastened to the bottom of the curtain. In addition, exterior doors shall have a compressible neoprene, rubber, or vinyl weather-seal attached to the bottom rail. For doors that are electric-power-operated, a combination compressible rubber seal and safety device for stopping the travel of the door shall be attached to the bottom rail.

9.4.3 Finish.

Finish shall be as specified on the drawings. Slats, bottom rail, and hood of exterior rolling doors shall be zinc-coated.

9.4.4 Guides.

Guides shall be standard rolled-steel angles not less than 3/16-inch thick, and shall form a channel pocket of sufficient depth to retain the curtain in place under the wind pressure specified. Guides shall be securely attached to adjacent construction with 3/8-inch diameter bolts spaced near each end and not over 30 inches apart. Guides shall be set back from the face of the jamb opening the distance recommended by the manufacturer.

9.4.5 Roller Shaft.

Roller shaft shall be constructed of steel pipe of the required diameter and thickness for the size of curtain. Deflection shall not exceed 0.03-inch per foot of span. The ends of the roller shall be closed with cast iron plugs machined to fit the pipe. An oil-tempered, helical, counter-torque to assure easy operation of the door curtain from any position shall be installed within the roller. Provisions shall be made for spring-tension adjustment from outside of the bracket without removing the hood.

9.4.6 Brackets.

Brackets shall be fabricated of heavy cast iron or steel, designed to close the ends of roller-shaft housing and to form a supporting ring for the hood. The ends of the roller shaft shall be journaled into bracket hubs to provide ample bearing for the required load. Bracket hubs and plug at the spring end of the shaft shall be fitted with self-lubricating bronze bearings or permanently lubricated sealed ball bearings.

9.4.7 Hoods.

Hoods shall be constructed of not lighter than 24-gage steel formed to fit the contour of end brackets and reinforced with steel rods or rolled beads at top and bottom edges. When installed in metal building flash at head to seal air movement off.

9.4.8 Locking Device. Exterior manually operated doors shall be fitted with the manufacturer's standard chain- or bar-type locking device on the inside.

9.4.9 Hand-Chain Operators.

Gears shall be high-grade gray iron, cast from machine-cut patterns. Gear reduction shall be calculated to reduce the pull required on hand chain to not over 35 pounds. Chains shall be galvanized.

9.4.10 Crank-Gear Operator.

The crank shall be removable and located approximately 34 inches from the floor. Gears shall be of high-grade gray iron, cast from machine-cut patterns. Gear reduction shall be calculated to reduce force exerted on crank to not over 35 pounds.

9.4.11 Electric-Power Operators.

Electric-power operators as specified hereinafter shall be furnished complete where indicated on the drawings with motor installed inside the building unless otherwise shown on the drawings.

9.5 OVERHEAD STEEL DOORS.

9.5.1 Operation and Design.

Doors shall be operated by means of lifting handles and pulldown ropes or straps manually operated by means of chain hoist, or electric-power-operated with auxiliary manual operation as shown on the drawings. Doors shall be sectional type with flush or semiflush horizontal sections, and joints between sections shall be made weathertight. Doors shall be designed to withstand a wind pressure of 20 pounds per square foot of door area. For exterior doors, a compressible weather seal shall be provided for door-frame jambs and door bottom. The weather seal for the door bottom shall be the door manufacturer's standard product made of neoprene, rubber, or vinyl. Weather seal for doorjamb shall be made of vinyl or wool pile not less than 50 mils thick and shall be set in a formed, zinc-coated-steel or extruded-aluminum frame that is secured to the doorframe by zinc- or cadmium-coated screws or bolts spaced not more than 12 inches on centers along the doorjamb. The jamb weather seal shall be so designed that the vinyl material can be replaced without removing the weather-seal frame from the doorjamb and shall be so installed as to provide a tight seal with the door. For doors that are power-operated, a combination weather seal and safety device for stopping travel of the door shall be attached at the bottom of the door. Glazed sections shall be formed with glazing beads or integral vinyl moldings sealing both glass and metal panels in accordance with Section 15, "Glass and Glazing." Glass openings shall be not less than 24 inches wide by inches high.

9.5.2 Construction of Door Sections.

Construction of door sections shall be of the following types unless otherwise shown on the drawings:

9.5.2.1 Formed tubular or box struts, rails, and tubular or channel stiles, all of steel not less than 0.0598-inch nominal thickness (16 gage) spot-welded to stiles and rails.

9.5.2.2 Built-Up from 6 inches high, rolled-steel pans not less than 0.0359-inch nominal thickness (20 gage), nominally 1 3/4 inches deep

assembled by interlocking the longitudinal sides and welding a steel channel not less than 0.0897-inch nominal thickness (13 gage) across each end. The sections shall be reinforced with box sections not less than 0.0598-inch nominal thickness (16 gage) placed transversely on the pans, spaced not more than 48 inches on center, and welded thereto. The bottom section of the door shall have a steel channel not less than 0.0897-inch nominal thickness (13 gage) welded to the lower edge.

9.5.2.3 Sections from 18 inches high to but not exceeding 21 inches high, overall thickness 2 inches, rolled-formed from a single sheet of steel not less than 0.0359-inch nominal thickness (20 gage) with horizontal edges of each section rolled to form continuous rabbeted weather joint. Reinforcement shall be provided on the vertical edge, and a hat-shaped strut shall be provided across stiles of each door section. Strut shall be welded to stiles of each door section with four equally spaced welds on both sides of strut for doors that are not over 12 feet wide. For doors wider than 12 feet, five or more equally spaced welds shall be used. Struts for sections of doors up to 12 feet in height shall be not less than 0.0359-inch nominal thickness (20 gage). Struts for sections of doors 17 feet in width and over shall be not less than 0.0598-inch nominal thickness (16 gage). Areas of zinc-coating damaged by welding shall be touched up with galvanizing-repair paint.

9.5.3 Finish.

Hinges and accessories shall be zinc-coated. Door sections shall be zinc-coated and shop-finished as specified on the drawings.

9.5.4 Tracks.

Tracks shall be of the manufacturer's standard design, size, and thickness for the type and size of door. Tracks shall be fabricated of zinc-coated steel and securely anchored to wall and ceiling construction as shown on the drawings.

9.5.5 Counterbalancing.

Doors shall be counterbalanced by means of oil-tempered extension springs or tempered torsional spring mounted on a continuous steel shaft. Springs shall be adjustable for proper tension and shall be connected to doors with galvanized-wire cable or other approved means standard of the door manufacturer.

9.5.6 Hardware.

Push-up doors shall have lifting handles on both sides of door and a five-pin cylinder lock and locking device, keyed as indicated on the drawings or approved by the COR. Doors operated by chain hoist shall have the manufacturer's standard type locking device and chain hoist mounted on the inside of the building. Chain cleat and pin shall be furnished for securing operator chains. All other items of hardware and accessories shall be provided as required for complete operation.

9.5.7 Pilot Doors.

Pilot doors, where shown on the drawings, shall be provided in overhead doors as indicated, and shall be of similar construction to that of overhead doors. Hardware consisting of a five-pin cylinder lock-set and either three spring hinges or a hydraulic door check shall be provided and installed by the door manufacturer for each pilot door.

9.5.8 Electric-Power Operators.

Electric-power operators as specified hereinafter shall be furnished complete where indicated on the drawings.

9.6 VERTICAL-LIFT SLIDING STEEL DOORS.

9.6.1 Design and Type.

Doors shall consist of a one-place, single section or of multiple sections as indicated on the drawings. Sections of multiple section doors shall be set one behind the other with operations and travel so arranged that all sections arrive at the full open position at the same time. Operation shall be manual push-up type, manual with endless chain and geared hoist, or automatic with electric-power operators and emergency manual operation by chain hoist as shown on the drawings. Doors shall be of sizes indicated and designed to withstand a wind pressure of 20 pounds per square foot of door area. Glass panels with metal glazing beads shall be provided as indicated on the drawings and installed in accordance with Section 15, "Glass and Glazing." Doors shall be furnished with all hardware, fittings, and accessories required for complete operation.

9.6.2 Construction.

Door sections, unless otherwise shown on the drawings, shall have stiles and rails constructed of structural-steel angle or channel shapes and shall be covered on exterior side with 14-gage sheet steel, tack welded to frame not to exceed 9-inch centers. For panels wider than 4 feet, intermediate horizontal stiffeners shall be provided at not more than 2-foot centers. Corners and intersections of frames shall be welded and ground smooth on exposed surfaces. Welds shall develop the full strength of the door. At the Constructor's option, doors not exceeding 14 by 14 feet in size with panels not exceeding 42 inches in height shall have stiles and rails constructed of 16-gage steel tubing with solid recessed panels formed of 14-gage steel and secured to stiles and rails by bolting or welding.

9.6.3 Guides and Jamb Plates.

The doors shall run in structural steel guides securely fastened to the main rails or jamb plates that, in turn, are tap-bolted to the building construction. The end counter-weight enclosure shall be the same channel shape as the jamb plates and extend to the same height. Guides and jamb plates shall be set in accordance with the door manufacturer's recommendations.

9.6.4 Hardware.

The sheaves over which the chain passes to the door shall have precision bearings with provision for lubrication. Doors shall be supported by chain or steel cable with an ultimate strength of 5,000 pounds. Counterweights shall be sectional cast iron with interlocking lugs to assure the proper alinement at all times. Counterweights shall be stacked on a steel weight-rod and shall be enclosed to a height of 7 feet. Manually operated doors shall be locked by a throw bolt or other approved device on the inside.

9.6.5 Manual Operation.

The doors shall be manually operated by means of a geared hoist actuated by an endless galvanized chain from floor level and located at jambs on the inside of the building. Housing shall be malleable iron with sheave of cast iron having machine grooves. Sheave shall be mounted on precision bearings with provision for lubrication. A gear reduction ratio of at least 26:1 shall be obtained by means of a pinion on the hand-chain sprocket mounted on the sheave. A pull not in excess of 15 pounds shall actuate the doors.

9.6.6 Electric-Power Operators.

Electric-power operators as specified hereinafter shall be furnished complete where indicated on the drawings.

9.6.7 Pilot Doors.

Pilot doors shall be provided in the lower section of the doors where indicated on the drawings. Construction shall be similar to that of the door. Hardware consisting of three spring hinges and a five-pin cylinder lockset for each door shall be supplied and installed by the door manufacturer. Keying shall be as directed by the COR.

9.6.8 Weather Seals.

Weather seals shall be provided between door sections at head of opening and bottom of lower section. For power-operated doors, the seal at bottom of lower section shall be a combination weather seal and safety device for stopping the travel of door as specified hereinafter.

9.6.9 Shop Finish.

Shop finish shall be as specified on the drawings.

9.7 HORIZONTAL SLIDING STEEL DOORS.

9.7.1 Design and Type.

Doors shall be manually operated, industrial tubular type, single-leaf or biparting double-leaf, supported on overhead track on the inside or

outside wall as indicated on the drawings. Doors shall be furnished complete with all hardware, tracks, guides, and accessories required for complete operation.

9.7.2 Construction.

Unless otherwise indicated on the drawings, sliding doors shall be constructed as follows: stiles and rails for doors less than 10 feet in height and width shall be constructed of 16-gage pressed-steel tubes. Stiles and rails for doors with either dimension 10 feet or over shall be 14-gage pressed-steel tubes. Joints between tube members shall be internally reinforced, full welded, and ground smooth. Joints at corners shall be mitered and welded; cross joints shall be butted and welded. Solid panels shall be formed of a single sheet of 14-gage steel welded to stiles and rails. Glazed panels, installed in accordance with Section 15, "Glass and Glazing," shall have formed muntins and glazing angles for inside glazing or shall consist of industrial steel-sash sections designed for inside glazing with continuous glazing angles. Biparting doors shall have steel astragal securely welded to one leaf.

9.7.3 Hardware.

Doors shall have heavy-duty overhead track complete with brackets and end stops. Each leaf shall have not less than two 4-wheel roller-bearing trolleys. Door handles, floor guides, end stops, hasp, and staples shall be furnished for each door.

9.7.4 Shop Finish.

Shop finish shall be as specified on the drawings. Tracks, guides, and other hardware shall be zinc-coated.

9.8 ELECTRIC-POWER OPERATORS.

Electric-power operators, where indicated on the drawings, shall be furnished complete with electric motor, reduction gears, brackets, pushbutton controls, automatic limit switches, and other required accessories. The operator shall be so designed that the motor may be removed without disturbing the limit-switch timing and without affecting emergency auxiliary operators. Provision shall be made for immediate emergency manual operation of the door by crank-gear or chain-gear mechanism in case of electrical failure.

9.8.1 Motor.

Motor shall have sufficient horsepower and torque output to move the door in either direction from any position and produce a door-travel speed of not less than one foot per second or as shown on the drawings. The motor shall be protected from overload by means of overload relays in the reversing starter. Motors shall be NEMA, MG1, and UL listed.

9.8.2 Controls.

Each door motor shall have an enclosed reversing across-the-line type magnetic started having thermal-overload protection, solenoid-operated brake, limit switches, and remote-control switch. The starter shall conform to NEMA Standard ICS. Remote-control switches shall be of the three-button type with the buttons marked "OPEN," "CLOSE," and "STOP." Close buttons shall be of the momentary-contact type requiring constant pressure of the operator to maintain motion of the door. Pushbuttons shall be of the full-guarded type to prevent accidental operation. Remote-control switches mounted on the exterior of a building shall be of the weatherproof key-operated type having corrosion-resistant cast-metal cover. Limit switches shall be provided to automatically stop the doors at their fully opened and closed position. Positions of the limit switches shall be readily adjustable. Pilot doors, if installed in power-operated doors, shall have a limit switch that will prevent the operation of the power unit except when the pilot door is in the fully closed position.

9.8.3 Transformer.

A control transformer shall be provided in power circuits in excess of 250 volts to reduce the voltage on the control circuits to 120 volts. Transformer shall be UL listed.

9.8.4 Safety Device.

The bottom or side (for sliding doors) of the door shall have a safety device that will immediately stop the door in its closing travel upon contact with an obstruction in the door opening. The safety device shall not substitute for a limit switch.

9.8.5 Electrical Work.

All manual- or automatic-control devices required for the operation of the doors herein specified, and any wiring required for a complete installation shall be furnished and installed by the Constructor. Wiring shall conform to Section 23, "Interior Electrical Work." Flexible connections between the door and fixed supports shall be made with Type SO cable. The cable shall have a spring-loaded automatic take-up reel or equivalent device.

9.9 INSTALLATION.

All doors and equipment specified hereinbefore shall be installed in accordance with the approved manufacturer's shop drawings and instructions. Anchors and inserts for brackets, guides and other features of the work shall be accurately located and securely installed. Upon completion, doors shall be properly adjusted and lubricated, and shall operate freely.

9.9.1 Field Measurements.

The Constructor shall verify all measurements at the building site and shall be responsible for dimensions, fitting, and the proper attachment of items directly connected with the door installation.

9.9.2 Workmanship.

The finished work shall be strong and rigid, neat in appearance, free from defects, warp, or buckle. Molded members shall be clean-cut and straight, with joints coped or mitered, well formed, and in true alignment. Exposed welded joints shall be dressed smooth.

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SECTION 10

METAL DOORS, FIRE DOORS, AND FRAMES

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SECTION 10

METAL DOORS, FIRE DOORS, AND FRAMES

10.1 GENERAL.

This section covers the requirements for the design, fabrication, and installation of metal doors, metal fire doors, and metal frames, as shown and noted on the drawings.

10.2 APPLICATION PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

10.2.1 Publications Listed Under Section 9, Rolling, Sliding, and Overhead Metal Doors, as Applicable.

10.2.2 American Society for Testing and Materials (ASTM):

B 85 Aluminum-Alloy Die Castings

B 308 Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded

10.2.3 American Welding Society (AWS):

A5.3 Aluminum and Aluminum-Alloy Arc-Welding Electrodes

D10.7 Recommended Practices for Gas Shielded-Arc Welding of Aluminum and Aluminum-Alloy Pipe

10.2.4 National Fire Protection Association (NFPA)

80 Standard for Fire Doors and Windows

101 Code for Life Safety from Fire in Buildings and Structures

10.2.5 Underwriters' Laboratories, Inc., Publications (UL)

Fire Protection Equipment List

Fire Resistance Directory

Building Material Directory

10.2.6 Factory Mutual System:

Approval Guide

10.3 SHOP DRAWINGS.

The Constructor shall submit shop drawings or catalog data prior to procurement, to the Contracting Officer's Representative (COR). The COR

will retain three (3) copies of each drawing, catalog data, or descriptive material submitted, and return the remainder of the copies to the Constructor. Hardware shall not be delivered to the jobsite prior to approval of the shop drawings, which shall indicate elevations of each door type; details of construction; method of assembling sections; location and installation of hardware; size, shape, and thickness of material; and joints and connections. Materials used in the design shall conform to the publications listed under Paragraph 10.2 unless otherwise approved by the COR.

10.4 SHOP FINISH.

10.4.1 Steel Surfaces.

Steel surfaces shall be thoroughly cleaned, and exposed surfaces shall be filled and ground smooth. Where specified hereinafter, steel sheets shall be zinc-coated. Assembled door components shall be zinc-coated by the hot-dipping process and the weight of coating shall be not less than 1.25 ounces per square foot of surface. Interior doors shall be given one coat of alkyd primer paint. Exterior doors having ferrous surfaces to be painted shall be thoroughly cleaned and given a zinc phosphate treatment and one coat of alkyd primer paint. Exterior doors or frames having zinc-coated surfaces to be painted shall be thoroughly cleaned and given a zinc phosphate treatment and painted one coat of zinc dust-zinc oxide primer paint.

10.4.2 Aluminum Surfaces.

Aluminum surfaces shall have a natural as-fabricated mill finish or shall be given a satin finish by caustic soda etching or by standard mechanical methods, as indicated on the drawings. Surfaces shall be protected from handling marks until protective coatings are applied.

10.4.2.1 Anodizing. After finishing, surfaces of aluminum shall be given an anodic coating to produce an aluminum oxide film weighing not less than 20 milligrams per square inch, and the coating shall be sealed with hot water not less than 206° F.

10.4.2.2 Protective Coating. After cleaning and finishing and prior to shipments, two coats of a clear, colorless, methacrylate lacquer shall be applied to all surfaces of the aluminum.

10.5 FIELD MEASUREMENTS.

The Constructor shall verify all measurements at the building site and shall be responsible for dimensions, fitting, and proper attachment of items directly connected with the door and frame installation.

10.6 FIRE DOORS.

Fire doors shall have door and frame construction and hardware as necessary to conform to the requirements of the UL or FM for the class of door

called for on the drawings. The label of one of the above laboratories will be accepted as evidence of conforming to this requirement. For fire doors exceeding the sizes for which testing and label service is offered by UL or FM, a design conforming to the requirements of the UL or FM shall be submitted to the COR for specific approval. Installation, including hardware and operational characteristics, shall be in accordance with NFPA Standard No. 101. See Paragraph 10.7.5 for additional requirements.

10.7 GENERAL REQUIREMENTS FOR HINGED DOORS.

10.7.1 Metal.

Metal for steel doors and frames shall be cold-rolled, stretcher-leveled sheet steel of gages hereinafter specified and shall have clean, smooth surfaces. Uncoated steel sheets and zinc-coated steel sheets shall conform to requirements of Paragraph 10.2.

10.7.2 Workmanship.

The finished work shall be strong and rigid, neat in appearance, free from defects, warp, or buckle. Molded members shall be clean-cut and straight, with joints coped or mitered, well formed, and in true alignment. Exposed welded joints shall be dressed smooth.

10.7.3 Size and Thickness.

Doors and matching frames shall be as follows: 1 3/4 inches thick for exterior doors and 1 3/8 inches thick for interior doors, unless otherwise indicated on the drawings. Door clearances shall be not more than 3/32 inch at jambs and heads, 1/8 inch at meeting stiles of pairs of doors, and 3/16 inch at bottom.

10.7.4 Dutch Doors.

Dutch doors shall have a shelf and be formed of steel, having a nominal thickness not less than 0.0747 inch (14 gage), with edges boxed and returned. Shelf shall be supported on manufacturer's stock-type steel brackets.

10.7.5 Stile Edges.

Pairs of exterior doors shall have a rubber-seal-type astragal applied on the edges of the meeting stiles or on the exterior face of each leaf, either surface-mounted or recessed. Mortised type will not be acceptable. Pairs of fire doors shall have a overlapped metal astragal applied on the active leaf.

10.7.6 Provisions for Hardware.

Doors or frames shall be mortised, reinforced, and drilled and tapped to receive template hinges, closers, locks, and flush bolts. Special

reinforcing shall be provided for bored-type locks and latches. Doors or frames to receive surface-applied hardware, except push plates, kick and mop plates, and armor plates, shall be provided with factory installed reinforcing only. Drilling tapping shall be done in the field. Reinforcing plates shall be at least 11 gage for mortised hardware and 14 gage for surface-applied hardware. Where concealed overhead door closers are required, the necessary cutouts, reinforcement, and provisions for fastenings shall be made in heads of doors for the closers.

10.7.7 Location of Hardware.

Location of hardware shall be as follows:

Doorknobs, centered 40 inches above floor.

Door pulls, centered 45 inches above floor.

Push plates, centered 45 inches above floor.

Cylinder deadlocks, 52 inches above floor.

Single push bars, 43 inches above floor.

Combination push bars, 42 inches above floor.

Crossbar of panic bolt, centered 36 1/4 inches above floor.

Top hinge, top edge 5 inches below head of frame.

Bottom hinge, lower edge 10 inches above floor.

Intermediate hinges, equidistant between top and bottom hinges.

10.7.8 Louvers.

Louvers for interior metal doors shall be stationary sight-proof type of manufacturer's stock design. Louvers for exterior doors shall be weather-proof. Blades shall be welded or tenoned to frame, and the entire assembly shall be built into the door. In addition, louvers for exterior doors, where so indicated, shall have steel-frames insect screen secured to louvers in a rigid manner to permit ready removal. Wire cloth for insect screens shall be 18-mesh aluminum, copper, or bronze wire not less than 0.0113-inch diameter.

10.7.9 Moldings.

Moldings around solid, glazed, or louvered panels shall be fitted to the panels, mitered, and welded at corners to form a continuous frame around the panel. Panel moldings on the outside of exterior doors and on corridor side of interior doors shall be nonremovable, either integral with the rails and stiles or interlocked and spot-welded thereto. Moldings on the inside of metal panels shall be either stationary or

keyed to the stiles and rails without the use of exposed fastenings. Moldings on the inside of glass and louvered panels shall be secured with countersunk screws. Snap-on moldings may be used on the inside of glazed panels.

10.7.10 Muntins.

Muntins shall be interlock at intersections and shall be fitted by coping or mitering, and welding to stationary panel moldings.

10.7.11 Glass.

Glass installation shall be as specified in Section 15, "Glass and Glazing".

10.8 STANDARD HOLLOW METALS DOORS, HINGED TYPE.

10.8.1 Flush-Panel Doors.

Flush-panel doors shall have stiles formed of 16-gage minimum steel and flush panels shall be formed of 18-gage minimum steel sheets. Flush panels shall be reinforced with interlocking Z-shaped bars welded to each inside face of panel and spaced approximately 14 inches on centers. As an option, reinforcing for panels may consist of 22-gage U-shaped transversed sections welded to the inside of panels at approximately 17-inch centers, alternating at front and rear so that a horizontal stiffener occurs at approximately every 8 1/2 inches. Panels shall be welded to 18-gage channels at each vertical edge and shall have an approved-type insulation, of thickness required to eliminate metallic sounds in normal operations, applied to interior surfaces. The entire panel assembly shall be rigidly interlocked with stiles to form a semiflush weathertight joint. The top and bottom of doors shall be reinforced and closed with 14-gage stiles. Muntins and glazing moldings shall be not lighter than 18-gage steel securely attached to door construction and shall present the same general appearance on each side of door.

10.8.2 Recessed-Panel Doors.

Recessed-panel doors shall have stiles and rails formed of 16-gage steel. Moldings shall be formed of 18-gage steel. Panel shall consist of two 18-gage steel sheets separated by sound insulation to provide a total panel thickness of 3/8 inch. Joints between stiles and rails shall be fullwelded and dressed smooth or formed with an interlocking semiflush watertight joint. Top and bottom of doors shall be reinforced with 14-gage steel channel fillers and closures welded to the inside of stiles and rails. Finish framing which is not functional in terms of door operation shall be specified on the drawing.

10.8.3 Glazed Stile and Rail Doors.

Glazed stile and rail doors shall have an intermediate rail of adequate width to receive the hardware specified. The rail shall be centered

approximately 38 inches from the bottom of the door. Stiles and rails shall be formed of 16-gage steel for doors 36 inches wide. Joints between stiles and rails shall be reinforced, continuously face-welded, and dressed smooth. Insulation of an approved type and of thickness required to eliminate metallic sounds in normal operation shall be provided on the inside of stiles and rails.

10.9 INDUSTRIAL TUBULAR-STEEL DOORS, HINGED TYPE.

Industrial tubular-steel doors, hinged type, shall have stiles and rails constructed of 16-gage formed steel tubes with joints face-welded and dressed smooth. Panels shall consist of a single sheet of 14-gage steel spot-welded or otherwise securely attached to stiles and rails. Glazed panels shall be of solid-section steel sash or shall have rabbets for glazing formed on stiles and rails. Muntins shall be T-bar sections with formed-angle removable glass stops. The sash unit shall be welded to stiles and rails.

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SECTION 11
METAL WINDOWS

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SECTION 11

METAL WINDOWS

11.1 GENERAL.

This section covers the requirements for the design, fabrication, and installation of steel and aluminum windows as shown and noted on the drawings.

11.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

11.2.1 Architectural Aluminum Manufacturers Association (AAMA):

302.7 Specifications for Aluminum Windows

11.2.2 American Society for Testing and Materials (ASTM):

A 386 Zinc-Coating (Hot-Dip) on Assembled Steel Products

11.2.3 Federal Specifications (FS):

L-S-125 Screening, Insect, Nonmetallic

RR-W-365 (Wire Fabric Insect Screening)

TT-C-490 Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings

TT-E-489 Enamel, Alkyd, Gloss (for Exterior and Interior Surfaces)

TT-P-641 Primer Coating, Zinc Dust-Zinc Oxide (for Galvanized Surfaces)

TT-P-645 Primer, Paint, Zinc-Chromate, Alkyd Type

11.2.4 Military Specifications (MIL):

MIL-P-6883 Paint, Blended Type, Coal-Tar-Pitch Base, Bituminous

MIL-A-8625 Anodic Coatings, for Aluminum and Aluminum Alloys

11.2.5 Steel Window Institute (SWI):

Recommended Specifications for Steel Windows

11.3 SHOP DRAWINGS.

The Constructor shall submit shop drawings or catalog data prior to procurement, to the Contracting Officer's Representative (COR). The COR will retain three (3) copies of each drawing, catalog cut, or descriptive material submitted, and return the remainder of the copies to the Constructor. Windows shall not be delivered to the jobsite prior to approval of the drawings. The shop drawings shall indicate elevations of each window type; details of construction; method of assembling sections; location and installation of hardware; size, shape and thickness of material; and joints and connections. Materials used in the design shall conform to the publications listed under Paragraph 11.2 unless otherwise approved by the COR.

11.4 GENERAL REQUIREMENTS.

Windows of one material shall be installed in a building or group of similar and adjacent buildings and shall be the standard product of a reputable window manufacturer. Windows shall be of the type and size indicated on the drawings.

11.4.1 Air Infiltration:

Except as specified hereinafter under each individual window type, the air infiltration shall not exceed 1/2-cubic foot per minute per foot of crack tested with a wind velocity of 25 miles per hour when tested with the sash closed, locked, and adjusted. Except for fixed-steel or aluminum windows, the Constructor shall furnish to the COR duplicate copies of an air infiltration test performed by the manufacturer, certifying that the type of windows being furnished meet the above requirement.

11.4.2 Mullions.

Mullions shall be provided between multiple-window units where indicated. Mullions shall be designed to withstand a uniform wind pressure of 20 pounds per square foot without deflecting more than 1/240 of the span. Mullions shall be securely anchored at each end to adjacent construction and secured to adjacent window units to form a watertight joint and to allow for expansion and contraction. Mullion covers of manufacturer's stock design shall be provided on the interior to completely close the recess between the window jambs and to present a neat appearance.

11.4.3 Provisions for Glazing:

Fixed sash and ventilating sash shall be designed for glazing in conformance with Section 15.

11.4.4 Mastic:

Metal-to-metal joints between members of metal windows, metal frames, mullions, and mullion covers shall be set in mastic of the type recommended by the window manufacturer to provide completely watertight joints. Excess mastic shall be removed before it hardens.

11.4.5 Fixed Sash.

Where fixed-sash sections are used in combination with ventilator sections, the fixed sash shall be of the same type as the ventilator sections.

11.5 ALUMINUM WINDOWS.

11.5.1 General Requirements.

Aluminum windows shall conform to the AAMA "Specifications for Aluminum Windows" except as modified herein.

11.5.1.1 Cleaning. After fabrication, fabricating oil, scratches, and tool marks shall be removed from the aluminum surfaces, and the surfaces shall be free from discoloration, blemishes, and defects.

11.5.1.2 Finish. Aluminum surfaces shall have not less than a natural as-fabricated finish unless otherwise specified on the drawings. Surfaces shall be protected from handling marks until protective coatings are applied.

11.5.1.3 Anodizing. When specified on the drawings, surfaces of aluminum shall be given a satin finish by caustic soda etching or by standard mechanical methods and then be given an anodic coating to produce an aluminum oxide film weighing not less than 20 milligrams per square inch. The coating shall then be sealed.

11.5.1.4 Protective Coating. After cleaning and finishing and prior to shipment, two coats of a clean, colorless, methacrylate lacquer shall be applied to all surfaces of the aluminum.

11.5.1.5 Protection from Dissimilar Materials. In addition to the protective coating specified, aluminum surfaces shall be protected from direct contact with dissimilar materials. Dissimilar metals, including galvanized ferrous metals but excluding stainless steel, shall be painted with a heavy brush coat of zinc-chromate primer and two coats of aluminum paint or a heavy brush coat of alkali-resistant bituminous paint. The ferrous metal may be separated from the aluminum by a heavy coat of mastic calking compound or by a nonabsorptive tape or gasket. Aluminum paint shall consist of aluminum phenolic resin spar varnish, mixed in the proportion of 2 pounds of paste to not more than 1 pint of thinner to 1 gallon of varnish. The paste, thinner, and varnish shall be field-mixed. Aluminum surfaces in contact with mortar, concrete, or other masonry materials shall be given one heavy brush coat of coal-tar-pitch base bituminous paint. Aluminum surfaces in contact with wood or other absorptive materials shall be given two coats of the aluminum paint or one heavy brush coat of bituminous paint.

11.5.1.6 Hardware for aluminum windows, except as otherwise specified under each individual window type, shall be the approved standard of the window manufacturer including cast bronze with a dull chrome finish, white bronze, or nonmagnetic stainless steel with a satin finish.

11.5.2 Awning Windows.

Awning windows shall conform to AAMA "Specifications for Aluminum Windows" for A-A2 commercial type with modifications as follows:

11.5.2.1 Operating Hardware for top ventilator shall be designed to drop the ventilator down in such manner as to permit cleaning toe outside of top sash from inside the building.

11.5.2.2 Continuous Drips shall be provided over heads of top ventilators. Where fixed sections occur adjacent to ventilators, drips shall be continued across the top of fixed sections.

11.5.2.3 Ventilating Units shall be controlled simultaneously by under-screen rotary-type operators with removable crank handles. Each side arm of ventilators shall have provisions for adjustment to provide even contact between sash and frame. Rotary operators shall be worm-gear type with cut gears of case-hardened steel. Operator housing shall be aluminum.

11.5.2.4 Where Rotary Operators are more than 6 feet above the floor, extension crank operators with removable handles of the length required to suit job conditions shall be provided.

11.5.3 Sliding Windows.

Sliding windows shall conform to AAMA "Specifications for Aluminum Windows," Type HS-A2, and shall be weatherstripped. Window units shall be completely assembled with weatherstripping, screens, and hardware in place. At the Constructor's option, sash and glass panels may be shipped glazed with glass of the type and thickness specified in Section 15.

11.6 STEEL WINDOWS.

Steel windows shall conform to the SWI "Recommended Standards for Steel Windows," except as modified herein.

11.6.1 Shop Finish.

After fabrication, the windows and their screens shall be given one of the following finishes, unless otherwise specified on the drawings. Mullions and mullion covers shall have the same shop finish as the adjacent windows.

11.6.1.1 Zinc-Coated Finish. This finish shall be used only for solid-section steel windows. Fittings, bolts, and nuts shall be centrifuged after treatment. The weight of the zinc coating shall be not less than 1.5 ounces per square foot of surface for the windows and 1.25 ounces per square foot of surface for the fittings, bolts, and nuts. If interior finish painting of the above windows is required, the paint shall be applied after installation and as specified in Section 18.

11.6.1.2 Zinc Phosphate Treatment and Alkyd Prime Coat shall be applied to windows and screens that are not zinc coated. For windows, screens, and storm windows having sections formed of zinc-coated sheets, phosphate treatment is not required and the primer coat shall be zinc dust-zinc oxide paint. Finish painting shall be applied after installation as specified under Section 18.

11.6.1.3 Factory-Applied Enamel Finish shall consist of a thermosetting primer in which the nonvolatile vehicle shall be based on a mixture of epoxy and phenol formaldehyde resins applied at a minimum dry-film thickness of 0.6 mil. The top coat shall be alkyd gloss baking enamel, and shall be applied at a minimum dry-film thickness of 0.8 mil. The color shall be as specified on the drawings. Abraded surfaces shall be touched up with air-drying enamel as specified for factory finish, color to match original paint.

11.6.2 Hardware.

Except as otherwise specified under each individual window type, exposed hardware for steel windows shall be stainless steel or cast bronze.

11.6.3 Sliding Windows.

Sliding windows shall be fabricated from hot-rolled hot-dipped galvanized sheet steel with lock-seal tubular construction. Corners of frames, sash, and glass panels shall be secured by full brazing or welding on both inside and outside. Where sliding window units over 42 inches in width are indicated on the drawings, mullions as specified in SWI "Recommended Standards for Steel Windows" shall be constructed between the units.

11.6.3.1 Assembly. Window units shall be shipped completely assembled with weatherstripping, screens, and hardware in place. At the Constructor's option, windows may be shipped glazed with glass as specified in Section 15.

11.6.3.2 Trim. Metal fins not less than 3/4-inch wide and not lighter than 18 gage shall be provided around the entire perimeter of sliding windows set in untrimmed masonry openings. Metal or wood trim shall be provided at other openings. Metal trim shall be hot-dipped galvanized steel not lighter than 22 gage. Wood trim shall be preservative-treated, clear white pine.

11.6.3.3 Finish. Metal parts shall be finished as hereinbefore specified. Wood casings, where required, shall be primed. At the Constructor's option, exposed metal parts of windows, except fins, shall be given a factory finish of white or gray exterior enamel, baked on.

11.6.3.4 Hardware. Windows shall have a locking device designed to prevent removal of sash from outside when locked. Ventilating sash shall be easily removable from inside when unlocked. Integral continuous pulls shall be provided on each ventilator.

11.6.3.5 Weatherstripping. Continuous weatherstripping shall be provided around the perimeter of each ventilating sash panel. Weatherstripping shall be wool pile, semirigid vinyl plastic, or a combination thereof. Wool pile shall be resilient, water-repellent, and mothproof. Glides and runners of nylon, plastic, or other material shall be provided to prevent metal-to-metal contact during operation and to assure smooth, easy operation of the ventilator.

11.6.3.6 Drainage. Adequate drainage of water shall be provided between the sliding ridges of sill section and through the lowest horizontal member of screen section.

11.6.4 Intermediate Projected Windows.

Intermediate projected windows shall conform to SWI "Recommended Standards for Steel Windows" for intermediate type as hereinafter modified, and shall be either heavy intermediate, or intermediate having combined weight of not less than 3 pounds per linear foot of frame and vent sections.

11.6.4.1 Each Outswinging Vent shall have a cam-type fastener, except that, vents over 36 inches wide and not pole operated shall have two cam-type fasteners.

11.6.4.2 Where Ventilators are more than 6 feet above the floor, hardware for operation by pole shall be provided. The fastener shall be located in the center of the frame.

11.6.5 Industrial-Type Projected Windows.

Industrial-type projected windows shall conform to SWI "Recommended Standards for Steel Windows" for commercial projected type with the following modifications:

11.6.5.1 Each Outswinging Vent shall have a cam-type fastener, except that, vents over 36 inches wide and not pole operated shall have two cam-type fasteners.

11.6.5.2 Where Ventilators are more than 6 feet above the floor, hardware for pole operation shall be provided. The fastener shall be located in the center of the frame.

11.7 INSECT SCREENS.

Insect screens shall be provided for all windows or other openings specified on the drawings.

11.7.1 General.

When specified or required, aluminum screen frames shall be provided for aluminum windows, and steel screen frames shall be provided for steel windows. Screens shall fit closely around the entire perimeter of each

ventilator or opening, shall be rewirable, easily removable, and interchangeable for ventilators and openings of the same size. Hardware, guides, stops, clips, bolts, and screws shall be furnished as required for a secure and insect-tight attachment to window. Material finish of hardware, and finish of screen frames shall be as specified for windows. Horizontal cross bracing of screens, where required, shall be provided at the approximate center of frames. Bracing shall be located opposite meeting rails or horizontal muntins.

11.7.2 Type.

Screens for casements, awning and other out-projecting ventilators shall be stationary type. Sliding wickets or top-hinged wickets with friction catches shall be provided in screens for out-opening vents without underscreen or through-screen operators. The wicket opening shall be framed from members identical in material and cross section with the screen frame and shall be reinforced by members of equal strength and rigidity extending across the screen. Reinforcement shall be either one horizontal member across the top of the opening or two vertical members, one on each side of the opening.

11.7.3 Steel-Frame Screens.

shall conform to SWI "Recommended Standards for Steel Windows." The frames shall have removable splines of steel or vinyl. Screening shall be 18 by 18 mesh nonmetallic glass material.

11.7.4 Aluminum-Frame Screens.

Aluminum-frame screens shall be of extruded aluminum, and shall conform to AAMA "Specifications for Aluminum Windows." The frames shall have removable splines of aluminum or vinyl. Screening shall be 18 by 18 mesh and of either aluminum or nonmetallic glass material.

11.8 INSTALLATION OF WINDOWS.

11.8.1 General.

Installation shall be done by skilled window craftsmen. Windows shall be set plumb, level, in alinement, and properly braced to prevent distortion. Ventilators and operating parts shall be protected against accumulation of cement, lime, and other building materials by keeping ventilators tightly closed.

11.8.2 Window Anchors.

Window anchors shall be properly spaced not exceeding 24 inches apart and set in masonry openings during progress of wall construction.

11.8.3 Adjustment.

After window installation and completion of glazing and painting, windows and operating hardware shall be adjusted to provide free operation and

watertight conditions when sashes are closed and locked. Hardware and operating parts shall be lubricated or waxed as required.

11.9 PROTECTION AND CLEANING.

11.9.1 Protection.

Care shall be used in handling windows during transportation and at the jobsite. Windows shall be stored at the site on edge and under cover. After installation, windows shall be protected from damage during subsequent construction activities.

11.9.2 Cleaning.

Metal surfaces of windows shall be cleaned, on both the inside and outside, of all mortar, plaster, paint, and other foreign matter to present a neat appearance and prevent fouling of weathering surfaces, weatherstripping, or the operation of hardware. In addition, aluminum windows and zinc-coated steel windows shall be washed with soap and water using a stiff-fiber brush and shall be thoroughly rinsed with clear water. Where aluminum windows have become stained or discolored, the windows shall be cleaned or have finish restored in accordance with recommendations of the referenced trade association publication. Abraded surfaces of steel windows shall be satisfactorily cleaned and touched up. After all other work in the area has been completed, including painting, the windows shall be cleaned for final acceptance by the COR.

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SECTION 12

METAL TOILET ENCLOSURES & SCREENS

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SECTION 12

METAL TOILET ENCLOSURES & SCREENS

12.1 GENERAL

This section covers the requirements for the fabrication and installation of metal toilet enclosures, urinal screens and room entrance screens as shown and noted on the drawings.

12.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification.

12.2.1 Uniform Building Code (UBC)

12.3 MATERIALS

All materials and finishes shall be standard of the enclosure and screen manufacturer. Minimum requirements are as follows:

12.3.1 Carbon-Steel Sheets

Carbon-Steel Sheets shall be stretcher-leveled standard of flatness. Surface shall be extra smooth or temper rolled and heat treated to a smooth surface. Surfaces shall be given a zinc phosphate treatment. All steel shall be suitable for necessary die drawings and forming operations without fracturing, flaking, or peeling the coating. Except where otherwise indicated, the minimum nominal thicknesses of zinc-coated sheet metal before fabrication shall be as follows for the items shown below based on United States standard gage:

<u>Item</u>	<u>Nominal Thickness (inch)</u>	<u>Gage</u>
Faces of doors - - - - -	0.0299	22
Faces of enclosures, overhead-braced pilasters, overhead bracing, and urinal screens; edge-locking strips of doors, and edge-facing strips - - - - -	0.0359	20
Edge-locking strips of floor-supported and ceiling-hung pilasters - - - - -	0.0478	18
Faces of floor-supported and ceiling-hung pilasters - - - - -	0.0598	16
Concealed reinforcement for tapping - - - - -	0.0747	14
Concealed reinforcement for anchoring devices - - - - -	0.1046	12

12.3.2 Cores

The cores of doors, screens, pilasters, and panels shall be a compressed, lightweight, corrugated paperboard material or heavypaper honeycomb flanged or faced on both sides with heavy kraft paper. The finished core shall be cemented to both face panels. The back 4 inches of the core for urinal screens adjacent to wall connections shall be steel reinforced as specified hereinafter.

12.3.3 Expansion Shields

Expansion Shields shall be of the type and style best suited for the purpose. Shields shall be accurately recessed and, unless otherwise specified, shall be recessed not less than 2 inches into concrete or masonry.

12.3.4 Paint

Prime coat shall be a thermosetting primer in which the nonvolatile vehicle shall be a mixture of epoxy and phenol-formaldehyde resins and shall be applied to a minimum dry-film thickness of 0.6 mil. Finish coat shall be an approved alkyd enamel and shall be applied at a minimum dry-film thickness of 0.8 mil. At the option of the manufacturer, other types of primer and enamel finish including acrylic resin type may be used provided the finish will be at least equal to an alkyd enamel coating and a total dry-film thickness of not less than 1.4 mil thickness is obtained. All paint finishes shall be conducive to easy cleaning.

12.3.5 Hardware

Hardware shall be standard of the manufacturer as shown or noted on the approved shop drawings.

12.4 SHOP DRAWINGS

The Constructor shall submit shop drawings or catalog data prior to procurement, to the Contracting Officer's Representative (COR). The COR will retain three (3) copies of each drawing, catalog cut, or descriptive material submitted, and return the remainder of the copies to the Constructor. The shop drawings shall show plans, elevations, details of construction, gages of metal, hardware reinforcing, fittings, floor mountings, and fastenings. Material shall not be delivered to the jobsite before the shop drawings have been approved.

12.5 DIMENSIONS

12.5.1 Toilet Enclosures

Toilet Enclosures shall be arranged as indicated on the drawings. Dimensions based on 2-foot 10-inch centering of panels shall be approximately as follows:

Enclosure Panels:

Enclosure depth	4 feet 9 inches
Height	4 feet 10 inches
Floor clearance	1 foot

Pilasters:

Height	5 feet 10 inches
Floor clearance	-----
Width:	
Wall end	4 inches
Intermediate	10 inches
Free end	8 inches

Doors:

Height	4 feet 10 inches
Width (opening)	2 feet

Urinal Screens:

Height	3 feet 6 inches
Floor clearance	1 foot
Depth	2 feet

Where the enclosure width varies from the standard 2-foot 10-inch by not more than 2 inches, the width of pilasters shall be as specified above, and the width of doors increased or decreased as required. For enclosures wider than 3 feet, 26-inch wide doors shall be used and the width of pilasters adjusted as required.

12.5.2 Room-Entrance Screens

Room-Entrance Screens shall be of the dimensions indicated on the drawings.

12.6 CONSTRUCTION

Panels, screens, pilasters, and doors shall be constructed of two face sheets, with integral, overlapped, or formed edges, assembled over and cemented under pressure to the core. Formed edges, if used, shall be bound and locked with slip-lock binding strips or by slip-lock edge-facing strips that hold the sheets with a tension grip. Binding and edge-facing strips shall be mitered and welded at corners with welds ground smooth or shall have corrosion-resisting-steel corner fitting clamped over the facing strip. Edges of doors, partitions, and pilasters shall be of the same design. The doors and pilasters shall be strengthened against torsional stress either by tack, spot, or plug welds, or by internal reinforcing. Doors, room-entrance screens, and panels shall finish uniformly 1-inch thick. Pilasters and urinal screens shall finish uniformly 1 1/4 inches thick with a tolerance of plus or minus 1/32 inch. Surfaces shall be smooth and free from wave, warp, and

buckle. Where machine screws are used for fastenings, the panels, pilasters, and doors shall have concealed tapped reinforcement welded or brazed to the backs of faces, or rivet nuts with gaskets for the attachment of hardware and accessories. Panels shall be fastened to pilasters by two stirrup brackets, each through-bolted to the panel with a tamperproof-head sex bolt and fastened to pilaster with two tamperproof-head machine screws providing 1/2-inch clearance between the edge of the panel and the face of the pilaster. Sheet-metal screws shall not be used in the assembly of the enclosures or accessories.

12.7 PILASTER BASES

Pilaster bases shall be of 0.031-inch thick corrosion-resisting steel not less than 3 inches high and shall be secured in place with screws or concealed clips. Finish shall be No. 4 or at the option of the manufacturer may be electropolished to produce a surface brightness of not less than No. 4.

12.8 BRACKETS

Wall and stirrup brackets for screens and pilasters shall be extruded bright-polish-finish anodic-coated aluminum, chromium-plated brass, or die-cast zinc alloy with rounded edges that are either chromium-plated or have a baked-enamel finish coat to match the partition finish. Brackets shall have clamp flanges fastened to the panels with 3/16-inch diameter chromium-plated brass tamperproof sex bolts. Each wall bracket shall be anchored with two toggle bolts for hollow masonry or plaster surfaces, machine screws with expansion shields for concrete surfaces, and 1/4-inch minimum lag screws into studs or blocking for drywall construction. The minimum bearing surface of the brackets against the wall shall be 3 square inches for screens and 2 square inches for pilasters, and the minimum projection shall be 3 inches.

12.9 SUPPORT AND ANCHORAGE OF PILASTERS

Pilasters shall be fastened to the structural slab by means of a built-in zinc-coated steel-channel or steel-plate anchoring device and a horizontal steel bolting member not less than 1/2- by 7/8-inch welded to inner pilaster faces. The anchoring device shall be fastened to the structural concrete by two 3/8-inch minimum-diameter cadmium-plated or zinc-coated steel studbolts and expansion shields having a penetration of not less than 2 inches into the structural concrete. Pilasters with wall supports shall have one such studbolt near the edge that adjoins the door. The top edge of doors and top edge of pilasters shall be at the same level when doors are closed.

12.10 FINISH

Phosphate-treated surfaces shall be given a factory-applied finish paint specified hereinbefore. It shall be applied by the spray method so controlled as to provide the specified thickness of coating over all areas of the partition component being painted. Colors for partitions

and doors shall be as selected by the COR from the manufacturer's standard color chart. All finishes applied shall be conducive to easy cleaning.

12.11 HARDWARE

12.11.1 General

Hardware and fastenings shall be plain, heavy pattern, aluminum, zinc alloy, corrosion-resisting steel, or, wrought, extruded, or cast brass. Exposed surfaces of hardware and fastenings shall be finished as follows: brass and zinc alloy shall have a chromium-plated finish; aluminum shall be satin finish and shall have an anodic coating; corrosion-resisting steel shall have an anodic coating; corrosion-resisting steel shall have a No. 4 finish. Enclosure doors shall swing in, and each enclosure shall be fitted with hinges, slide latch or concealed bolt, combination stop and keeper, and combination coat hook and bumper. Hinges, stops, and keepers shall have clamp flanges fastened with 3/16-inch sex bolts or fittings applied internally to formed edge of pilaster face. Surface-applied hardware shall be applied with machine screws. Sex bolts and machine screws shall have one-way right-hand heads or spanner heads. Where boltheads and screwheads are spanner type, two tools to fit the heads shall be provided.

12.11.2 Hinges

Hinges shall be of the spring-tension, gravity, or torsion-bar type and shall be adjustable to bring the door to rest in any position. Hinges shall be adjusted to hold the door open at 30 degrees.

12.11.2.1 Spring-Tension and Gravity Types. The lower hinge shall be concealed within the door and shall have either a corrosion-resisting ball bearing roller operating on a corrosion-resisting steel cam or two mating nylon-resin cams aligned by a steel pin. The contact surface between cam and roller or between mating cams shall be in the same plane at all locations. The upper hinge shall have a pivot pin secured above and below the point of bearing with the bearing concealed in a supporting member placed in a cutout near the top of the door. Top pivots of gravity-actuated hinges shall be designed to accommodate the vertical movement of the door. Pivot guide pins shall be plastic-resin or hardened corrosion-resisting steel. Moving parts shall have either nylon, self-oiling graphite-bronze, or thrust-frictionless bearings.

12.11.2.2 Torsion-Bar Type. The upper and lower hinges shall have a torsion-bar attached to a stationary member at one end and to an oil-impregnated copper-base-alloy bearing at the other end operating on a corrosion-resisting steel bushing. Working parts shall be concealed within the door. Upper and lower brackets shall be of die-cast zinc alloy or other nonferrous alloy. The weight of the door shall be carried on a thrust bearing held in alignment by a fixed vertical pintle.

12.11.3 Latch and Bolt

The latch shall be the sliding type and shall consist of an encased bar approximately 3/4-inch wide by 3 inches long operated by a knob. At the Constructor's option a corrosion-resisting steel bolt actuated by a cam mechanism of die-cast zinc or other nonferrous alloy installed between faceplates of doors may be used. The latch shall be mounted on the door midway between the top and bottom edges.

12.11.4 Combination Stop and Keeper

Combination Stop and Keeper shall be of type standard with the manufacturer, and shall be of nonferrous alloy, fitted with a rubber bumper.

12.11.5 Combination Clothes Hook and Bumper

Combination Clothes Hook and Bumper shall have a minimum projection of 3 inches and a base not less than 1 1/2 inches in diameter. The hook and bumper shall be mounted approximately 3 inches from the top and 6 inches from the swing edge of the door.

12.12 URINAL SCREENS

Urinal Screens shall be the wall-hung flush type, 24 x 42 x 1 1/4 inches, fabricated of zinc-coated steel faceplates over core as specified for toilet enclosure panels except that the 4 inches of the panel abutting the wall shall have concealed reinforcement from the top to the bottom of the screen. The reinforcement shall be 4- x 4-inch angles of not lighter than 11-gage steel (0.1196-inch nominal thickness) or other equivalent steel shape continuously welded to the backs of the faceplates. The screen shall be fastened to the wall by four bolts on each side of the screen through the reinforcing-angle flange, using 1/4-inch toggle bolts in masonry walls, 1/4-inch anchor bolts in expansion sleeves in concrete walls or 1/4-inch lag screws into wall studs or blocking in dry wall construction. Screens shall be painted as specified in Paragraph 12.10, "Finish" hereinbefore. The color shall be the same as the toilet enclosures.

12.13 ERECTION

The enclosures and screens shall be erected straight and plumb, with all horizontal lines level. Enclosure panels shall be installed with a clearance of approximately 1 inch at walls. Wall-end pilasters shall be installed with a clearance for cove base. Panels and pilasters shall be fastened to walls with brackets located near top and bottom. The clearance of vertical edges of doors shall be uniform from top to bottom and shall not exceed 3/16 inch. Hardware shall be carefully adjusted and left in perfect working order. After all other work in the area, including painting, is completed, the exposed surfaces of the enclosures, screens, and fittings shall be cleaned.

SECTION 14

CARPENTRY

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SECTION 14

CARPENTRY

14.1 GENERAL.

This section covers the requirements for carpentry including framing and finishing, wood doors and frames, drywall finish and thermal insulation as shown and noted on the drawings.

14.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specifications:

14.2.1 American Institute of Timber Construction (AITC):

100 Timber Construction Standards

14.2.2 American Wood-Preservers' Association (AWPA):

American Wood Preservers' Association Standard

14.2.3 Federal Specifications (FS):

L-S-125B	Screening, Insect, Nonmetallic
FF-B-575C	Bolts, Hexagon and Square
FF-B-588C	Bolt, Toggle; and Expansion Sleeve, Screw
FF-N-105B	Nails, Brads, Staples, and Spikes, Wire, Cut and Wrought
FF-S-325	Shield, Expansion; Nail Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
HH-I-521E	Insulation Blankets, Thermal (Mineral Fiber for Ambient Temperatures)
HH-I-585C	Insulation, Thermal (Vermiculite)
QQ-S-698	Steel Sheet and Strip, Low-Carbon
QQ-S-700C	Steel Sheet and Strip, Medium and High-Carbon
QQ-S-775E	Steel Sheets, Carbon, Zinc-coated (Galvanized) by the Hot-Dip Process)
QQ-W-461G	Wire, Steel, Carbon (Round, Bare, and Coated)

QQ-Z-363B	Zinc-Base Alloy; Die Castings
RR-W-365	Wire Fabric (Insect Screening)
RR-W-370B	Wire Fabric, Steel, Hot-Dipped Galvanized
SS-B-775A	Building Board, Asbestos-Cement; Flat and Corrugated
SS-L-30D	Lath, and Board Products, Gypsum
TT-C-490B	Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings
TT-V-121G	Varnish, Spar, Water-Resisting
TT-W-571I	Wood Preservation; Treating Practices
TT-W-572B	Wood Preservative: Water-Repellent
UU-B-790A	Building Paper, Vegetable Fiber; (Kraft, Waterproofed, Water Repellent and Fire Resistant)
LLL-B-805	Building Board, Hard Pressed, Vegetable Fiber; Prefinished Hardboard Panels
LLL-I-535A	Insulation Board, Thermal and Insulation Block, Thermal
MMM-A-125C	Adhesive; Casein-Type, Water and Mold-Resistant
MMM-A-188C	Adhesive; Urea-Resin-Type (Liquid and Powder)

14.2.4 International Conference of Building Officials:

Uniforms Building Code (UBC)

14.2.5 National Forest Products Associations (NFPA):

National Design Specification for Stress-Grade Lumber and Its Fastenings

14.2.6 National Woodwork Manufacturers Association (NWMA):

Water Repellent Preservative Treatment

14.2.7 Redwood Inspection Service:

Standard Specifications for Grades of California Redwood Lumber

14.2.8 U.S. Department of Commerce Commercial Standards (CS):

PS1-66 Softwood Plywood--Construction and Industrial

CS-73 Old Growth Douglas Fir, Sitka Spruce, and Western Hemlock
Standard Stock Doors

GS-120 Standard Stock Ponderosa Pine Doors

CS-171 Hardwood, Veneered Doors (Solid-Core, Hollow-Core, and
Panel and Sash)

R16 Simplified Practice Recommendation

14.2.9 Underwriter's Laboratories, Inc., (UL):

Building Materials Directory

Fire Resistance Index

14.2.10 West Coast Lumber Inspection Bureau Standard:

Rule 16 Standard Grading and Dressing Rules for West Coast Lumber

14.2.11 United States Gypsum:

Gypsum Drywall Construction Handbook

14.2.12 American Society for Testing and Materials (ASTM):

A 366 Steel, Carbon, Cold-rolled Sheet, Commercial Quality

D 245 Establishing Structural Grades and Related Allowable
Products for Visually Graded Lumber

E 84 Surface Burning Characteristics of Building Materials
Test for,

14.2.13 American National Standards Institute (ANSI):

A97.2 Installation of Steel Framing Members to Receive Screw
Attached Gypsum Wallboard and Backing Board, Specifications
for,

14.3 LUMBER.

14.3.1 Grade Marking.

Each piece of yard and structural lumber shall bear the official grade
mark of the appropriate inspection bureau or association.

14.3.2 Sizes and Patterns.

Lumber shall be surfaced four sides and the dressed sizes of yard and
structural lumber shall conform to Department of Commerce R16. Worked
material, except as otherwise indicated on the drawings, shall conform
to the standard patterns of Department of Commerce R16.

14.3.3 Moisture Content.

Boards and dimension lumber not over 2 inches nominal thickness to be incorporated in a structure, except finish material and flooring, shall be kiln-dried or air-dried and moisture content shall not exceed 19 percent. Moisture content of lumber over 2 inches nominal thickness shall conform to the rules of the association under which it is graded and may be incorporated in a structure without further seasoning. Exterior and interior finishing lumber and flooring shall be kiln-dried and at time of delivery to the building site the moisture content shall not exceed 12 percent for material 1-inch or less in thickness, and shall not exceed 14 percent for material over 1-inch in thickness. Millwork, which is assembled or built up of more than one piece at the mill, except doors, shall have a moisture content not in excess of 12 percent.

14.3.4 Treated Lumber.

All lumber used for skids and framing up to underside of subfloors, sills installed on concrete, and all lumber as noted on the drawings, shall be fully pressure treated with pentachlorophenol. Lumber sawed, bored, or cut after treatment shall have cut surfaces well brushcoated with same preservative. Lumber delivered to the material staging area shall be accompanied by a certificate from the lumber treatment company certifying to the amount of treatment and percentage of moisture after kiln drying.

14.3.5 Fire Retardant Lumber and Plywood.

Fire retardant lumber and plywood shall conform to the specification for the material included under paragraph 14.11.

14.3.6 Storage.

Lumber delivered to the site shall be carefully stacked off the ground in such manner as to ensure proper ventilation, and protection from the weather.

14.4 WOOD FRAMING.

Framing lumber and other rough work shall be closely fitted, accurately set to required lines and levels, and rigidly secured in place. Rafters and ceiling joists shall be set with crown edge up, and bottom edges shall be free from pronounced defects. Studs and joists shall be sized to give true surfaces for finish. No framing members, shall be cut, notched, or bored for the passage of pipes and conduits without permission from the Contracting Officer's Representative (COR). Framing members damaged by cutting shall be reinforced. Nailing and spiking shall be done in a thorough manner, using nails and spikes of the size as required on the drawing or in the referenced material.

14.4.1 Partitions and Walls.

Partitions and walls shall be framed with 2- by 4-inch studs spaced 16 inches on centers, unless otherwise shown on the drawings. Plates of partitions resting on concrete floors shall be anchored in place with 1/2-inch bolts spaced not more than 6 feet apart. Studs shall be doubled at openings. Headers for openings up to 4 feet in width shall be made of two pieces of stud material set on edge; for openings greater than 4 feet, they shall be as indicated on the drawings, or approved by the COR. Corners shall be thoroughly spiked and made solid. Partitions and exterior walls shall be provided with one row of horizontal blocking, the full width of the studding, cut-in and securely nailed. Studs shall be framed as shown or as required for proper installation of finish, fixtures, cabinets, and other work.

14.4.2 Floor and Roof Framing.

Members shall be assembled, fitted, and set as shown or noted on drawings. Tops of joists shall form a true plane and shall be framed on sills or plates with close joints. Blocking shall be provided where necessary to form nailings for floor or roof deck.

14.4.3 Nailing Strips.

Nailing strips, shall be continuous unless otherwise shown on the drawings, cut with square ends in as long lengths as practicable, and rigidly secured in place.

14.5 METAL STUD FRAMING.

14.5.1 Channels.

Channels shall be formed from steel sheets conforming to Federal Spec. QQ-S-700 or QQ-S-775, Class E, as applicable. Channels shall be galvanized or coated with manufacturer's standard protective coating and shall conform to the following dimensions unless otherwise shown on the drawings.

14.5.1.1 Ceiling and Floor Runner Channels shall not be less than 0.0221-inch nominal thickness. Runner channel shall have 1 1/4-inch flanges and channel web-sized to nest with comparable steel studs herein-after specified.

14.5.2 Steel Studs.

Steel studs shall be of the size indicated on drawings, conform to Federal Spec. QQ-S-698 and be galvanized or coated with manufacturer's standard protective coating. Stud flanges shall be not less than 1 3/8 inches wide and each flange shall, in addition, have a stiffening lip bent parallel to the stud web. Stiffening lips shall be at least 1/4-inch wide with turned or folded edges.

14.5.3 Fasteners.

14.5.3.1 Bolts shall conform to Federal Spec. FF-B-575C.

14.5.3.2 Expansion Shields shall conform to Federal Spec. FF-S-325, Group I, II, or III, of the type and class applicable.

14.5.3.3 Screws for wallboard attachment shall be shouldered flat-head design for use with special power-driven tools. Metal screws shall be not less than one inch long with self-tapping threads and self-drilling points.

14.5.3.4 Toggle Bolts shall conform to Federal Spec. FF-B-588, type and class best suited for the purpose.

14.6 EXTERIOR WOOD FINISH.

Exterior wood finish shall be milled from the material specified and shall be erected as shown on the drawings. Exposed surfaces of finish woodwork shall be smooth-machine-sanded ready to receive paint. Nailing shall be blind where possible, and where face nailing is used, face nails shall be set for putty-stopping. Door trim shall be in single lengths. Exterior millwork shall be constructed so that water cannot pass through joints.

14.7 INTERIOR WOOD FINISH.

Interior wood finish shall be manufactured of the woods specified and shall be of sizes shown on the drawings. Surfaces other than trim or molding shall be fire-retardant with a UL labeled flame spread rating as specified in 14.11.1.5 of this section. Finish shall be stored at the site only in weathertight sheds. Interior finish shall be milled, fabricated, and erected as shown on the drawings. Interior finish shall be machine-sanded at the mill and sandpapered smooth at the building when necessary. All interior trim shall be standard stock moldings and members of design and type shown. Interior trim to be set against wood in the building shall be run with hollow backs. Joints shall be made in an approved manner to conceal shrinkage and be tight. Trim shall be secured with fine finishing nails and with screws and glue where required. Wood finish shall be set straight, plumb, or level, in perfect alignment, and shall be closely fitted. Fixed window and door trim shall be in single lengths. Base shall be in lengths as long as practicable. Moldings shall be mitered at corners and coped at angles.

14.8 DOOR FRAMES.

14.8.1 Exterior Door Frames.

Exterior door frames, unless otherwise shown, shall be 1 1/2 inches thick and double-rabbeted from the solid for door of thicknesses specified.

14.8.2 Interior Door Frames.

Interior door frames shall be 1 5/16 inches thick, full width of finished wall or partition, double-rabbeted from the solid. At the Constructor's option, door frames for partitions may be 3/4-inch thick by width required and may have 1/2-inch thick applied stops. Frames shall be set plumb and square, and secured with finishing nails. Double-wedge blocking shall be driven back of jambs as nailing points, also at back of butts and lock strikes.

14.9 DOORS.

Doors shall be of the sizes, thicknesses, designs and species indicated on the drawings. Top and bottom edges of doors shall be given two coats of spar varnish at the factory before shipment. Exterior doors shall be fabricated with water-resistant adhesives.

14.9.1 Exterior Doors.

Exterior doors shall be of softwood, as indicated on the drawings. Softwood doors shall have solid stiles and rails. Grade 2 for paint finish; of Douglas fir, Sitka spruce, or western hemlock shall conform to CS73, Grade B for paint finish; of redwood, cypress, or southern pine shall be equal in construction and quality to the corresponding grades of CS120 or CS73.

14.9.2 Interior Doors.

Interior doors shall be flush type, hollow core, unless otherwise indicated on the drawings. Face veneer shall be vertical grain both sides and edges of door, glued to core with phenolic resin glue using heat and pressure method as recommended by the manufacturer. Face veneers shall be paint-grade birch, unless indicated otherwise on the drawings.

14.9.3 Metal Louvers.

Metal louvers shall be pressed steel, adjustable type, of size noted on the drawings, baked enamel finish, color as selected by the COR.

14.9.4 Fitting, Hanging and Trimming.

Doors shall be fitted, hung, and trimmed as hereinafter specified and as indicated on the drawings. Doors shall have 1/16-inch clearance at sides and top, and 3/16-inch clearance over thresholds, unless otherwise directed by the COR. Doors in openings without thresholds shall have 3/8-inch clearance. Doors shall have the lock or latch edge beveled at the rate of 1/8 inch in 2 inches. Doors shall be hung and trimmed with hardware as shown or noted on the drawings and specified in Section 19, "Hardware." Locks with standardized cases shall all be installed at the same height. Knob locks and knob latches shall have the center of the knob 40 inches above the finished floor. Cylinder deadlocks shall have the center of the cylinder at the same height as the center of the cylinder of knob locks.

14.9.5 Dutch Doors.

Dutch doors shall be as detailed on drawings.

14.10 DRYWALL FINISH.

14.10.1 General.

Gypsum board applied to walls and ceilings shall be of the standard fire-resistant type noted on the drawings and shall be installed in one or more layers as shown.

14.10.2 Materials.

14.10.2.1 Gypsum Wallboard of the type required shall be standard size sheets 48 inches wide by lengths up to 16 feet. Unless otherwise indicated, edges of boards shall be tapered to receive joint reinforcing strips. Wallboard shall be not less than the thickness indicated on the drawings. Wallboard referred to herein is the basic board, papered on both sides and without special face coating and shall be non-combustible, shall have been tested according to the "Method of Test of Surface Burning Characteristics of Building Materials, ASTM No. E-84" (aka NFPA No. 255) an approved, nationally recognized, testing laboratory and material shall have a flame spread rating not greater than 25, a fuel contributed rating not greater than 50, and a smoke developed rating not greater than 50.

14.10.2.2 Corner Beads shall be formed to an angle of 90 degrees and shall be either zinc-coated steel not lighter than 26 gage (0.0179-inch nominal thickness) with wings not less than 7/8-inch wide and perforated for nails and cement treatment, or formed of zinc-coated steel or protected aluminum legs approximately 3/4-inch wide, pressed into a bedding of rubber-base adhesive.

14.10.2.3 Joint Cement shall be an adhesive cement recommended by the manufacturer of the gypsum wallboard.

14.10.2.4 Nails for securing the wallboard shall have heads of approximately 1/4-inch diameter. Nail lengths shall be approximately 1 1/8 inch for 3/8-inch wallboard, 1 1/4 inch for 1/2-inch wallboard, and 1 3/8 inch for 5/8-inch wallboard shall be approximately 1 1/2 inch, 1 3/4 inch and 2 inch respectively. Nails may be cement coated or blued. Nail spacing shall be 6 inches to 8 inches for walls and 5 inches to 7 inches for ceiling. Nailing methods shall be in accordance with the wallboard manufacturers instructions. Special nailing shall be as shown on the drawings.

14.10.2.5 Reinforcing Tape where required, shall be as recommended by the manufacturer of the gypsum wallboard.

14.10.2.6 Storage. Wallboard delivered to the site shall be carefully stacked and off the ground and covered in a manner to assure protection from the weather.

14.10.3 Waterproofing.

Before erection, the paper-covered faces and edges of gypsum wallboard abutting of adjoining concrete, shall be treated with a waterproofing agent approved by the manufacturer of the wallboard, or treated with two coats of sizing varnish. The treatment shall extend not less than 4 inches in on the paper on both faces of the board.

14.10.4 Application.

Wallboard shall be applied with the reverse side against the framing members and with the separate boards in moderate contact but not forced into place. At internal and external corners the cut edges of the boards shall be concealed by the over-lapping covered edges of the abutting boards. The boards shall be so staggered that the corners of any four boards will not meet at a common point except in vertical corners. Wallboard shall be applied in such lengths as will result in a minimum of joints.

14.10.4.1 Ceilings. Wallboard shall be applied to the ceilings with the long dimension of the wallboard parallel to or at right angles to the nailing members and shall be supported in such manner as to prevent sagging along the entire length of the wallboard until sufficient nailing is completed to hold the board in place.

14.10.4.2 Walls. The long dimension of the boards shall be placed parallel to the framing members. The panels shall be of the length required to reach from the ceiling line to the floor line in one continuous length. Joints shall be made over framing members. For horizontal application, the long dimension of the boards shall be placed at right angles to the framing members. End joints, where required, shall be made over framing members.

14.10.4.3 Two-Layer Application to walls and ceilings, when required by the drawings, shall be applied with all joints broken, with respect to the first layer, by at least one wall or ceiling bearing. Nails shall be driven along accurately struck lines.

14.10.4.4 Joint, Corner and Nail Depression Treatment shall be accomplished by the Constructor using methods and tools consistent with modern drywall finishing. Finished surfaces shall be smooth, ready for paint application on walls and spray-on acoustical treatment on ceilings unless indicated otherwise on the drawings.

14.11 FIRE RETARDANT LUMBER.

14.11.1 General.

14.11.1.1 Tests and Approval. All fire-retardant lumber and plywood shall be the product of a manufacturer regularly engaged in the production of this type of material. All lumber and plywood shall be fire-retardant and shall have been tested according to the "Method of Test of Surface

Burning Characteristics of Building Materials, ASTM No. E-84" (aka NFPA No. 255) (aka UL 723). Test shall have been performed by an approved nationally recognized testing laboratory and material shall have a flame spread rating not greater than 25, a fuel contributed rating not greater than 50, and a smoke developed rating not greater than 50.

14.11.1.2 Manufacture. All lumber and plywood shall be pressure-impregnated with inorganic mineral salts and shall be Koppers Company, Inc., "NON-COM EXTERIOR" (nonleaching) or an approved equal.

14.11.1.3 Lumber shall be construction grade Douglas fir having a fiber stress of 1200 psi, surfaced 4 sides and of sizes indicated on the drawings.

14.11.1.4 Plywood shall be laminated Douglas fir, exterior type, DFPA, with faces and thicknesses indicated on the drawings. All sheets shall be 4 x 8 feet in size.

14.11.1.5 Fire Hazard Classifications for the fire-retardant lumber and plywood, based on comparative classifications of 100 for untreated red oak and zero for asbestos-cement board, determined by UL, Test 723 (ASTM E-84) and shall not exceed the following:

	<u>DF Lumber</u>	<u>DF Plywood</u>
Flame Spread	25	25
Fuel Contributed	50	50
Smoke Developed	50	50

14.12 INSULATION.

14.12.1 General.

The types and thermal conductivity of insulation shall conform to the requirements noted on the drawings. Thickness of insulation indicated is nominal. The Constructor shall install insulation of proper thickness and density to provide the required "U" factor as called for on the drawings. UL flame spread rating shall not exceed 25, fuel contributed and smoke developed not over 50. UL classification must be attached.

14.12.2 Installation.

Installation of thermal insulation shall conform to the manufacturer's recommendations or specifications. Special installations shall conform to the details shown on the drawings.

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SECTION 15

GLASS & GLAZING

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SECTION 15

GLASS & GLAZING

15.1 GENERAL.

This section covers the requirements for glass and glazing pertinent to windows, doors, walls, partitions and mirrors as shown and noted on the drawings.

15.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

15.2.1 Federal Specifications (FS):

DD-G-451	Glass, Plate, Sheet, Figured (Float, Flat, for Glazing, Corrugated, Mirror, and Other Uses)
DD-M-411	Mirrors, Glass
QQ-L-201	Lead Sheet
TT-G-410E	Putty and Elastic Compounds
TT-P-791	Putty: Linseed-Oil Type (for Wood-Sash-Glazing)
TT-V-121	Varnish, Spar, Water-Resisting

15.2.2 Underwriters' Laboratories (UL):

Classified Building Materials Index

15.2.3 National Fire Protection Association (NFPA):

Standard No. 80 Fire Doors and Windows

15.2.4 International Conference of Building Officials (UBC):

Uniform Building Code

15.2.5 U. S. Department of Energy (DOE):

Manual Appendix 2401

15.3 MATERIALS.

15.3.1 Glass.

Glass shall be of the following types, qualities, and thicknesses and shall conform to FS DD-G-451:

15.3.1.1 Clear Sheet Glass shall be double strength, B quality, for sizes up to and including 80 united inches; and 3/16-inch thick, A quality, for sizes over 80 up to and including 144 united inches.

15.3.1.2 Polished Plate Glass shall be 1/4-inch thick, glazing quality, for sizes over 144 united inches.

15.3.1.3 Obscure Glass shall be glazing quality, not less than 1/8-inch thick, rolled, figured one surface, unpolished, pattern as called for on the drawings.

15.3.1.4 Rolled Wire Glass shall be clear, 1/4-inch thick, polished both surfaces. Obscure glass where required, shall be rolled, figured one surface, unpolished, pattern as called for on the drawings. Wire incorporated in the glass shall be twisted hexagonal mesh or welded diamond mesh. Where used in fire walls or doors, the wire glass shall bear the labels of the UL or FM indicating the fire rating of the glass.

15.3.1.5 Light-Diffusing Glass shall be glazing quality, not less than 1/8-inch thick, rolled, figured one surface, unpolished, pattern as called for on the drawings. Light diffusing glass shall be polished on the smooth surface for interior installations only.

15.3.1.6 Laminated Glass shall be two or more pieces of glass held together by interlayers of transparent plastic having suitable binding characteristics, stable without edge sealing. Interlayers shall be either clear polyvinyl butyl plasticized with 21.0 plus or minus 2 parts by weight of triethylene glycol di-2-ethyl butyrate, 3GH per 100 parts resin, or a silicone material of not less than 0.15-inch thickness. Each glass assembly shall be indelibly marked with the manufacturer's trade mark, and with the word "Laminated" etched or sandblasted on the glass surface. Laminated glass shall be fabricated from the type and thickness of glass called for on the drawings.

15.3.1.7 Glass Security-Barriers. Where primary reliance is placed on glass as a physical security- barrier, it shall meet the standards specified in D.O.E. Manual Appendix 2401. The glass shall be shatter - resistant - laminated glass panes of 9/32" minimum thickness.

15.3.1.8 Corrugated Glass shall be plain or obscure, as called for on the drawings, and shall be not less than 1/4-inch body thickness. One surface shall be polished for exterior installation and both surfaces shall be polished for interior installations. The panels shall be the manufacture's standard widths, with the cut edge along the top of a corrugation.

15.3.2 Mirrors.

15.3.2.1 Polished Plate Glass Mirrors larger than 18 by 30 inches shall be of mirror glazing quality, not less than 1/4-inch thick. Mirrors shall conform to FS DD-M-411. One surface of the glass shall be coated as follows:

Silver coating shall consist of chemically deposited silver. It shall be free from defects or blemishes in the reflecting surface such as lifting or separation of silver from the glass, free from sulfide or other spots, from haze resulting from incomplete removal of chemicals used in preparing the silvered surface of the glass, and from any other defects in the silver.

Copper backing shall consist of a film of copper electrolytically deposited to a thickness of 0.0002-inch directly over the silver surface.

Protective coating consisting of two coats of clear, water-resisting spar varnish shall be applied over the silvered and copper-coated surface and all edges of the mirror.

Frames shall be of the type and material indicated on the drawings.

15.3.3 Multiple-Pane Insulating Units shall be the manufacturer's standard products, consisting of lights of glass separated by dehydrated air spaces hermetically sealed at the factory. Dehydration shall be guaranteed by the manufacturer for a period of not less than 5 years. The manufacturer's identifying label shall be affixed to both exterior surfaces of the glass unit. Obscure glass, where indicated, shall be installed as the outside pane of the unit, with the smooth surface of the glass on the exterior. The obscure pane shall be installed so that the figures run in the same direction in all panes after installation. Units may be of the type with glass bonded to metal or sealed in a corrosion resisting metal frame.

15.4 INSTALLATION.

15.4.1 General.

The sizes of glass shown on the drawings are approximate. The sizes and proper edge clearances, as specified in Table 54c of the Uniform Building Code, shall be determined by measuring the actual unit to receive the glass. Except where specified otherwise, each piece of glass shall bear the manufacturer's label to identify its type, as well as thickness and quality. Labels shall not be removed until final approval is obtained. Operative sash shall move freely and properly in the frame of the unit prior to glazing. Movable items shall be securely fixed, or in a closed and locked position until putty or glazing compound has thoroughly set.

15.4.1.1 Clear Sheet Glass shall be used except where indicated otherwise. The glass shall be cut and installed with the visible lines or waves running with the horizontal dimensions.

15.4.1.2 Obscure Glass shall be used in doors and windows of toilet rooms, borrowed lights, and elsewhere as indicated. Glass for exterior units shall be installed with smooth side on the outside and the design in the same direction in all openings.

15.4.1.3 Wire Glass shall be used in doors and windows where indicated, and shall be clear or obscure glass as indicated. Where used in fire partitions or doors, wire glass and frames shall conform to NFPA Standard No. 80 and shall be UL listed.

15.4.1.4 Special type glass and treated glass shall be used where indicated. Glass utilized for safety purpose shall be approved or approved/tested by the COR.

15.4.2 Glazing Accessories.

15.4.2.1 Standard type corrosion resistant glazing points, wire springs, and setting shims shall be provided as required.

15.4.2.2 Special type shims, clips, springs, angles, beads, and attachment screws required for special units shall be furnished by the unit manufacturer, and installed in accordance with the approved written instructions of the manufacturer.

15.4.2.3 Resilient setting blocks, shims, clips, springs, spacers, angles, and vinyl or neoprene plastic channels required for setting multiple pane units, unless otherwise provided for, shall be installed in accordance with the approved written instruction of the insulating unit glass manufacturer.

15.4.3 Glazing in Wood.

15.4.3.1 Factory-Glazed Wood Items shall be shipped with rabbets and beads treated, or primed and painted at the factory prior to glazing.

15.4.3.2 Field-Glazed wood items shall have rabbets and beads primed and painted as specified under Section 18, "Painting," prior to glazing at the site. Glass, unless otherwise specified, shall be embedded in pure linseed-oil putty or elastic glazing compound. Glass panes, unless secured with beads furnished with the unit, shall be secured with not less than 8 zinc-coated glaziers points, and shall be neatly face puttied. The glass shall be firmly seated into the previously bedded and back-bedded rabbet. The manufacturer's specified number of glazing points, equally spaced on all four sides, shall be carefully driven into the wood to keep the glass from shifting. The rabbet shall then be filled with putty, beveled back against the wood members and cut to a neat trim line. Where beads are furnished with the unit, the beads shall be attached with not less than 1 1/2-inch length finishing nails, or flathead wood screws counter-sunk, and set approximately 5 inches on centers. A positive seal shall be provided between the glass and the wood on both sides of the glass. Nails or screws used in beads of exterior units shall be of a corrosion resistant type.

15.4.4 Glazing in Metal.

Elastic glazing compound shall be used for glazing in steel. A glazing compound having a composition and color particularly adapted for aluminum

and requiring no painting shall be used for glazing in aluminum. Glass panes, unless secured with screwed-on or snap-in beads furnished with the unit shall be secured with not less than 8 applicable glazing or wire springs, and shall be neatly face-puttied. The glass shall be firmly seated into the previously bedded and back-bedded rabbet, and the manufacturer's specified number of clips or springs, equally spaced on all four sides, shall be attached to keep the glass from shifting. The rabbet shall then be filled with glazing compound, beveled back against the metal members, and cut to a neat trim line. Beads, other than snap-in types, shall be attached with applicable length countersunk flathead screws set approximately 5 inches on centers. A positive seal shall be provided between the glass and the metal on both sides of the glass. Except where vinyl or neoprene channels are used in connection with glazing beads, glass installed in aluminum units shall rest on plastic shims or separators not less than 1/8-inch thick, installed in accordance with accepted glazing procedure so that glass will not rest on nor touch any aluminum member. Where glass lights are more than 1000 square inches in area, or with either dimension 36 inches and are in movable units without beads, the glass shall be secured by angle glazing clips, equally spaced and fastened to the metal members with applicable metal screws.

15.4.4.1 Glass in single-light fixed metal frames shall be set in continuous vinyl or neoprene plastic channels, and secured with metal beads attached with countersunk flathead screws, spaced approximately 5 inches on centers.

15.4.4.2 Rabbets and Beads of galvanized, bonderized, or factory coated metal units shall be thoroughly cleaned but require no painting prior to glazing.

15.4.5 Glazing of Insulating Units.

Units shall be installed in strict compliance with the glass manufacturer's warranty and written instruction. Edges and corners of the unit shall not be ground, nipped, cut, or fitted after leaving the factory. Springing, twisting, or forcing of units in setting will not be permitted. Units shall be set in 3/16-inch thick vinyl or neoprene setting channels or shall have not less than 3 vinyl or neoprene setting blocks 3/16-inch thick, not less than 4 inches long at top, bottom, and both sides. Units shall be additionally secured with metal glazing clips, beads, or angles, as required. Where vinyl or neoprene setting channels are used, they shall be of sufficient size and depth to cover the seal or corrosion-resistant metal frame completely.

15.4.6 Laminated Glass.

Laminated glass shall be embedded in glazing compound of a type that will not affect the lamination, as recommended by the glass manufacturer.

15.4.7 Corrugated Glass Panels.

15.4.7.1 General Setting. Panels shall be set on wood, hard neoprene, or plastic blocks, not less than 4 inches long and spaced not over 12 inches on centers. The blocks shall provide clearance not smaller than 1/8-inch on each jamb and at top and bottom of frames.

15.4.7.2 Interior Setting.

Butt Joints. Where glass is shown set edge to edge, the sides of abutting lights shall be accurately ground, and a coat of clear cellulose acetate lacquer or transparent cellulose tape shall be applied to prevent touching and spalling of edges.

Division bars. Where division bars are shown, the glass shall be secured as detailed, and not less than 1/2-inch coverage shall be provided from the edge of each light.

Moldings. The glass shall be held in plumb position with head and sill and finished with moldings as shown. Wood moldings shall be primed prior to setting.

15.4.7.3 Exterior Setting.

Butt joints, including mitered joints in exterior installations, shall be made waterproof by using a filler such as approved showcase cement.

Division bars. Approved weatherproof tape shall be used between the division bars and the glass, both inside and outside.

Moldings. The glass shall be bedded in elastic glazing compound most suitable for the purpose and colored to match the molding head, sill, and side jambs. Where aluminum moldings are shown, a compound that requires no painting and is applicable to aluminum shall be used.

15.4.8 Mirror Mounting Accessories.

Mirror mounting accessories shall consist of wood screws in lead or threaded metal sleeves, rosettes in metal expansion shields, lugs and anchors, toggle bolts, or other types of fastening devices as required by the construction. Mirrors in toilet and wash rooms shall be installed not more than 54 inches from the floor to the bottom of the mirror and centered on lavatory drains. Those in battery shall be carefully aligned. Mirrors shall be securely attached to anchors only after plastering, painting, and cleaning of the location have been completed.

15.5 REPLACEMENT AND CLEANING.

Upon completion of the work, all glass surfaces shall be thoroughly cleaned, with all labels, paint spots, putty, and other defacements removed. Cracked, broken, and imperfect glass shall be replaced.

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SECTION 16

RESILIENT FLOORING

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SECTION 16

RESILIENT FLOORING

16.1 GENERAL.

This section covers the requirements for the furnishing and installation of resilient flooring and base as shown and noted on the drawings.

16.2 APPLICABLE PUBLICATIONS.

The latest issues of the following Federal Specifications (FS), including revisions and amendments, form a part of this specification:

L-F-475	Floor Covering Vinyl, Surface (Tile and Roll), with Backing.
RR-T-650	Treads, Metallic and Nonmetallic, Nonskid
SS-T-312	Tile, Floor: Asphalt, Rubber, Vinyl, Vinyl-Asbestos
LLL-F-1238	Floor Covering, Linoleum

Adhesive for each type of resilient flooring shall be compatible with the flooring and as recommended by the flooring manufacturer. Metal edge strips shall be standard commercial type.

16.3 STORAGE.

Materials shall be stored at a minimum temperature of 75° F. for at least 24 hours before installation. Adequate ventilation shall be provided to remove moisture and volatile fumes. Materials and methods used shall be in accordance with the recommendations of the manufacturer of the resilient flooring. Materials shall be delivered to the project site in the manufacturer's original unopened containers with the manufacturer's brand and name clearly marked thereon.

16.4 MATERIALS.

Materials shall conform to SL L-F-475, RR-T-650, SS-T-312, and LLL-F-1238, as applicable. Material shall have a flame spread rating not greater than 25, a fuel contributed rating not greater than 50, and a smoke developed rating not greater than 50.

16.4.1 Resilient Flooring.

Resilient flooring shall be of the type, size, thickness, pattern, and as shown on the drawings, or approved by the Contracting Officer's Representative (COR).

16.4.2 Linoleum.

Linoleum shall be of thickness, design, and colors indicated on the drawings or approved by the COR.

16.4.3 Rubber or Vinyl Base.

Rubber or vinyl base shall be set-on type cove base, at least 5 inches high, color as indicated on the drawings or selected by the COR. Preformed inside and outside corners shall be provided. Cement shall be a waterproof type as recommended by the manufacturer of the rubber or vinyl base.

16.4.4 Adhesive.

Adhesive shall be the type required for the particular type of resilient flooring being installed, as recommended by the resilient flooring manufacturer.

16.5 INSTALLATION.

16.5.1 Surface Preparation.

Surfaces to receive resilient flooring shall be swept clean and shall be free from moisture, grease, oil, and other foreign substances. Cracks in concrete floors shall be filled with an approved plastic material. Depressions shall be brought to a level plane with a floor patch mixture of materials compatible with the type of adhesive to be used with the resilient flooring.

16.5.2 Priming Coat.

Priming coat, where required in accordance with the resilient flooring manufacturer's recommendations, shall be applied to concrete floors. The primer shall be worked well into the surface with a stiff brush or steel trowel using the minimum quantity of primer that will assure complete coverage. Primer shall be thoroughly dry prior to application of the adhesive.

16.5.3 Application of Resilient Flooring.

The adhesive or cement, as recommended by the manufacturer of the resilient flooring material, shall be applied to the floor with a notched steel trowel and allowed to set until the surface is tacky or as otherwise recommended. The flooring material shall be laid in such a manner that the entire underside of the flooring will be securely bonded in place. Floor tiles shall be laid in straight checkerboard design unless otherwise noted on the drawings. Flooring material, including tiles, sheet rubber or vinyl, and linoleum, shall be set with tight joints and in straight alignment. Where recommended, flooring shall be rolled with a heavy steel roller. Metal edge strips shall be provided to protect the edges of flooring where exposed at openings. All excessive adhesive or cement shall be removed from the surface of the flooring as recommended by the resilient flooring manufacturer.

16.5.4 Set-On Cove Base.

Set-on cove base shall be rubber or vinyl and shall be firmly cemented to the wall with the bottom in contact with the floor.

16.5.5 Cleaning and Finishing.

Upon completion of the installation, all flooring shall be thoroughly cleaned.

16.6 SPECIAL FLOOR TREATMENT.

Special floor treatment shall be of the material and application shown on the drawings.

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SECTION 17
ACOUSTICAL WORK

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SECTION 17

ACOUSTICAL WORK

17.1 GENERAL.

This section covers the requirements for the furnishing of acoustical material and the installation of acoustical work shown and noted on the drawings.

17.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

17.2.1 American Society for Testing and Materials (ASTM):

C 36 Gypsum Wallboard, Specification for

E-84 Surface Burning Characteristics of Building Materials,
Test for

17.2.2 Federal Specifications (FS):

SS-S-111 Sound Controlling Materials (Trowel and Spray Applications)

SS-S-118 Sound Controlling Blocks and Boards (Acoustical Tiles and
Panels, Prefabricated)

17.2.3 Underwriters' Laboratories, Inc., Publications (UL):

Building Materials Directory

Fire Resistance Directory

17.3 MATERIALS.

Material shall be tested according to the "Method of Test of Surface Burning Characters of Building Materials, ASTM No. E-84" (aka NFPA No. 255) (aka U.L. 723). Test shall have been performed by an approved nationally recognized testing laboratory and material shall have a flame spread rating not greater than 25, a fuel contributed rating not greater than 50, and a smoke developed rating not greater than 50. Suspension systems, adhesives and other materials used in the work shall be the standard products of recognized manufacturers and as shown on the drawings. All adhesives shall be U.L. listed and applied at the U.L. listed rate. Materials shall conform to the publications listed above, as applicable.

17.4 SUSPENDED CEILINGS.

17.4.1 Suspension System.

Suspension system for the support of set-in acoustical units or gypsum board and adhesive-applied acoustical units shall be the type indicated on the drawings. Runners to receive gypsum board shall be slotted type for nailing application. Where runners will be exposed in the acoustical ceiling system the metal shall be aluminum or enameled steel. Spacing of support runners and cross runners shall be as shown on the drawings or as specified by the manufacturer of the system. Hanger wire shall be not less than 12 gage unless otherwise shown on the drawings. The completed suspension system shall be accurately leveled and secured to walls to prevent side movement of the grid.

17.4.2 Installation of Acoustical Units.

Installation of acoustical units shall conform to the manufacturer's specifications for the particular type of ceiling being installed. Ceilings shall be symmetrical about the center lines of each room or space unless otherwise noted on the drawings. During erection, joints around pipes, ducts, and other work extending through the acoustical units shall be fitted tightly and look neat and finished.

17.4.3 Installation of Adhesive-Applied Acoustical Units.

17.4.3.1 Gypsum Board shall be of the thickness shown on the drawings, and of sufficient length to permit staggering of all joints. Boards shall be nailed to the slotted or channeled runners with ratchet- or serrated-type nails not less than 1 1/8-inch long for 1/2-inch gypsum board or 1 1/4-inch long for 5/8-inch gypsum board. Nails shall be spaced 6 inches on centers. Care shall be taken to avoid crushing the gypsum board when nailing.

17.4.3.2 Ceiling Tiles of the type and design noted on the drawings shall be applied to the gypsum board with joints parallel with the walls and symmetrical about the center lines of the rooms or spaces. Adhesive shall be of the type and in the amount recommended by the acoustical tile manufacturer. Tiles shall be firmly pressed into place and all joints shall be in true alignment.

17.5 FINISH AT WALLS.

Unless shown otherwise on the drawings, metal moldings shall be provided where ceiling units abut walls. Moldings shall be aluminum or enameled steel to match exposed grid system, and enameled steel for unexposed grid systems and adhesive-applied acoustical systems. The exposed-to-view surfaces of the metal shall be finished in a color to match existing exposed surfaces of adjacent acoustical units unless otherwise noted on the drawings.

17.6 MISCELLANEOUS ACOUSTICAL APPLICATIONS.

17.6.1 Adhesive Application.

Acoustical units to be applied directly to new or existing wall or ceiling surfaces shall be of the size, type, and design indicated on the drawings. Surfaces shall be clean, dry and free from irregularities. Old concrete shall be coated with an approved sizing material. Painted surfaces shall be tested by means of the installation of a single unit applied with adhesive. The test unit shall be removed after 72 hours, or as otherwise recommended by the acoustical tile manufacturer, and the paint shall be inspected. If the paint has softened, it shall be removed or the tiles shall be installed using an alternate method such as nailing or stapling to existing surfaces or to wood furring strips. Adhesive shall be the type recommended by the acoustical tile manufacturer. Install moldings in accordance with the manufacturer's recommendations except acoustical units applied to walls may be banded with wood moldings, if approved by the COR.

17.6.2 Application to Wood Furring Strips.

Furring strips shall be kiln-dried, noncombustible exterior (NCX) grade, soft wood, 1-inch x 3-inch nominal, spaced 12 inches on centers, securely nailed or anchored in place as required. Shot-pins may be used to fasten strips to concrete. Acoustical units shall be attached to the wood strips as recommended by the acoustical tile manufacturer. Install metal or wood molding as specified above.

17.7 CLEANING.

Following each installation, soiled acoustical units shall be cleaned. Damaged units shall be removed and replaced with new units.

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SECTION 18

PAINTING

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SECTION 18

PAINTING

18.1 GENERAL

This section covers the requirements for the furnishing of all materials and supplies as well as the application of paint to surfaces shown and noted on the drawings. The term "Paint," as used herein, includes emulsions, enamels, paints, stains, varnishes, sealers, cement-vinyl filler, and other coatings, whether used as prime, intermediate, or finish coats.

18.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

18.2.1 American National Standards Institute (ANSI)

Bulletin A13.1 Identification of Piping Systems

18.2.2 Federal Specifications (FS)

SS-C-192	Cement, Portland
TT-E-489	Enamel, Alkyd, Gloss, (for Exterior and Interior Surfaces)
TT-E-506	Enamel, Alkyd, Gloss, Tints and White (for Interior Use)
TT-E-508	Enamel, Interior, Semigloss, Tints and White
TT-E-543	Enamel, Interior, Undercoat, Tints and White
TT-F-336	Filler, Wood, Paste
TT-P-25 Mixed,	Primer Coating, Exterior (Undercoat for Wood, Ready- White and Tints)
TT-P-0026	Paint, Interior, Fire Retardant
TT-P-29	Paint, Latex-Base, Interior Flat, White and Tints
TT-P-30	Paint, Alkyd, Odorless, Interior, Flat, White and Tints
TT-P-34	Paint, Exterior, Fire Retardant, White and Light Tints
TT-P-55	Paint, Polyvinyl Acetate Emulsion, Exterior
TT-P-95	Paint, Rubber; for Swimming Pools and other Concrete and Masonry Surfaces

TT-P-102 Paint, Oil: Chalk-Resistant, Lead Free, Exterior,
Ready-Mixed, White and Tints

TT-P-320 Pigment, Aluminum; Powder and Paste for Paint

TT-P-641 Primer Coating, Zinc Dust-Zinc Oxide (for Galvanized
Surfaces)

TT-S-711 Stain, Oil Type, Wood, Interior

TT-V-119 Varnish, Spar, Phenolic-Resin

TT-V-121 Varnish, Spar, Water-Resisting

18.2.3 Federal Standards (FST)

595 Colors

18.2.4 Military Specifications (MIL)

MIL-S-12935 Sealer, Surface, for Knots

MIL-C-15328 Primer, Pretreatment (Formula No. 117 for Metals)

18.2.5 Underwriters' Laboratories (UL)

Building Materials Directory

18.3 MATERIALS

Paints shall be in unbroken containers that plainly show at the time of use the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer; all of which shall be plainly legible at the time of use. Pigmented paints shall be furnished in containers not larger than 5 gallons. Materials shall conform to the painting schedule herein.

18.4 CLEANING AND PREPARATION OF SURFACES

18.4.1 General

Hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be painted shall be removed prior to surface preparation and painting operations, or otherwise protected. Following completion of painting of each space, removed items shall be reinstalled. Exposed nails and other ferrous metal on surfaces to be painted with water-thinned paints shall be spot-primed with zinc dust-zinc oxide or red lead and metal primer. Surfaces to be painted shall be clean before applying 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 and shall have flash point in excess of 100° F. Cleaning and painting

shall be so programmed that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

18.4.2 Concrete and Masonry Surfaces

Concrete and masonry surfaces to be painted shall be prepared by removing all efflorescence, chalk, dust, dirt, grease, oil, tar, and old-weathered paint, and by roughening to remove glaze. Surface deposits of free iron shall be removed prior to painting. Immediately before coating with cement-latex filler, concrete-masonry-unit surfaces to be painted shall be uniformly and thoroughly dampened, with no free surface water visible, by several applications of potable water with fog spray, allowing time between the sprayings for the water to be absorbed.

18.4.3 Wood Surfaces

18.4.3.1 Wood Surfaces, except surfaces to be given natural finish, shall be primed and finish-coated as specified in the painting schedule herein. Wood surfaces to be painted shall be cleaned of all dirt, oil, and other foreign substances with mineral spirits, scrapers, sandpaper, and/or wire brush. Finished surfaces exposed to view shall be made smooth by sandpapering. Edges of doors that have been trimmed during hanging and fitting shall be given a coat of the specified first-coat material. Small, dry, seasoned knots shall be surface-scraped and thoroughly cleaned, and shall be given a thin coat of knot sealer before application of the priming coat. Pitch on large, open, unseasoned knots and all other beads or streaks of pitch shall be scraped off, or if still soft, shall be removed with mineral spirits or turpentine and the resinous area thinly coated with knot sealer. After priming, all holes and imperfections in finish surfaces shall be filled with putty or plastic wood-filler colored to match the finish coat, allowed to dry, and sandpapered smooth.

18.4.3.2 Interior Wood Surfaces to receive natural finish shall be stained to the shade specified on the drawings and lightly sanded. Open-grain wood shall be given the same treatment and, in addition, shall be given a coat of paste and wood filler not less than 8 hours after the application of stain. Excess filler shall be removed and the surface then sanded smooth. Each varnish coat shall be lightly sanded prior to application of subsequent coat.

18.4.4 Ferrous Surfaces

Ferrous surfaces that have not been shop coated shall be cleaned and painted one coat of zinc chromate or alkyd primer paint followed by finished coats as hereinafter specified. Shop coat metal shall be protected from corrosion before and after installation by treating corroded areas immediately upon detection. Abraded or corroded spots on shop-coated surfaces shall be wire-brushed and touched up with the same material as the shop coat. Cut edges of galvanized sheets and exposed threads and cut ends of galvanized piping, electrical conduit, and metal pipe sleeves, not to be finished-painted shall be solvent-cleaned and primed with zinc dust-zinc oxide metal primer.

18.4.5 Galvanized Surfaces

Galvanized surfaces to be painted shall be solvent-cleaned and treated with vinyl-type washcoat as hereinafter specified.

18.4.6 Mastic-Type Surfaces

Mastic-type surfaces to be painted shall be prepared by removing all foreign material.

18.4.7 Fabric Covering

Fabric covering over insulation on pipes, ducts, tanks, and other equipment to be painted shall be given a heavy coat of nonpenetrating size to which subsequent paint coats will permanently adhere. The size shall be applied in such manner as to completely seal the surface. A sufficient amount of fungicidal agent shall be added to the size and each finish coat of paint thereafter to render the fabric mildewproof. The fungicidal agent shall be of a type that will not adversely affect the color, texture or durability of the paint, or size. One percent of the phenyl mercuric compound or 4 percent tetrachlorophenol is acceptable for oil-base materials and chlorinated-rubber paint. Four percent sodium tetrachlorophenate is acceptable for water-emulsion paints and size. Percentages are based on nonvolatile content of the paint.

18.5 FIRE-RETARDANT COATING

Fire retardant coating can only be used on existing construction with the approval of the COR. Lumber and plywood requiring a coating to reduce combustibility of the material shall be coated with a fire-retardant coating of the type specified on the drawings to reduce the flame spread value to 25 or less. Application may be by brush or spray and shall conform to the manufacturer's directions. Unless otherwise approved, the coating shall be used on interior surfaces only. Each container shall bear the inspection label of the UL. The number of coats to be applied and total coverage shall be as shown on the drawings.

18.6 PAINT APPLICATION

18.6.1 General

The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, hiding, texture, and finish. Special attention shall be given to ensure that edges, corners, crevices, welds, and rivets receive a film thickness equivalent to that of adjacent painted surfaces. Respirators shall be worn by persons engaged or assisting in spray painting. Adjacent areas and installation shall be protected by the use of drop cloths or other approved precautionary measures. Metal or wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up prior to the application of water-thinned paints.

18.6.2 Storage, Mixing, and Thinning

At the time of application, paint shall show no signs of deterioration. Latex paints shall be protected from exposure to cold weather by storing in shelters so as to prevent freezing of the paint. Paint shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Paints of different manufacturers shall not be mixed together. Where necessary to suit conditions of surface, temperature, weather, and method of application, packaged paint other than cement-latex filler may be thinned immediately prior to application in accordance with the manufacturer's directions, but not in excess of 1 pint of suitable thinner per gallon. Vinyl-type wash coat shall be mixed by adding 1 volume of acid component to 4 volumes of resin component. The acid component shall be added slowly with constant stirring to the resin component. After mixing, the wash coat shall be used within 8 hours. If additional thinning is required to maintain a wet spray, reduction shall be made with normal butyl alcohol or 99 percent isopropyl alcohol.

18.6.3 Atmospheric Conditions

Paints other than water-thinned coatings shall be applied only to surfaces that are completely free of surface moisture as determined by sight or touch. In no case shall paint be applied to surfaces upon which there is visible frost or ice. While painting is being done, the temperature of the surfaces to be painted and of the atmosphere in contact therewith shall be maintained at or above 50° F. for water-thinned coatings and 45° F. for other coatings. During periods of inclement weather, painting may be continued by enclosing the surfaces with temporary shelters and applying heat, provided the temperature requirements prescribed above are maintained. Salamanders and open fires will not be permitted.

18.6.4 Time Between Surface Preparation and Painting

Surfaces that have been cleaned, pretreated, or otherwise prepared for painting shall be given a coat of the specified first-coat material as soon as practicable after such preparation has been completed, but in any event prior to any deterioration of the prepared surfaces.

18.6.5 Method of Paint Application

Method of paint application shall be as recommended by the paint manufacturer.

Vinyl-type wash coat used on metal surfaces may be applied by brush or spray. On other surfaces, exterior first coats shall be applied by brush, and interior first coats shall be applied by brush or roller; subsequent coats may be applied by brush, spray, or roller. Rollers for applying enamel shall have a short nap. Areas inaccessible to spray painting shall be coated by brushing or other suitable means. Brushes used for the application of water-emulsion paints shall be soaked in water prior to brushing operation.

18.6.5.1 Cement-Vinyl Filler. Cement-vinyl filler shall be vigorously scrubbed into the surface with a stiff-bristle brush having Tampico or Palmyra bristles not longer than 2 1/2 inches. All surface voids, pores, and cracks shall be completely filled. The dry film shall be uniform and free from pinholes or other voids. The material shall not be applied over calking compounds. Curing cement-vinyl filler coating is not required.

18.6.5.2 Vinyl-Type Wash Coat. Vinyl-type wash coat shall be applied at a coverage rate of 250 to 300 square feet per gallon to give a dry-film thickness of 0.3 to a maximum 0.5 mil. Care shall be exercised in spray application to avoid the deposition of dry particles on the surface. A wet spray shall be maintained at all times. Surfaces treated with the wash coat shall be permitted to dry for not less than 1 hour and shall be coated as soon thereafter as possible.

18.7 SURFACES TO BE PAINTED

18.7.1 General

The surfaces listed in the painting schedule below shall receive the surface preparation, paints, and number of coats prescribed. Piping shall not be field-painted until it has been tested and approved. Explanatory information for use with the painting schedule is as follows:

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

18.7.1.2 Colors and Tints. Colors and tints, including shades of stain, shall match the respective color specimens selected by the Contracting Officer's Representative (COR). Colors and tints shall conform to Federal Standard 595. Stains shall conform in shade to manufacturer's standard color. All preceding coats shall match the color of the finish coat.

18.7.1.3 Method of Surface Preparation. Method of surface preparation and pretreatment shown in the schedule is for identification purposes only. Cleaning and pretreatment of surfaces prior to painting shall be accomplished in accordance with the detailed requirements herein described.

18.7.2 Painting Schedule

<u>Surface</u>	<u>Surface Preparation and Pretreatment</u>	<u>1st Coat</u>	<u>2nd Coat</u>	<u>3rd Coat</u>
Exterior concrete and concrete masonry blocks	Remove all foreign matter, loose particles, and efflorescence from units	Cement-vinyl filler	Polyvinyl acetate emulsion, exterior TT-P-55*	None
Exterior ferrous surfaces subject to atmospheric exposure	As previously specified	Exterior oil paint TT-P-105*	Exterior oil paint TT-P-105*	None
Exterior wood surfaces	Solvent cleaning, scraping, sealing, and sandpapering as specified	Exterior primer TT-P-25*	Exterior oil paint TT-P-105*	Exterior oil paint TT-P-105*
Exterior galvanized surfaces other than roofing and siding	Wash with solvents, apply vinyl-type wash coat	Zinc dust-zinc oxide primer TT-P-641*	Exterior oil paint TT-P-105*	None
Exposed exterior calking compound	Clean	Aluminum paint TT-P-320* & TT-V-119*	Same as adjacent areas	None
Interior surface of exterior concrete masonry walls	As previously specified above	Cement-vinyl filler	Polyvinyl acetate emulsion TT-P-55*	None
Interior concrete masonry units, gypsum board	As previously specified for each type of surface	Latex base paint TT-P-29*	Latex base paint TT-P-29*	None
Interior concrete masonry unit in high maintenance areas such as toilet room walls, laboratory rooms, etc. (4 coats)	Remove all foreign matter, loose particles, and efflorescence	Cement-vinyl filler	Latex base paint TT-P-29*	Enamel under coat TT-E-543*
				<u>4th Coat</u>
				Gloss enamel TT-E-489*

*Federal Specification Number, see Paragraph 18.2.2.

<u>Surface</u>	<u>Surface Preparation and Pretreatment</u>	<u>1st Coat</u>	<u>2nd Coat</u>	<u>3rd Coat</u>
Interior walls and ceilings in toilet rooms except concrete masonry units	As previously specified for each type of surface	Latex base paint TT-P-29*	Latex base paint TT-P-29*	Gloss enamel TT-E-489*
Interior ferrous surfaces, unless otherwise specified	As previously specified	Enamel under-coat TT-E-543*	Semi-gloss enamel TT-E-508*	None
Ferrous surfaces of mechanical equipment and machinery other than machined surfaces	As previously specified	Alkyd gloss enamel TT-E-506*	Alkyd gloss enamel TT-E-506*	None
Wood and metal interior trim, and windows except in toilet rooms and natural-finished wood surfaces	As previously specified for each type of surface	Enamel primer TT-E-543*	Enamel under-coat TT-E-543*	Semi-gloss enamel TT-E-508*
Interior wood and metal surfaces in toilet rooms, other than equipment and natural-finished wood surfaces	As previously specified for each type of surface	Enamel primer TT-E-543*	Enamel under-coat TT-E-543*	Gloss enamel TT-E-506*
Interior fiber-board surfaces (existing construction only)	As previously specified for wood surfaces	Enamel primer TT-E-543*	Enamel under-coat TT-E-543*	Semi-gloss enamel TT-E-508*
Wall bases	As previously specified for wood surfaces	Rubber-base paint TT-P-95*	Rubber-base paint TT-P-95*	None
Interior wood surfaces unless otherwise specified	Remove foreign matter. Sandpaper as required	Enamel primer TT-E-543*	Enamel under-coat TT-E-543*	Semi-gloss enamel TT-E-508*

* (see page 18-7)

<u>Surface</u>	<u>Surface Preparation and Pretreatment</u>	<u>1st Coat</u>	<u>2nd Coat</u>	<u>3rd Coat</u>
Interior wood surface to receive natural finish	Clean and sandpaper as required, stain, fill, and seal as necessary	Spar varnish TT-V-121*	Spar varnish TT-V-121*	Spar varnish TT-V-121*
Electrical conduit runs, metallic tubing ducts, pipes, hangers, louvers, grilles, registers, in areas having painted adjacent surfaces	As previously specified for each type of surface	Enamel primer TT-E-543*	Semi-gloss enamel TT-E-508*	
Electrical conduit runs, metallic tubing, ducts, pipes, and pipe hangers, (other than aluminum, aluminum-alloy, or galvanized) surfaces, in areas having unpainted adjacent surfaces	As previously specified for each type of surface	Alkyd paint TT-P-30*	Alkyd paint TT-P-30*	None
Interior surfaces of refrigerated surfaces	As previously specified for each type of surface	Latex base paint TT-P-29*	Latex base paint TT-P-29*	Rubber-base paint TT-P-95*
Exposed threads of galvanized piping and electrical conduit, and cut edges of galvanized sheets not to be finish-painted, interior and exterior	Solvent clean	Zinc dust-zinc oxide primer TT-P-641*	None	None
Structural steel and other interior ferrous surfaces of work areas	As previously specified	Exterior oil paint TT-P-105*	Exterior oil paint TT-P-105*	None
Fabric covering over insulation on pipes, ducts, tanks, and other equipment, interior	As previously specified	Paint to match adjacent surface or apply two coats of rubber-base paint--TT-P-95*		

* (see 18-7)

18.8 IDENTIFICATION OF PIPING

18.8.1 Standards

The standard referred to herein is the American National Standards Institute (ANSI) Bulletin A13.1.

18.8.2 Materials

Materials used shall meet ANSI Standards and shall be Westline "Tel-A-Pipes" markers for industrial piping, as manufactured by Western Lithograph Company, Los Angeles, California, or an approved equal.

18.8.3 General

18.8.3.1 Requirements. Piping systems which are accessible for maintenance operations shall be identified with bands, legends, and arrows, clearly visible, in the colors designated hereinafter. Piping shall be identified in power plants, distillation plants, fresh and salt water pumping stations, mechanical equipment rooms, and on utility lines where they enter or emerge from the ground. At other locations where pipe identification is required, shall be as shown on the drawings or directed by the COR.

18.8.3.2 Identification Legends, Banding, and Directional Flow Arrows shall be applied to the piping at the following locations or as directed by the COR:

Adjacent to each valve, group of valves, or strainers.

At each branch and riser at takeoff.

At each pipe passage through wall, floor, and ceiling construction.

At each pipe passage to underground.

At not more than 15-foot spacings on straight pipe runs.

Each pipe in each room shall have at least one identification.

18.8.4 Piping Identification System

18.8.4.1 Colored Bands shall consist of a 2 1/4-inch wide tape wrapped around pipe and each end of the legend marker tape which labels the media conveyed or indicates direction of flow with arrows. Bands shall be of the same color as the legend background. Color-code tape shall be furnished in 2 1/4-inch widths rolled on not less than 3-inch diameter core.

18.8.4.2 Legend Markers shall be placed so as to be easily read from the operating position, and in accordance with the attached sketch and ANSI Bulletin A13.1.

18.8.4.3 Color Code Schedule - for labels

<u>Commodity In Pipeline</u>	<u>Band Color</u>	<u>Legend</u>	<u>Background Color and Type</u>
Acids	Yellow	Acid	Yellow
Diesel Oil	Yellow	Diesel Oil	Yellow
Fire-Automatic Sprinklers	Red	Fire-Automatic Sprinklers	Red
Fire Alarm Box	Red	Fire Alarm	Red
Gasoline, Automotive Type	Yellow	Mo-Gas	Yellow
Gasoline, Aviation Type	Yellow	Av-Gas	Yellow
Jet Fuel	Yellow	Jet Fuel (JP-4)	Yellow
Lube Oil	Purple	Lube Oil	Purple
Refrigerants	Yellow	Freon	Yellow
Live Steam	Yellow	Steam	Yellow
High Temp. H.W.	Yellow	HTHW	Yellow
Exhaust Steam	Yellow	Exhaust Steam	Yellow
Blowoff	Yellow	Blowoff Water	Yellow
Boiler Feed	Yellow	Boiler Feed	Yellow
Condensate	Yellow	Condensate	Yellow
Fresh Cold Water	Green	Fresh Cold Water	Green
Fresh Hot Water	Yellow	Fresh Hot Water	Yellow
Salt Water	Green	Salt Water	Green
Brine	Green	Brine	Green
Chilled Water	Green	Chilled Water	Green
Makeup Water	Green	Makeup Water	Green

<u>Commodity In Pipeline</u>	<u>Band Color</u>	<u>Legend</u>	<u>Background Color and Type</u>
Oxygen	Yellow	Oxygen	Yellow
Compressed Air	Green	Compressed Air	Green
Instrument Air	Green	Instrument Air	Green
Vent	Yellow	Vent	Yellow

18.8.4.4 Types of Markers to be used for the various sizes of pipelines shall be placed as follows:

On flat surfaces or applied longitudinally, rather than around, on pipes of total diameter of 2 inches or larger.

On pipes with O.D.s from 3/4 inch to 2 inches, similarly apply 1 1/8-inch wide markers (from 2 1/4-inch x 9-inch marker tape designed to be cut into 1 1/8-inch widths). Also use 1 1/8-inch markers for small flat surfaces.

On pipe and tubing where the O.D. is less than 3/4 inch, apply 2 1/4-inch x 1-inch (from 2 1/4-inch x 9-inch marker tape designed to be cut into 9 markers).

18.8.5 Wall-Mounted Identification Tape Legend

The Color-Code Tape Legend shall be laminated phenolic with satin finish black face and white letters and outlines. The legend shall conform to the color code schedule for labels, Paragraph 18.8.4.3. The legend shall be mounted in each building or facility using pipe identification, or placed where directed by the COR.

18.9 CLEANUP

All cloths, solvents, waste, oily rags, flammable liquids, and cotton waste that might constitute a fire hazard shall be placed in closed metal containers and stored away from the work in a protected, ventilated area, or destroyed at the end of each day. Paint spots, oil, or stains upon adjacent surfaces shall be removed and the entire job left clean.

SECTION 19

HARDWARE

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SECTION 19

HARDWARE

19.1 GENERAL.

This section covers the requirements for the furnishing and installation of rough and finish hardware as shown and noted on the drawings and as specified herein.

19.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

19.2.1 Federal Specifications (FS):

FF-H-106	Hardware, Builders', Locks and Door Trim
FF-H-111	Hardware, Builders', Shelf and Miscellaneous
FF-H-00116	Hinges, Hardware, Builders'
FF-H-121	Hardware, Builders', Door-Closing Devices
FF-P-101	Padlocks

19.2.2 National Fire Protection Association (NFPA):

Standard 80 Fire Doors and Windows

19.2.3 Underwriters' Laboratories (UL):

Building Materials Directory

19.2.4 Factory Mutual Engineering Corporation (FM):

Approval Guide

19.3 REQUIREMENTS.

Unless otherwise specified, hardware shall conform to the applicable requirements of the publications listed above. All modifications to hardware, required by reason of construction characteristics, shall be such as to provide the specified operative or functional features. Hardware for application on metal shall be made to standard templates. All Hardware used on fire doors shall be UL listed or FM approved and installed in accordance with those listings and/or approvals, and NFPA Standard 80.

19.4 HARDWARE TYPES.

19.4.1 Armor and Kick Plates.

Armor and kick plates (FS FF-H-111) shall be Type 1227 black or brown, as required, unless otherwise specified. Width shall be 1 3/4 inches less than the door width on the push side of the door, and 1/2 inch less than the door width on the pull side of the door.

19.4.1.1 Armorplates shall be 40 inches high. Where doors have louver panels, the plate shall be omitted if the top of louver frame is more than 20 inches above the bottom of the door.

19.4.1.2 Kickplates shall be 10 inches high, unless the bottom rail of the door is less than 10 inches, in which case kickplates shall extend to within 1 inch of the panel or glass bead.

19.4.2 Automatic Door Bottoms.

Automatic door bottoms shall be the surface type with aluminum or brass cover, and a wool felt or rubber seal, actuated by opening and closing the door, that will exclude light and dust when the door is in the closed position.

19.4.3 Automatic Door Holders.

Automatic door holders (FS FF-H-111) shall be of the following types:

19.4.3.1 Floor-Type Holders shall be of Type 1168, unless otherwise specified.

19.4.3.2 Overhead-Type Holders shall be of type specified on the drawings. Holders shall hold doors open at 90 degrees, minimum.

19.4.4 Butt Hinges.

Butt hinges (FS FF-H-00116) shall be the following types:

19.4.4.1 For Outswinging Exterior Doors. Type T2106, T2107, T2135, T2145, or T2155, as applicable.

19.4.4.2 For Inswinging Exterior Doors With Door Closer. Type 2107.

19.4.4.3 For Inswinging Exterior Doors Without Closer. Type 2127.

19.4.4.4 For Interior Doors With Door Closer. Type 2107.

19.4.4.5 For Interior Doors Without Closer. Type T2127.

19.4.4.6 For Doors 42 Inches Wide or Wider. Extra-heavy types, as required.

19.4.4.7 For Doors With Channel Iron Frames. Type T2145 or T2155, as applicable.

19.4.4.8 For Kalamein Doors With Pressed-Steel or Kalamein Frames. Type T2135 or T2139, as applicable.

19.4.4.9 For Industrial Steel Doors. Type T2135 or T2155, as applicable.

19.4.4.10 Butt Hinge Widths. Where the projection of the door trim is such as to prevent clearance with the butt hinges specified, hinges with leaves of sufficient width to clear the trim shall be provided.

19.4.4.11 Constructor's Option. Constructor has the option of supplying butt hinges with oil-impregnated bearings in lieu of the ball-bearing-type hinges specified.

19.4.4.12 Butt Hinges Per Door:

<u>Height of Door (Inches)</u>	<u>Butts Required</u>
60 or less	2
Over 60 and not over 90	3
Over 90	4
Dutch-type doors, each leaf	2

19.4.4.13 Butt Hinge Sizes:

<u>Door Thickness (Inches)</u>	<u>Door Width</u>	<u>Butt Size (Inches)</u>
7/8 or 1	Any	2 x 2 1/2
1 1/8	Any	3 x 3
1 3/8	Any	3 1/2 x 3 1/2
1 3/4	3 feet and less	4 1/2 x 4 1/2
1 3/4	Over 3 feet	5 x 4 1/2
2 1/4 and 2 1/2	Any	5 x 5

19.4.5 Door Closing Devices.

Door closing devices (FS FF-H-121) shall be as follows:

19.4.5.1 Surface-Type Closers shall be Type 3001H, unless otherwise specified, and shall be provided with clock-key or capped valve. Sizes shall conform to those noted on the drawings. Closers for outswinging exterior doors shall have parallel arms. Where there is less than 7 inches clearance between a closer-equipped door and an intersecting wall when the door is opened 90 degrees, the closer shall also be provided with parallel arms. Type 3230 closer modified for surface applications shall be used on wood interior doors only, in specified areas where floors are not more than 3 feet wide.

19.4.5.2 Type 3230 Closer Mortised Into Toprail of Doors shall be used on metal interior doors only, in specified areas where doors are not more than 3 feet wide.

19.4.5.3 Checking Floor Hinges, Floor Pivots, and Intermediate Pivots shall be the types and sizes noted on the drawings.

19.4.5.4 Smoke Actuated Type or Fusible Element Type Closers shall conform to the types specified on the drawings. See Paragraph 19.3 and Section 44 for additional requirements.

19.4.5.5 Door-Closer Products of One Manufacturer only, will be acceptable for any one building or group of adjacent buildings.

19.4.6 Door Coordinators.

Door coordinators (FS-FF-H-00106) shall be type 836.

19.4.7 Door Silencers.

Door silencers (FS FF-H-111) shall be Type 1337A. Three silencers shall be provided for each pressed steel frame for single doors, and two silencers for each pressed steel frame for pairs of doors. Silencers are not required for fire-door installations.

19.4.8 Door Stops.

Door stops (FS FF-HH-111) shall be Type 1330 or 1330A, as applicable, unless otherwise specified. Stops shall be supplied wherever an item of door hardware or a door, when opened, might contact a wall or other part of the building construction.

19.4.9 Extension Lever Flush Bolts.

Extension lever flush bolts (FS FF-H-111) shall be Type 1045, unless otherwise specified. Except where metal thresholds occur, the bottom bolt shall be provided with dustproof strike, Type 1048. Bolts for double-acting doors shall have rounded fronts.

19.4.10 Flush Cup Pulls.

Flush cup pulls (FS FF-H-111) shall be similar to Type 459, with a plate size of 4 x 10 inches. Plates shall be cut for cylinders, where required.

19.4.11 Locks, Lock Sets, and Latch Sets.

Locks, lock sets, and latch sets (FS FF-H-106):

19.4.11.1 Manufacturer. Except for special backset deadlocks for narrow-stile doors, the locks, lock sets, and latch sets furnished shall be those of a single manufacturer. Unless otherwise specified on the drawings, locksets and latchsets shall be Series 160 or 161 as applicable.

19.4.11.2 Knobs and Roses for Series 161 cold-forged, heavy-wrought type. Metal may be solid, laminated, or reinforced. The minimum thickness of knob shells and of roses shall be 0.050 inch. Laminated or reinforced-type knobs and roses shall have a minimum outer-shell thickness of 0.035 inch. Roses shall be of the concealed-screw type.

Lock Trim for Bored-Type Locks and Latches shall be Type 4, unless otherwise specified on the drawings.

19.4.11.3 Backset shall be 2 3/4 inches, unless otherwise specified.

19.4.11.4 Fronts for single-acting doors at least 1 3/4 inches thick shall have the standard bevel 1/8 inch in 2 inches. For double-acting doors, the fronts shall be rounded.

19.4.11.5 Pins. Cylinder locks shall have six pins, unless five-pin tumblers are required for existing master-key systems.

19.4.11.6 Marking. The key change number and the manufacturer's name or trademark shall be stamped or engraved on the cylinder or cam of each lock.

19.4.11.7 Security Combination Locks shall be manipulation-proof, combination-type locks, with three or four brass, steel, or nylon tumblers, and shall have an extension with accompanying strike so designed as to prohibit pinching, forcing, or jacking. Lock shall have a springbolt latch with a deadlocking feature to prevent forcing the latch bolt back when in a locked position. Bolts shall have hardened-steel inserts to prevent sawing. Locks shall have an inside release to permit opening of the lock from the inside, should the door be closed. Upon closing the door, the automatic-locking feature will secure the lock. Locks shall be provided for doors opening in or out and either right- or left-hand. Dials shall have US26D finish, unless otherwise specified.

19.4.11.8 Two- and Three-Point Lock. Where locks are required for the fire doors they shall be of the types listed by the Underwriter's Laboratories, Inc. Two-point locks shall be furnished for the inactive leaf of pairs of fire doors, and three-point locks shall be provided for single fire doors and for the active leaf of pairs of fire doors. Knob trim to match other lock set trim shall be furnished for both two- and three-point lock sets.

19.4.12 Metal Thresholds.

Metal thresholds shall be of the type shown on the drawings.

19.4.13 Padlocks.

Padlocks (FS FF-P-101) shall be Type EPC with six-pin tumblers, size 2 inches, except that Type EPC with five-pin tumblers, size 2 inches, shall be furnished when required to be master-keyed into the keying system.

19.4.14 Panic Bolts (FS FF-H-106):

19.4.14.1 Single Doors. For Exit Only: Type 810; For Exit and Entrance: Type 810H or 810K.

19.4.14.2 Pairs of Doors. For Exit Only: Type 821 (each leaf); For Exit and Entrance; Type 821K or 821, with thumb-piece handle operation Type 421 (each leaf).

19.4.14.3 Pairs or Doors Requiring Astragal. Type 822H or 822K

19.4.14.4 Narrow-Stile Tubular-Type Doors shall bolt similar to surface type except modified by being concealed in the door stile, with top and bottom locking.

19.4.15 Push Plates.

Push plates (FS FF-H-106):

19.4.15.1 Plain Push Plates shall be Type 465.

19.4.15.2 Combination Push and Pull Plates shall be Type 456. The hole for cylinder, where required, shall be cut 2 inches above the offset.

19.4.16 Push-Pull Bars.

Push-pull bars shall be of the types shown on the drawings.

19.4.17 Roller Bumpers.

Roller bumpers shall be provided for each door whenever two doors open against each other.

19.5 MISCELLANEOUS REQUIREMENTS.

19.5.1 Access Doors, Hollow Metal:

2 Butts (FS FF-H-00116) T2127 - 3 1/2- x 3 1/2-inch.

Lock 194 (FS FF-H-106)

19.5.2 Access Doors, Metal Covered.

2 Tee Hinges (FS FF-H-00116) 2208 - 6-inch

Hasp (FS FF-H-111) F1405 - 6-inch

Padlock EPC - 2-inch, with chain

19.5.3 Access Doors, Wood.

2 Hinges (FS FF-H-00116) 2208 - 6-inch, with regular or reverse pad, as required.

Lock 194 (FS FF-H-106)

19.5.4 Batten Wood Doors.

2 Hinges (FS FF-H-00116) 2208 - 6-inch, with regular or reverse pad, as required.

19.5.5 Coat Hooks.

Coat hooks (FS FF-H-111) shall be Type F1172.

19.5.6 Closet Hanger Bars.

Closet hanger bars (FS FF-H-111) shall be Type F1171 by size required.

19.5.7 Wood Counter Gates.

Hinges (FS FF-H-00116) 2390

19.6 FINISHES.

19.6.1 Hardware.

Hardware shall have the following U.S. Standard finishes unless noted otherwise on the drawings:

US P - Exposed surfaces of ferrous metal.

US 4 - Exposed surfaces of brass metal.

US 10 - Exposed surfaces of bronze metal.

US 26 - Exposed surfaces of brass or bronze when used in toilets, baths, and kitchens.

US 26D - Exposed surfaces of brass or bronze when aluminum or corrosion-resisting steel is furnished.

US 28 - Exposed surfaces of aluminum.

US 32D - Exposed surfaces of corrosion-resisting steel.

Metallic lacquer - Exposed surfaces of surface-type door closers.

19.6.2 Matching of Hardware Finishes.

The finish of the hardware for a project shall be furnished in any one of the above but not a combination of any of these finishes, unless otherwise noted on the drawings.

19.7 CYLINDER CORES.

Cylinder cores shall be construction type (temporary) to be used until the buildings are accepted by the Government, at which time the permanent cylinder cores will be furnished and installed by the Government. The keys shall be turned over to the COR, properly tagged and designated as to location.

[REDACTED]

19.8 APPLICATION OF HARDWARE.

Hardware shall be applied with fastenings of proper size, quantity, and finish. Machine screws and lead expansion shields shall be used for hardware attachment to concrete, stone, tile, and masonry.

19.8.1 Armorplates.

Armorplates shall be installed on the push side of single-acting doors and both sides of double-acting doors.

19.8.2 Butt Hinges.

19.8.2.1 Top Hinges shall be installed with the center line of hinge not more than 10 inches below the top of the door.

19.8.2.2 Bottom Hinges shall be installed with the center line of hinge not more than 11 inches above the finish floor.

19.8.2.3 Intermediate Hinges and intermediate or supplementary pivots shall be equidistant between the top and bottom hinges or pivots.

19.8.3 Combination Push-and-Pull Plates.

Combination push-and-pull plates shall be installed so that the offset overhangs the armorplate 2 inches. For unarmored doors, the plates shall be installed with the center line approximately 45 inches above finish floor.

19.8.4 Door-Closing Devices.

Door-closing devices shall be installed in strict accordance with the templates and printed instructions supplied by the manufacturer of the devices.

19.8.5 Extension Lever Flush Bolts.

Extension lever flush bolts shall be installed in the edge of the door. The operating mechanism shall be located 6 inches below top of door and 12 inches above the bottom of the door for the bottom bolt.

19.8.6 Flush Cup Pulls.

Flush cup pulls shall be installed with the centerline of plate 45 inches above the finish floor.

19.8.7 Kick Plates.

Kick plates shall be installed on the push side of the door.

19.8.8 Lock and Latch Strikes.

19.8.8.1 The Location of Strikes for Knob Locks and Knob Latches shall be determined by installing the center of the doorknob 40 inches above the finish floor.

19.8.8.2 The Location of Strikes for Deadlocks shall be determined by installing the lock cylinder 60 inches above the finish floor.

19.8.9 Panic Bolts.

Panic bolts shall be installed so that the undepressed crossbar is 42 inches above the finish floor.

19.8.10 Push Plates.

Push plates shall be installed so that the center of the plate will be 45 inches above the finish floor.

19.8.11 Roller Bumpers.

Roller bumpers shall be installed at the top of the door near the edge of the lock stile.

19.9 HARDWARE SETS.

Hardware sets required for each building or structure will be shown on the drawings.

19.10 ROOM NUMBERS.

A door sign indicating room number shall be provided above the door to each room. These signs shall be approximately 3 x 6, with 2-inch-high numbers in condensed block pattern. Unless otherwise indicated on the drawings, signs shall be 1/8-inch-thick plastic and contain holes for screw attachment.

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SECTION 20

GENERAL PIPING AND MATERIALS

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SECTION 20

GENERAL PIPING AND MATERIALS

20.1 GENERAL.

This section covers the requirements for the furnishing of all labor and materials for the installation of all heating and air conditioning and other nonpotable process piping shown and noted on the drawings and specified hereinafter. Potable Water is covered in Section 21, "Plumbing".

20.2 APPLICATION PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

20.2.1 American Society for Testing and Materials (ASTM):

A 53	Welded and Seamless Steel Pipe
A 120	Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses
B 42	Seamless Copper Pipe, Standard Sizes
B 43	Seamless Red Brass Pipe, Standard Sizes
B 68	Seamless Copper Tube, Bright Annealed
B 75	Seamless Copper Tube
B 88	Seamless Copper Water Tube
B 135	Seamless Brass Tube
C 533	Calcium Silicate Block and Pipe Thermal Insulation
C 547	Mineral Fiber Preformed Pipe Insulation
C 592	Mineral Fiber Blanket Insulation and Blanket - Type Pipe Insulation (Metal-Mesh covered) (Industrial Type)
D 1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
D 2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
D 2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

- D 2466 Socket-type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
- D 2467 Socket-type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- D 2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- E 84 Test for Surface Burning Characteristics of Building Materials
- 20.2.2 American National Standards Institute (ANSI):
 - B2.1 Pipe Threads (Except Dryseal)
 - B16.3 Malleable Iron Screwed Fittings, 150 and 300 lbs.
 - B16.4 Cast Iron Screwed Fittings 125 and 250 lbs.
 - B16.5 Steel Pipe Flanges and Flanged Valves and Fittings
 - B16.21 Nonmetallic Gaskets for Pipe Flanges
 - B16.22 Wrought Copper and Bronze Solder-Joint Pressure Fittings
 - B16.23 Cast-Bronze Solder-Joint Drainage Fittings-DWV
 - B16.25 Butt Welding Ends
 - B16.26 Cast Copper Alloy Fittings for Flared Copper Tubes
 - B31.1 (ASME) Code for Power Piping
 - B36.10 Welded and Seamless Wrought Steel Pipe
- 20.2.3 American Water Works Assoc. (AWWA):
 - C 203 Coal Tar Enamel Protective Coatings for Steel Water Pipe
- 20.2.4 Federal Specifications (FS):
 - GG-D-76D Gages, Pressure and Vacuum, Dial Indicating (for Air, Steam, Oil, Water, Ammonia and Chloro-Fluoro Hydrocarbon Gases and Compressed Gases)
 - HH-I-551E Insulation Block, Pipe Covering and Boards, Thermal (Cellular Glass)
 - HH-I-554A Insulation, Thermal, Magnesia: Block, Pipe and Tubing

HH-I-558B	Insulation, Blocks, Boards, Blankets, Felt, Sleeving (Pipe and Tube Covering) and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)
QQ-S-561	Solder; Silver
WW-F-406	Flanges, Cast Iron (classes 125 and 250) and Bronze (Classes 150 and 300)
WW-N-351C	Nipples, Pipe, Threaded
WW-P-377D	Pipe, Copper, Seamless, Standard Sizes
WW-P-404D	Pipe, Steel (Seamless and Welded, Black and Zinc-Coated) (Galvanized)
WW-P-406D	Pipe, Steel (Seamless and Welded for Ordinary Use)
WW-P-521	Pipe Fittings, Flange Fittings, and Flanges, Ferrous and Steel (Screwed and Butt-Welded) 150 Pound
WW-T-799E	Tube, Copper, Seamless Water and Refrigeration (for Use with Solder, Flared or Compression-Type Fittings)
WW-U-531E	Unions, Pipe, Steel, or Malleable Iron, Threaded Connection, 150 Pounds and 250 Pounds
WW-V-51E	Valve, Angle, Check, and Globe, Bronze (125, 150, and 200 Pound, Threaded End, Flange Ends, and Brazed End for Land Use)
WW-V-54D	Valve, Gate, Bronze (125, 150, and 200 Pound, Threaded Ends, Flange End, Solder End, and Brazed Ends for Land Use)
WW-V-58B	Valves, Gate, Cast Iron: Threaded and Flanged (for Land Use)

20.2.4 Military Specifications (MIL):

MIL-S-16293	Strainer, Sediment, Pipeline, Water, Air, Gas, Oil, or Steam
MIL-V-20064	Valve, Nonferrous, for Use with Halogenated Refrigerants

20.2.5 Underwriter's Laboratories, Inc., Publications (UL)

Building Materials Directory

Gas and Oil Equipment Directory

Electrical Appliance and Utilization Equipment Directory

Electrical Construction Materials Directory

20.2.6 Factory Mutual System (FM)

Approval Guide

20.3 GENERAL REQUIREMENTS

The main and branch piping in the heating, air conditioning, and process systems shall be complete systems. The components used shall be essentially the standard product of a manufacturer. Where two or more units of the same type are required, these units shall be products of a single manufacturer. Component parts of the system need not be the products of the same manufacturer. Wherever there are UL/FM listed products that serve the desired function, only UL or FM products will be acceptable.

20.4 PIPING MATERIAL

The materials for various services unless otherwise shown on the drawings shall be as follows:

Steam	Black Steel
Condensate Return	Black Steel
Hot Water Heating	Black Steel/Copper
Chilled Water	Black Steel/Copper/PVC
Condenser Water	Black Steel/Copper
Compressed Air (Above Ground)	Black Steel with Protective Coating
Compressed Air (Below Ground)	Black Steel with Protective Coating
Gas (Above Ground) Above 11" Water gage (W.G.)	Black Steel (Schedule 80.)
Gas (Above Ground) (11" W.G.) Tubing)	Black Steel/Copper (Schedule 40,
Gas (Below Ground)	Black Steel with Protective Coating (Socket Welded)
Refrigerant (Freon)	Copper Tubing
Brine	PVC/Red Brass/Bronze

20.5 STEEL PIPING

20.5.1 Steel Pipe.

Steel pipe schedules specified herein shall meet ASTM A 53 and A 120 for black and seamless. All pipes up through 2 inches shall have threaded fittings and pipes 2 1/2 inches and larger shall have seamless steel welded fittings unless noted otherwise on the drawing.

20.5.2 Cast Iron Fittings.

Cast iron fittings for steam and condensate piping 2 inches and smaller shall be threaded, standard steam pattern, black, 125 or 250 pound working pressure as specified, conforming to ANSI B16.4.

20.5.3 Malleable Iron Fittings.

Malleable iron fittings shall be threaded, banded, standard weight

(except when noted otherwise on the drawing), black or galvanized, conforming to ANSI B16.3.

20.5.4 Welded Fittings.

Welded fittings shall be forged steel standard weight butt-welded, except when noted otherwise on the drawing.

20.5.5 Flanges.

Flanges shall be furnished and installed adjacent to all flanged valves, fittings, and equipment. All flanges shall be of the welding type.

20.5.6 Flanged Joints.

Flanged joints shall be 150 pound or forged steel welding neck flanges with 1/16-inch raised face. In all connections made to equipment with smooth face cast iron type of flanges, (bronze valves, etc.) the abutting flange shall be smooth, and full face gasket used.

20.5.7 Bolts And Nuts.

Bolts and nuts shall be American Standard regular machine bolts with semifinished square heads, and nuts shall be American Standard regular medium carbon, semifinished, steel hexagon nuts. All bolts shall be extended at least 1/8-inch beyond nut. Care shall be taken that bolts are not stretched during pulling up operation.

20.5.8 Gaskets.

Gaskets used shall be selected for service and temperature as follows, or as shown on the drawing.

20.5.8.1 Water and Other Fluids, to 150 psig and 200° F. use cloth inserted rubber, John Crane #777 or equal.

20.5.8.2 Low-Pressure Steam to 15 psig and high-pressure hot water to 250° F. use wire inserted red rubber, John Crane #666 or equal.

20.5.8.3 Air and Gas Services to 220° F. and steam to 100 psig use heavy duty red rubber, John Crane #555 or equal.

20.5.8.4 All Gaskets shall be 1/16-inch thick, ring or full face type as required for service and flange materials, unless otherwise noted on drawing. Gaskets for use above 250° F. or 100 psig steam, shall be specifically approved for the service conditions.

20.6 COPPER TUBING, PIPING, AND FITTINGS.

20.6.1 Copper Tubing.

Copper tubing shall be type "L" or "K" hard or soft, as shown on drawing, and shall conform to the requirements of ASTM B 88.

20.6.2 Copper Fittings.

Copper fittings shall be wrought copper, solder joint type, suitable for hard or soft solder capillary joints in conformance with ANSI B16.22 or 37-degree flared type conforming to ANSI B16.26.

20.6.3 Flared or Sweated Tubing.

Flared or sweated tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be cleaned with steel wool before sweating. Care shall be taken to prevent annealing of fittings and hard-drawn tubing when making connections. Installation shall be made by competent workmen in accordance with manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will be not permitted. Joints for soldered fittings other than refrigerant service, shall be made with noncorrosive paste flux and 50-50 for chilled water, 95-5 for low-pressure steam (15 psi or less) or heating water (250° F. maximum) for all sizes to 2 1/8-inch O.D. maximum. All joints larger than 2 1/8 inches or at 250° F. or higher, shall use 1100° F. melting point silver alloy solid string or wire solder. Cored solder will not be permitted. Joints in copper pipe and tubing 2 1/2-inch diameter and larger shall be made with heat applied uniformly around entire circumference of the pipe and fittings by a multiflame circular torch.

20.6.4 Refrigerant Piping.

Refrigerant piping shall be identified as suitable for ACR (Air Conditioning and Refrigeration) field service. Straight lengths 3/8 inch and larger shall be Type "L", hard temper, deoxidized, dehydrated, and capped. Soft tube in coils 1/8-inch through 1 3/8-inch O.D. shall be similarly marked and cleaned.

20.6.5 Fittings for Refrigerant Piping.

Fittings for refrigerant piping shall be made up with flared fittings or with wrought copper solder type fittings. Solder shall be silver alloy type, with not less than 1100° F. melting point. Refrigerant piping shall conform to the recommended practices as outlined in the ASHRAE guide.

20.7 PLASTIC PIPE AND FITTINGS.

20.7.1 Use of PVC Pipe and Fittings.

Use of PVC pipe and fittings for process water or other fluids shall require the approval of the Contracting Officer's Representative (COR). All fittings shall be the same materials as the pipe and shall match the pressure rating of the pipe. PVC pipe of 6 inches or less diameter may be used for brine piping and chilled water services. Material shall be Type II, Grade I, when pipe exposure below 40° F. is expected. Chlorinated PVC (Type IV, Grade 1) may be used with limit of 180° F. maximum operation temperature.

20.7.2 Use of Other Plastic Piping.

Use of piping of other thermoplastic or similar nonmetallic materials such as PE (Polyethylene), ABS (Acrylonitrile - Butadiene - Styrene), CAB (Cellulose - Acetate - Butyrate), or reinforced epoxy shall require the approval of the COR, or as otherwise shown on the drawing.

20.7.3 PVC Plastic Pipe Socket-Type Fittings.

PVC plastic pipe socket-type fittings shall be solvent-welded using a solvent cement or an equivalent compound furnished by the pipe manufacturer. Threading of PVC pipe with a wall thickness less than Schedule 80 is prohibited.

20.8 INSTALLATION.

20.8.1 Mains, Branches, and Runouts.

Piping shall be installed as indicated on the drawings. Pipe shall be cut accurately to measurements established at the structure and shall be worked into place without springing or forcing. Care shall be taken during installation of systems not to weaken the structural portions of the building or trailer. Piping above ground shall be run parallel with the lines of the structure unless otherwise shown or noted on the drawing. Branch pipe from service lines may be taken off the top of the main, bottom of the main, or side of the main, using such crossover fittings as may be required by structural or installation conditions. Service pipe, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2-inch between finished covering on the different services. No piping shall be embedded in floors unless specifically indicated on the drawings. Changes in pipe size shall be made with reducing fittings. The use of long screws and bushings will not be permitted.

20.8.2 Pipe Drains.

Pipe drains unless otherwise indicated on the drawings, shall consist of 1/2-inch globe valves with renewable disks and 3/4-inch hose nipples. Additional drains shall be installed at low points on the piping, and all piping shall grade down to the drains.

20.8.3 Expansion and Contraction of Piping.

Allowance for pipe expansion and contraction shall be made throughout the system. Horizontal runs over 50 feet long shall be anchored to the wall or to the supporting construction about midway on the run to force the expansion movement to divide equally. Sufficient flexibility shall be provided on all branch runouts from mains to risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that the pipe will spring enough to allow for expansion without straining.

20.8.4 Water Hammer Arrestors.

Water hammer arrestors shall be provided when specified on the drawings, piston type "O" ring seal, Precision Plumbing Products, Inc., or an approved equal sized to suit service.

20.8.5 Condensate Return Lines.

Condensate return lines below grade shall be Schedule 40 Black Steel pipe with welded joints or Schedule 80 with threaded joints, and shall be coated or wrapped. Lines shall be insulated if so specified on the drawings.

20.8.6 Unions.

Unions on ferrous pipe 2 inches in diameter and smaller shall be malleable iron, black or zinc-coated to match piping, Unions on copper tubing 2 inches in diameter and smaller shall be brass. Unions on water piping 2 1/2 inches in diameter and larger shall be flange pattern and shall be brass or bronze 150-pound Class on copper tubing and 125-pound Class on ferrous pipe. Gaskets for flanged unions shall not be concealed in walls, ceilings, or partitions. Install dielectric unions or couplings between all copper and ferrous metal lines or systems.

20.8.7 Protective Coatings for Service Pipe.

Ferrous pipe and fittings installed underground and through exterior concrete walls or floors shall be protected by approved wrapping or given one coat of coal-tar primer and two coats of coal-tar enamel conforming to AWWA Standard C203, as applicable. Piping shall be tested and thoroughly cleaned of foreign matter by wire-brushing and solvent-cleaning before the protective coating is applied.

20.8.8 Reduced-Pressure-Type Backflow-Prevention Device.

Reduced-pressure-type backflow-prevention device shall be installed as indicated, so located that no part of the device will be submerged, and in such manner as to permit access for maintenance and testing. Each device shall be a standard commercial unit of size and capacity indicated on the drawings.

20.8.9 Valves.

Valves shall be provided on all supplies to equipment. Valves indicated on drawings in connection with runouts, risers, branches, and mains shall be in accordance with the drawings. No valve shall be installed on any line with its stem below the horizontal plane. All shutoff valves shall be gate valves unless otherwise indicated on the drawings. Gate valves up to and including 3 inches in diameter shall be all brass with threaded ends for ferrous pipe and sweat-type connections for tubing, and shall have finished trimmings. Valves 4 inches and larger in diameter shall have iron bodies, brass mountings, and either screw or

flange ends for ferrous pipe, and shall be of brass designed for sweat connections for installation with tubing.

20.8.10 Pressure-Reducing Valves.

Unless otherwise specified on the drawings, all service connections to water mains with operating pressure in excess of 80 psi shall be fitted with a pressure-reducing station consisting of one or more P. R. valves in sized in accordance with the drawings.

20.8.11 Condensate Traps.

Condensate traps shall be installed at the ends of all steam mains, at all low points on steam mains, or outlet side of all equipment requiring steam, and where indicated on drawings. Sizes shall be as recommended by the manufacturer, with a minimum safety factor of 3.

20.8.11.1 All Traps on Steam Lines having a pressure of 15 psig or lower, shall be Armstrong, or approved equal, combination float and thermostatic trap.

20.8.11.2 Radiator Traps shall be thermostatic type with brass bellows. Trap shall have nicked body with removable seat and plunger. Trap shall be Armstrong, or approved equal.

20.8.11.3 All Traps on Steam Lines having a pressure above 15 psig shall be Armstrong, or approved equal, bucket type, of designed working pressure suitable for the working pressure of the system.

20.8.11.4 "Y" Type Strainers. Provide "Y" type strainers ahead of all steam traps where traps are without integral strainers. No strainers will be required ahead of radiator traps.

20.8.11.5 Drip Traps. Furnish and install in all low points and at ends of compressed-air lines Armstrong 71, or approved equal, drip traps with drip drain line to nearest drain.

20.8.11.6 Automatic Air Eliminator Vents. Furnish and install automatic air eliminator vents at all radiators and high points of low-pressure and hot and chilled water systems. Relief vents shall be expansion washer or float-operated, automatic reset type, vent shall be Bell & Gossett or equal.

20.8.11.7 Automatic Vacuum Relief Valve. Furnish and install automatic vacuum relief valve ahead of inlet to all steam coils or radiators. Valve shall consist of a standard 3/4-inch swing check valve or be a product of the coil manufacturer. Valve shall be mounted in accordance with manufacturer's instructions, or generally installed above the top of the coil, horizontally, with a drop leg to coil inlet.

20.8.12 Strainers.

All strainers shall be as manufactured by Yarway, or approved equal. Screens shall be brass or bronze for steam, and monel or stainless steel for all other services, and shall have 1/32-inch perforations. Strainers 2 inches and under shall be screwed, 2 1/2 inch and above shall be flanged.

20.8.13 Drain and Vents.

All drain, vent, bleed, overflow, etc., connections on apparatus and equipment shall be properly valved and run to atmosphere (outside of building) or to floor drain or open sight drain provided by others. All vents through roof shall be flashed 12 inches from side of vent in all directions and counter-flashed with four sheelpound lead.

20.8.14 Threaded Pipe.

After cutting and before threading, pipe shall be reamed and shall have burrs removed. Screw joints shall be made with graphite or inert filler and oil or with an approved graphite compound applied to male threads only. Teflon tape may be used for all services except for refrigeration (freon) and steam, unless stated otherwise on the drawing. Calking of threaded joints to stop or prevent leaks will not be permitted. Unions shall be provided where required for disconnection of exposed piping. Unions shall be permitted where access is provided. Dielectric unions shall be provided at connections between ferrous and nonferrous metal piping, except at fixtures, to break galvanic couple and prevent metallic corrosion.

20.9 HANGERS AND SUPPORTS.

Hangers and supports shall be provided and installed for piping and tubing wherever indicated on the drawings or as specified below.

20.9.1 Material.

Material shall be of steel or other durable noncombustible materials. Wood, wire, or perforated strap iron shall not be used as permanent hangers or supports.

20.9.2 Installation of Hangers.

Installation of hangers shall be supported from structural steel members, concrete inserts, wood trusses, joists, and pipe racks. Hangers shall be installed so as not to interfere with the free expansion and contraction of piping.

No hangers shall be secured to underside of lightweight roof decking, lightweight floor slabs, or lightweight wood joists. No drilling of holes in steel members or metal decks will be allowed, except upon approval of the COR.

20.9.3 Hangers for Pipes.

Hangers for pipes shall include adjustable wrought steel clevis or ring type or as specified on the drawings. Hangers shall be complete with bolts and nuts. Where threaded rods are used with hangers, rods may be all-thread or end-threaded. Minimum rod diameters and maximum hanger spacings for general installations shall be as follows:

<u>Pipe Size</u>	<u>Diameter of Rod</u>	<u>Pipe Size</u>	<u>Maximum Span, Feet</u>
3/8"-1/2"	3/8"	3/8"-1/2"	5
3/4"-2"	3/8"	3/4"-1 1/4"	8
2 1/2"-3 1/2"	1/2"	1 1/2"-2 1/2"	10
4" and 5"	5/8"	3"-4"	12
6"	3/4"	5"-6"	14
8"-12"	7/8"	8"-Larger	16
14"-16"	1"		

20.9.4 Special Hangers.

20.9.4.1 "I" Beam Clamps shall be malleable iron with bolts, nut, and socket threaded for rod.

20.9.4.2 Roller Supports shall be pipe rolls to suit.

20.9.4.3 Small Tubing to gages and controls shall be secured in place with bolted steel clips.

20.9.4.4 Hangers for Groups of Pipes shall be fabricated from unistrut sections or structural steel shapes supported from ceiling inserts or through-slab rods and fishtail-plates with 3/4-inch diameter threaded rods.

20.9.4.5 Riser Piping shall be supported by riser clamps.

20.9.4.6 Saddles shall be used when pipes are insulated and need to be supported.

20.10 SLEEVES

20.10.1 Sizes.

Sizes shall be nominal 1 inch larger than outside diameter of pipe when passing through walls. When pipes are covered, the sleeves shall be large enough to allow ample clearance for covering. When passing through outside wall, space between sleeve and pipe shall be filled with lead wool, fiberglass, mineral wool, packed oakum, or equivalent. Sleeves exposed to the weather, or below grade shall be filled as above and made weather and watertight, using non-hardening mastic, or approved equal.

20.10.2 Sleeves Through Roofs.

Sleeves through roofs shall be flashed to extend 12 inches from side of sleeve in all directions. Materials shall be compatible with piping and may be galvanized, lead, copper, or stainless steel, using details shown on drawings or shown in referenced standards.

20.11 VALVES.

Furnish and install valves ahead of all equipment, on all principle branch lines and where indicated on drawings. Valves for pipe erected with welding fittings shall be flanged type.

20.11.1 Steam and Return - 15-Pound, or Less.

20.11.1.1 Gate Valves 2 inches and smaller shall be Crane No. 430, bronze, double wedge disc, screwed, rising stem, for 125-pound steam pressure.

20.11.1.2 Gate Valves 2 1/2 Inches and larger shall be Crane No. 465-1/2, iron body, bronze stem and bronze seat, O.S. and Y. flanged, for 125-pound steam pressure.

20.11.1.3 Globe Valves 2 Inches and smaller shall be Crane Figure No. 14-1/2P, bronze, screwed for 150-pound steam pressure.

20.11.1.4 Globe Valves 2 1/2 Inches and larger shall be Crane Figure No. 351 iron body, bronze trimmed, flanged for 125-pound steam pressure.

20.11.1.5 Check Valves 2 Inches and smaller shall be Crane No. 36 standard bronze swing, screwed, for 200-pound steam pressure.

20.11.1.6 Check Valves 2 1/2 Inches and larger shall be Williams-Hager iron body, bronze trimmed, flanged for 125-pound steam service.

20.11.2 Forced Heating Water Supply and Return, Chilled Water Supply and Return, and Condenser Water Supply and Return - to 150 PSIG.

20.11.2.1 Gate Valves 2 Inches and smaller shall be Crane No. 430, double wedge disc, screwed, rising stem, for 125-pound steam pressure.

20.11.2.2 Gate Valves 2 1/2 Inches and larger shall be Crane No. 465-1/2, iron body, bronze stem and bronze seat, O.S. and Y. flanged, for 125-pound steam pressure.

20.11.2.3 Globe Valves 2 Inches and smaller shall be Crane Figure No. 14-1/2P, bronze, screwed for 150-pound steam pressure.

20.11.2.4 Globe Valves 2 1/2 Inches and larger shall be Crane Figure No. 351 iron body, bronze trimmed, flanged for 125-pound steam pressure.

20.11.2.5 Check Valves 2 Inches and smaller shall be Crane No. 36, standard bronze swing, screwed, for 200-pound steam pressure.

20.11.2.6 Check Valves 2 1/2 Inches and larger shall be Williams-Hager iron body, bronze trimmed, flanged for 125-pound steam service.

20.11.2.7 Plug Cocks 2 inches and smaller shall be Crane, No. 250 semi-steel, screwed, 125-pound working pressure; include wrench.

20.11.2.8 Plug Cocks 2 1/2 Inches and larger shall be Crane No. 325, all-iron, flanged, 125-pound working pressure; include wrench.

20.11.2.9 Check Valves Located on the Discharge Side of pumps shall be Williams-Hager, center guided, silent check valves. The valve bodies shall be semi-steel or cast steel as required for the intended working pressure. Valves shall be fitted with renewable bronze seats and disc unless otherwise specified. Valves 2 1/2 inches and larger shall be flanged.

20.11.2.10. Ball Valves 2 Inches and smaller shall be Walworth or Jamesbury, bronze body and ball, screwed, for minimum 180 psig working steam pressure at 400° F. Ball valves larger than 2 inches shall not be used, unless specified on the drawing.

20.11.3 Compressed Air - to 150 psig

20.11.3.1 Gate Valves 2 Inches and smaller shall be Crane No. 430, bronze, double wedge disc, screwed, rising stem, for 200 psig water, oil, gas (WOG) pressure.

20.11.3.2 Gate Valves 2 1/2 Inches and larger shall be Crane No. 465-1/2, iron body, bronze stem and bronze seat, O.S. and Y flanged, for 200 psig (WOG).

20.11.3.3 Globe Valves 2 Inches and smaller shall be Crane Figure No. 14-1/2P bronze, screwed for 200 psig (WOG).

20.11.3.4 Globe Valves 2 1/2 Inches and larger shall be Crane Figure No. 351 iron body, bronze trimmed, flanged for 200 psig.

20.11.3.5 Check Valves 2 Inches and smaller shall be Crane No. 36 standard bronze swing, screwed, for 400 psig (WOG).

20.11.3.6 Check Valves 2 1/2 Inches and larger shall be Crane No. 373 iron body, bronze trimmed, flanged for 200 psig (WOG).

20.11.4 Gas - to 125 psig

20.11.4.1 Gas Cocks 2 Inches and smaller shall be Crane No. 252 bronze, screwed, machined core and cylinder type with flat operating head, for 125-pound working pressure; include wrench.

20.11.4.2 Gas Cocks 2 1/2 Inches through 4 inches shall be Crane No. 324, iron body, screwed, with bronze plug and washer, machined core and cylinder type with square operating head for 125-pound working pressure; include wrench.

20.11.4.3 Gas Cocks Larger than 4 Inches shall be Crane No. 143XR globe valve, cast-steel body, flanged, standard type, 150-pound working pressure.

20.11.4.4 All By-Pass Valves shall be plug disc type globe valves. Valves shall be one-half the size of regulating or reducing valve which they bypass and one size smaller than the trap by-passed, unless otherwise noted on drawing.

20.11.5 BRINE - to 150 psig

(Valves for all-bronze systems)

20.11.5.1 Gate Valves 2 Inches and smaller shall be Crane No. 430, all bronze, double wedge disc, screwed, rising stem, 200 psig (WOG).

20.11.5.2 Same as 20.11.3.2

20.11.5.3 Same as 20.11.3.3

20.11.5.4 Same as 20.11.3.4

20.11.5.5 Same as 20.11.3.5

20.11.5.6 Same as 20.11.3.6

(Valves for PVC systems)

20.11.5.7 Ball Valves, 2-Inch and smaller shall be Chemetrol Series TU, double-union type, with socket-weld end fittings, CPVC body.

20.11.5.8 Ball Valves, 3 Inches in size, shall be flanged, Chemetrol series DE, double entry, CPVC body.

20.11.5.9 Ball Valves, 4 Inches in size shall be flanged, Chemetrol series SE, CPVC body.

20.11.5.10 Check Valves, thru 4 Inch in size, shall be Chemetrol series BC, double-union type, with socket-weld end fittings, CPVC body.

20.11.5.11 Angle Valves and "Y" Pattern Valves, thru 1 inch in size shall be Chemetrol series AC or YP, threaded ends, PVC body.

20.11.6 Refrigerant (Freon).

Note: Gate Valves and Plug Cocks, and all valves and fittings with threaded or ordinary union couplings are not recommended for refrigerant service.

20.11.6.1 Globe and Angle Line Valves thru 5/8-inch nominal diameter shall be diaphragm, packless type, brass body, with back-seating stem. Henry Valve Co., Type 516 flare or solder as required.

20.11.6.2 Globe and Angle Line Valves 7/8-Inch and larger shall be wing cap, bolted bonnet, packed type, back-seating stem. Body shall be all bronze for solder connections. Flanged connections shall have semi-steel cast body and flanges, with copper solder connection, Henry Valve Co., Type 203.

20.11.6.3 Check Valves shall be piston type, bronze body, bolted cap, with solder connections, Henry Valve Co., Type 205.

Note All valves which must be operated frequently, or rapidly in emergencies, and are placed in inaccessible locations, shall be furnished with adequate remote operators.

20.12 GAGES.

Pressure gages shall be of the Bourdon tube type. Working parts shall be of corrosion-resisting metals. Dial diameter and scale numerals shall allow easy reading from the floor. Range shall place operating pressure near middle 1/3 of scale. Dial diameter where not shown on the drawing shall be not less than 2 1/2 inches, and shall be U. S. Gage Fig. No. 1530, or approved equal.

20.13 THERMOMETERS.

Thermometers shall be mercury red reading separable socket type. Scale shall allow easy reading from floor. Range shall place operating temperature near middle of scale. Scale shall be not less than seven (7) inches long and shall be Taylor, or approved equal.

20.14 ARRANGEMENT AND ALIGNMENT OF PIPING.

All piping shall be arranged and aligned in accordance with the drawings and as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the COR.

20.14.1 Aboveground Piping.

Piping shall be installed in a uniform manner, parallel to walls or ceilings, and all changes in direction shall be made with fittings. Horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible, all piping shall be arranged to provide a maximum head room.

Piping shall be installed as directly as possible between connecting points insofar as the work of other trades permits. Work shall be coordinated with other trades, and where interference occurs with another trade whose work is more difficult to route, reroute piping as required to avoid interference.

Piping shall be carefully installed to provide for proper alignment, slope, and expansion.

Stresses in pipe lines shall be guided and pipe shall be supported in such a manner that pipe lines shall not creep, sag, or buckle. Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

Small tubing to gages, controls, or other equipment installed on any apparatus shall not be coiled nor excessive length, but shall be installed neatly, carefully bent at all changes in direction, secured in place, and properly fastened to equipment at intervals to prevent sagging.

Install stop valves on the inlet side of all gages or thermometers. Install snubbers on any gage where excess pulsations can be transmitted to gage.

Piping of all trades shall be run parallel, and wherever practical, all piping shall be supported on common group hangers. The trade with the most pipe shall furnish group hangers to support the piping of all trades.

20.14.2 Underground Piping.

Where changes in direction occur wherever else required, piping shall be anchored to prevent blowouts or creep from either exterior or interior stresses at pipe joints.

Allowance shall be made wherever necessary for any future settlement of pipe lines to assure the required pitch and avoid pocketing.

Wherever practical, piping for various services underground shall be installed in one trench except where prohibited by codes.

20.14.3 Welded Joints.

All welding shall be done by an approved metallic electric arc process. All welding shall be done by competent, licensed and certified, welders experienced in piping work. All work shall conform to the current ANSI B31-1 (ASME-Code for Power Piping).

All welds shall be of sound weld metal, thoroughly fused into the ends of the pipe and the bottom of the joint, and shall be built-up to excess of the pipe wall thickness to give reinforcement of not less than one-quarter of the pipe wall thickness and in such a manner that the weld metal will present a gradual increase in thickness from the surface of the pipe to the center of the weld. The minimum width of the weld shall be two and one-half times the pipe-wall thickness.

No mitred elbows shall be permitted. Long radius welding elbows, standard welding tees, and fittings shall be used throughout.

Weld-O-Lets or butt-welded pipe tees may be used in place of welding tees when the branch connection is not more than one-half the diameter of the main line.

All pipe ends shall be thoroughly reamed to remove all burrs and irregular surfaces before pipe is beveled.

20.15 INSULATION.

After tests have been completed and surfaces cleaned, insulation, where required by the drawings, shall be installed on all pipe, fittings, and valves. All insulation and vapor-barrier materials shall have been tested according to the "Method of Test of Surface Burning Characteristics of Building Materials, ASTM No. E 84" (aka NFPA No. 255) (aka UL 723).

Test shall have been performed by an approved nationally recognized testing laboratory and material shall have a flame spread rating not greater than 25, a fuel contributed rating not greater than 50, and a smoke developed rating not greater than 50.

Refrigerant piping flexible insulation shall have a flame spread rating not greater than 25 and a smoke developed rating not greater than 100.

20.15.1 All Pipe Insulation.

All pipe insulation shall conform to ASTM C 547, C 533, or C 592. Vapor-barrier and/or weather resistance jackets shall be provided and installed as specified hereinafter, or as shown on the drawings, or approved by the COR.

20.15.2 Insulation on Valves.

Insulation on valves and fittings shall be insulated with factory premolded, prefabricated, or field fabricated segments of insulation of the same material and thickness as the adjoining pipe insulation or may be coated with insulating cement to a thickness equal to the pipe insulation, in accordance with manufacturer's recommendations.

20.15.3 Types of Insulation.

Types of insulation and thickness shall be determined by the type of service and the pipe temperature or ambient temperature as follows, unless otherwise shown on the drawings or approved by the COR.

20.15.3.1, High Pressure Steam (above 150 psig) or other working medium above 360° F. or any service ambient above 200° F. shall be covered with preformed sectional hydrous calcium silicate (asbestos-free) fiber bond insulation with factory or field applied 8-ounce canvas jacket and shall be Johns-Manville Thermo-12 or approved equal. Insulation thickness shall be as follows:

<u>Pipe Size</u>	<u>Thickness</u>
1/2"	1 1/2"
3/4", 1"	2"
1 1/4", 1 1/2"	2 1/2"
2", 2 1/2"	3"
3" thru 4"	3 1/2"
4 1/2" thru 6"	4"
7" thru 10"	4 1/2"

20.15.3.2 Low and Medium Pressure Steam, Condensate Piping, Heating Hot Water Supplies and Returns. Piping shall be covered with preformed fiberglass pipe insulation, having not greater than .22 "K" thermal conductivity at 75° F. ambient temperature. Insulation shall have factory-applied all purpose vapor barrier jacket and shall be Johns-Manville "Flame-Safe" Type AP or approved equal. Insulation thickness shall be as follows:

<u>Pipe Size</u>	<u>Thickness</u>
3/8" thru 6"	1 1/2"
7" and over	2

20.15.3.3 Chilled Water Supply and Return, Brine, or other Cold Services. Same as Paragraph 20.15.3.2 except thickness shall be as follows:

<u>Pipe Temperature</u>	<u>Pipe Size</u>	<u>Thickness</u>
50° F. or below	up to 2"	1"
	2 1/2" to 14"	1 1/2"
Above 50° F.	up to 1"	1/2"
	1 1/4" to 14"	1"

20.15.3.4 Refrigerant Piping (Freon). Piping shall be covered with preformed foam plastic pipe insulation having thermal conductivity not greater .28 "K" at 75° F. ambient temperature and shall be Rubatex FS or approved equal. Insulation thickness shall be as follows:

<u>Pipe Size</u>	<u>Thickness at Pipe Temp.</u>		
	50° F.	35° F.	0° F.
3/8" thru 3"	3/8"	1/2"	3/4"
over 3" thru 5"	1/2"	1/2"	3/4"

20.15.3.5 Installation - Interior and Exterior. The covering shall be continuous through pipe hangers. At hangers where the pipe is supported by the insulation, semicircular galvanized-steel saddles 8 inches long and not less than 0.019-inch thick shall be fastened to the insulation with two bands. High intensity inserts, the same thickness as the adjacent insulation, shall be installed at the hanger supports. Insulation inserts shall be 180 degrees and not less than the length of the saddle.

Coverings shall be applied to the pipe with ends joints tightly butted. Ends of the pipe insulation shall be sealed off with vapor-barrier adhesive or mastic at all flanges, valves, and fittings and at intervals of not more than 12 feet of continuous runs of pipe. Flanges, valves, and fittings shall be insulated with factory premolded, prefabricated, or field-fabricated segments of insulation and sealed with an approved vapor-sealing tape and hard, smooth surface of insulating cement. Covering shall be terminated neatly on the ends of the unions with insulating cement. Where exposed fixture supplies drop from overhead in rooms, the insulation shall be fitted with a metal protector supported by a ceiling plate secured by means of a setscrew.

20.15.3.6 Exterior Installations. Equipment rooms and other locations where mechanical abuse is expected. Install and secure factory or field applied aluminum jacket, .016-inch thick (26 gage) with sealing bands, jacket shall be Johns-Manville "Metal-On" or approved equal.

20.16 INSPECTION AND TESTS.

20.16.1 All Piping.

All piping shall be tested with hydrostatic pressure or as indicated on the drawings, and shall be proven tight as hereinafter specified, in the presence of the COR before it is insulated, enclosed, or covered in any way. The Constructor shall notify the COR 48 hours in advance of any testing. The piping may be tested in sections to keep abreast of job progress schedule.

20.16.2 Pressure Isolation.

During these tests, piping test pressure shall be isolated from any tank, shell, or other manufacturing or process equipment that may be connected to the line under test.

20.16.3 Reliance for Protection.

Reliance for protection of the equipment shall not be placed upon any valve, but full physical disconnection shall be made at or near the final connection to the equipment and the line capped or plugged.

20.16.4 Contractor Furnished Items.

The Constructor shall furnish and install all plugs and make all temporary connections necessary for tests. He shall furnish all labor, tools, and equipment necessary to perform these tests.

20.16.5 Hydrostatic Pressure Testing.

Hydrostatic pressure testing shall be equal to one and one-half (1 1/2) times the normal working pressure, but not less than 50 pounds per square inch except where specified otherwise. The duration of hydrostatic pressure tests shall be sufficient to permit inspection of all joints by the COR.

20.16.6 Leaks.

Any leak in pipe or fittings, other than at joints, shall be cause for rejection. All pinhole leaks which develop in welded joints shall be chipped out and rewelded. A general sweating at any joint shall be cause for rejection. Rejected materials shall be replaced. Rejected joints shall be remade. Caulking will not be permitted.

20.16.7 Threaded Joints.

All threaded joints which develop leaks shall be rejected. Either the thread, fitting, or both shall be removed and replaced. No caulking will be permitted.

20.17 CLEANING SYSTEM.

20.17.1 Equipment.

All equipment shall be cleaned from time to time as the work progresses. At the completion of the job, the Constructor shall clean all piping, strainers, dirt pockets, traps, etc., to insure proper operating condition. Steam condensate shall be drained to the sewer until it runs clean and free from all foreign matter.

20.17.2 Boilers.

Boilers, including drum and tubes, shall be internally cleaned and degreased in accordance with the recommendations of the boiler manufacturer.

20.18 PITCHING LINES.

20.18.1 Steam.

All steam, condensate, and condensate pump discharge lines shall be pitched down in the direction of flow, one inch in fifty feet.

20.18.2 Hot Water Heating.

All hot water heating, chilled water, and cold water lines shall be pitched up in the direction of flow, one inch in forty feet.

20.18.3 Compressed Air Lines.

All compressed air lines shall be pitched down in the direction of flow one inch in forty feet in heated areas and one inch in twenty feet in unheated areas to drip points. Install drain connections at low points.

20.18.4 New Pitch.

If, for any reason, the pitch in the above paragraphs cannot be maintained, the Constructor shall submit to the COR, for his approval, the new pitch he intends to use.

20.19 SHOP DRAWINGS.

The Constructor shall submit shop drawings, catalog cuts, design data, and wiring and control data to the COR, prior to procurement. Three copies of the submittal will be retained by the COR and the remainder of the copies will be returned to the Constructor. No construction shall start until the shop drawings have been approved.

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SECTION 21

PLUMBING

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SECTION 21

PLUMBING

21.1 GENERAL.

This section covers the requirements for the furnishing and installation of all plumbing materials, fixtures, and supplies shown and noted on the drawings and as specified. This covers building service lines and building distribution systems.

21.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

21.2.1 American Society for Testing and Materials (ASTM).

A 47	Malleable Iron Castings
A 48	Gray Iron Castings
A 53	Welded and Seamless Steel Pipe
A 74	Cast-Iron Soil Pipe and Fittings
A 120	Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses
A 126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
B 32	Solder Metal
B 42	Seamless Copper Pipe, Standard Sizes
B 43	Seamless Red Brass Pipe, Standard Sizes
B 68	Seamless Copper Tube, Bright Annealed
B 75	Seamless Copper Tube
B 88	Seamless Copper Water Tube
B 135	Seamless Brass Tube
B 370	Copper Sheet and Strip for Building Construction
C 4	Clay Drain Tile
C 547	Mineral Fiber Preformed Pipe Insulation

- C 592 Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
- D 1785 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- D 2104 Specification for Polyethylene (PE) Plastic Pipe, Schedule 40
- D 2466 Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
- D 2468 Specification for Socket-Type Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
- D 2665 Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings

21.2.2 American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code Section VIII, Division 1, Pressure Vessels

21.2.3 American Water Works Association (AWWA):

- C 100 Cast-Iron Pressure Fittings
- C 203 Coal-Tar Enamel Protective Coatings for Steel Water Pipe
- C 500 Gate Valves 3-Inch Through 48-Inch for Water and Other Liquids
- C 601 Disinfecting Water Mains

21.2.4 Cast-Iron Soil Pipe Institute (CISPI):

- Std 301-72 Specification Data for Hubless Cast-Iron Sanitary System with "No-Hub" Pipe and fittings.

21.2.5 Hydraulic Institute (HI)

Standards of the Hydraulic Institute

21.2.6 International Conference of Building Officials

Uniform Building Code (UBC)

21.2.7 National Electrical Manufacturers' Association (NEMA):

- MG 1 Motors and Generators

21.2.8 National Fire Protection Association Standards (NFPA):

Std 255 Surface Burning Characteristics of Building
Materials, Test For (ASTM, E-84)

21.2.9 Underwriters' Laboratories, Inc., Publications (UL)

Building Materials Directory

Gas and Oil Equipment Directory

Electrical Appliance and Utilization Equipment Directory

Electrical Construction Materials Directory

21.2.10 Factory Mutual System (FM)

Approval Guide

21.2.11 U.S. Department of Commerce Commercial Standard:

CS 188 Cast-Iron Soil Pipe and Fittings

21.2.12 American National Standards Institute (ANSI):

A 21.8 Cast-Iron Pipe Centrifugally Cast in Sand-Lined Molds, for Water or Other Liquids

A 112.11.1 Standard for Drinking Fountains and Self-Contained, Mechanically Refrigerated Drinking Water Coolers

**A 117.1 Specifications for Making Buildings and Facilities Accessible
to and Usable by, the Physically Handicapped**

B 16.5 Steel Pipe Flanges and Flanged Valves and Fittings

B 16.21 Nonmetallic Gaskets for Pipe Flanges

**B 16.23 Cast-Bronze Solder-Joint Drainage Fittings-DWV, Including
Supplement B 16.23a-1973**

B 36.10 Welded and Seamless Wrought Steel Pipe

21.2.13 National Sanitation Foundation (NSF):

**Std. No. 14 Thermoplastic Materials, Pipe, Fittings, Valves, Traps,
and Joining Materials**

Std. No. 15 Thermoset Plastic Pipe, Fittings, Valves, Tanks, Appurtenances, Joining Materials, and Thermoset Plastic Coatings for use in Potable Water Supply Systems

21.2.14 Occupational Safety and Health Administration (OSHA):

All applicable OSHA Regulations

21.2.15 International Association of Plumbing and Mechanical Officials:

Uniform Plumbing Code (UPC)

21.3 GENERAL REQUIREMENTS.

The general arrangement of the plumbing shall be as indicated on the drawings. Examine the drawings carefully for the proper fitting of materials and equipment. All work shall comply with the latest edition of the Uniform Plumbing Code. All materials shall conform to the publications listed above, as applicable. Wherever there are UL/FM-listed products that serve the desired function, only UL or FM products will be acceptable.

21.3.1 Utilities.

Water and drainage piping shall be connected to the service system piping, and shall follow the general requirements for building service connections as specified in Paragraph 28.3.

21.3.2 Cross-Connections.

No plumbing fixture, device, or pipe shall be installed that will provide a cross-connection between a potable water supply system and any plumbing fixture or any tank, receptacle, equipment or device, through which it may be possible for non-potable, used, unclean, polluted and contaminated water, or other substances, to enter into any part of such potable water system under any condition.

21.3.3 Specifications.

Required materials not covered by this specification shall meet the requirements of the applicable specifications listed above, and shall be of the required class, grade, type, and size shown on the drawings.

21.3.4 Connections to Equipment and Fixtures.

Provide all necessary material and connect to the plumbing system all fixtures and equipment having plumbing connections. Drainage connections shall be trapped. The service line to each item of equipment shall be equipped with a cutoff valve to enable isolation of the item for repair and maintenance without interfering with operation of other equipment or fixtures. When fixtures and equipment are not delivered prior to completion

of the work, the valves shall be capped or plugged at walls or floors and left ready for future connection.

21.3.5 Drawings.

Because of the scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Carefully investigate the structural and finish conditions affecting all work and arrange such work accordingly, to meet such conditions.

21.3.6 Cutting and Repairing.

Cutting of existing structure shall be done only when approved by the Contracting Officer's Representative (COR). Damage to structures, piping, wiring, or equipment as a result of cutting shall be repaired by skilled craftsmen for the trade involved.

21.3.7 Protection to Fixtures, Materials, and Equipment.

Pipe openings shall be closed with caps or plugs during installation. Fixtures and equipment shall be tightly covered and protected against dirt, water, and chemical or mechanical injury. Upon completion of all work, the fixtures, materials, and equipment shall be thoroughly cleaned, adjusted, and operated. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts shall be fully enclosed or provided with guards, unless they are inaccessible from personnel.

21.4 EXCAVATING, TRENCHING, AND BACKFILLING.

Excavating, trenching, and backfilling is specified in Section 1 of these specifications.

21.5 SOIL, WASTE, DRAIN, VENT PIPING..

Soil, waste, and drain pipe and fittings under concrete slabs shall be coated or uncoated extra-heavy bell-and-spigot cast-iron unless otherwise specified on the drawings or approved by the COR. Soil, waste, drain, and vent piping for use aboveground and smaller than 3 inches shall be galvanized steel, or DWV plastic ABS. Pipe 3 inches and larger for similar installations shall be standard weight cast-iron pipe (bell-and-spigot or "No-Hub") or DWV plastic ABS. Fittings for aboveground piping shall be drainage pattern for all threaded drain and waste piping and soil fittings cast-iron pipe. Fittings on all dry vents may be black malleable iron, black cast iron, or DWV plastic ABS. Copper drain, waste, and vent lines may be installed in lieu of steel or cast iron. Nonmetallic DWV pipe shall not be installed under a building or through structure-bearing walls without the use of a load-supporting sleeve, or as otherwise stated on the drawings.

21.5.1 Installation.

21.5.1.1 Drainage Pipes and Vent Piping. Horizontal soil and waste pipes shall be given a grade of 1/4 inch per foot where possible, but in no case less than 1/8 inch per foot. All main vertical soil and waste stacks shall be extended full size through the roof and 18 inches above roof as vents, except where otherwise specifically indicated. Where practicable, two or more vent pipes shall be connected and extended as one pipe through the roof. Vertical vent pipes may be connected into one main vent riser above vented fixtures. Where a circuit vent pipe from any fixture or line of fixtures is connected to a vent line serving other fixtures, the connection shall be at least 4 feet above the floor on which the fixtures are located, to prevent the use of any vent line as a waste line. Horizontal waste lines receiving the discharge from two or more fixtures shall be provided with end vents, unless separate venting of a fixture is noted. The cast iron bell-and-spigot pipe inside of buildings shall be extended 6 inches above the lowest floor where the floor is supported on the ground, and 6 inches aboveground where the lowest floor is self-supporting.

21.5.1.2 Fittings. Changes in pipe size on soil, waste, and drain lines shall be made with reducing fittings or recessed reducers. No drain line shall be reduced in size in the direction of flow. All changes in direction shall be made by the appropriate use of 45-degree wyes, half wyes, long-sweep 1/4-bends, 1/6-, 1/8-, or 1/16-bend, except that sanitary tees may be used on vertical stacks, and short quarter bends or elbows may be used in soil and waste lines where the change in direction of flow is from the horizontal to the vertical, and on the discharge from water closets.

21.5.1.3 Union Connection. Slip joints will be permitted only in trap seals or on the inlet side of the traps except that tubing traps may be connected to their trap arms by means of an approved-type ground joint or sweat-type hexagonal adapter fittings. Tucker or hub drainage fittings shall be used for making union connections wherever practicable. The use of long screws and bushings is prohibited.

21.5.2 Joints

21.5.2.1 Cast Iron Pipe. Joints in bell-and spigot, cast-iron soil, waste, and vent pipes, or between cast-iron soil, waste, and vent pipes, and threaded pipe or calking ferrules, shall be firmly packed with jute packing and calked with lead at least 1-inch deep.

21.5.2.2 Threaded Pipe. Threaded joints shall have American-National taper screw threads with graphite and oil compound applied to the male thread. Connections between threaded pipe and soil pipe shall be similar and the threaded pipe shall have a ring or half coupling screwed on to form a spigot end.

21.5.2.3 Solvent-Welded Joints. DWV plastic pipe ABS and fittings shall be solvent-welded in accordance with manufacturers' recommendations.

Molded threads in fittings will be allowed on Schedule 80 pipe only. No cutting of threads in DWV plastic ABS will be allowed.

21.6 CLEANOUT PLUGS AND TEST TEES.

Cleanouts shall be the same size as the pipe except that cleanout plugs larger than 4 inches will not be required. A cleanout installed in connection with cast-iron bell-and-spigot pipe shall consist of a long-sweep 1/4-bend or one or two 1/8-bends extended to the place indicated on the drawings, or, if not indicated, to an easily accessible place. A cast-brass ferrule with countersunk trap screw cover shall be calked into the hub of the fitting and shall be flush with the floor. Where cleanouts in connection with threaded pipe are indicated and are accessible, they shall be cast-iron drainage, T-pattern, 90-degree branch fittings with extra-heavy brass screw plugs of the same size as the pipe up to and including 4 inches. Test tees with cast brass cleanout plugs shall be installed at the foot of all soil, waste, drain, and vent stacks systems that extend vertically through the roof.

21.7 FLOOR DRAINS AND FLOOR SINKS.

Floor drains and floor sinks shall be of the type, size, and manufacture indicated on the drawings or shown in the equipment schedule. Floor drains shall be provided in all rooms where floors are subjected to flush or flood type cleaning or where normal operations release or discharge water or other liquid waste onto the floor. Such floors should be graded to provide effective drainage. Floor drains shall be furnished with polished brass strainers, unless otherwise noted. Floor sinks shall have cast-iron hinged strainer and removable sediment bucket and acid resistant enameled interior. Floor drains and sinks shall have adjustable strainer and be depressed not less than 3/4 inch, unless otherwise indicated, to provide adequate drainage of the floor. Flanges shall be flashed with 4 pounds per square foot sheet lead.

21.7.1 Installation.

21.7.1.1 Floor Sinks and Drains. When waterproofing is used in a floor, a suitable clamp for attaching drain to metal flashing or waterproofing membrane shall be provided.

21.7.1.2 Toilet Rooms. Where floor drains occur in toilet rooms, they shall be 5-inch diameter top.

21.7.1.3 Shower Rooms. Where floor drains occur in shower rooms, they shall be 5-inch diameter top and 2-inch minimum outlet, rated for the anticipated load.

21.7.1.4 Equipment Rooms. Where floor drains occur in mechanical equipment rooms or to serve water heaters, they shall be the integral trap-type with the strainer of the adjustable combination indirect waste funnel drain-type; funnel shall extend 6 inches above finished floor.

21.7.1.5 Equipment Traffic Areas. Where floor drains occur in maintenance or shop areas, they shall be cast-iron double drainage pattern with removable cast-iron sediment bucket, 3-inch minimum outlet, 9-inch minimum diameter, rated for the anticipated load.

21.8 FLASHINGS.

Pipes protruding through exterior walls or roofs shall be flashed and made watertight with standard commercial galvanized sheet steel flashing units or 4 pounds per square foot lead. Flashings in connection with cast-iron pipe vents shall be turned down into the pipes or hubs and sealed. Flashing shields shall extend not less than 8 inches from the pipes in all directions.

21.9 TRAPS.

Each fixture and piece of equipment requiring connections to the drainage system shall be equipped with a trap. Fixtures with continuous waste shall be air-dropped to a trap. Traps are to be supplied with the fixtures. Each trap shall be placed as near to the fixture as possible and no fixture shall be double-trapped. Traps installed on bell-and-spigot pipe shall be cast iron. Traps installed on threaded pipe shall be recess drainage pattern. Lavatory traps furnished with fixtures shall be chromium plated, and shall have cast-brass cleanout plugs.

21.9.1 Trap Primer Valve.

Trap primer valve shall be provided when specified on the drawings, adjustable to line pressure and desired delivery amount, "O" ring seals, Precision Plumbing Products, Inc., or approved equal.

21.9.2 Trap Primer Distribution Units.

Trap primer distribution units for use with trap primer valve shall be provided when specified on the drawings, Precision Plumbing Products, Inc., or approved equal.

21.10 SUMP PUMPS.

Sump pumps shall be installed where shown on the drawings. The pumps shall be of the automatic, electric-motor-drive, submerged type, complete with all necessary control equipment, and steel or cast-iron perforated split covers and and bronze centrifugal-type open impellers. Shafts shall be stainless steel with replaceable bronze bearings. The pumps shall be direct-connected by means of a flexible coupling to a vertical electric motor having a continuous oiling device. Motors shall be as indicated on the drawings and shall be equipped with a thermal-overload cutout switch. Each pump shall be fitted with a high-grade thrust-bearing mounted above the floor. Each shaft shall have two alignment bearings, one at each end, and shall be of proper length so the suction inlet will be not more than 6 inches nor less than 3 inches above the bottom of the sump. The suction side of each pump shall have a strainer

of ample capacity. The motor shall be operated by a nonmetallic float, or a float switch having two electrodes adjusted to start and stop the motor at predetermined water levels. The switch shall be completely enclosed in a steel case. Motors, wiring, motor-control switching, and protective equipment shall conform to Section 23 of these specifications. The discharge line from the pump shall be provided with a check valve and union in an accessible location near the pump.

21.11 WATER PIPE, FITTINGS, AND CONNECTIONS.

21.11.1 Cast Iron.

Water service pipe and fittings 3 inches and larger, below grade, to 5 feet outside of buildings shall be cast-iron bell-and-spigot type, Class 150. The pipe shall terminate inside of the building wall with a cast-iron spigot-and-flange special fitting.

21.11.2 Copper Tubing and Fittings.

Piping aboveground shall be Type L Copper Tubing; piping underground shall be Type K Soft Copper Pipe for sizes 2 inches and smaller. No fittings shall be installed in or below concrete floors. Fittings shall be cast-brass or wrought-copper suitable for sweat or brazed connections for use with hard-drawn tubing, and flared-pattern for annealed tubing. Dielectric couplings shall be used in all connections between ferrous and nonferrous piping or tubing.

21.11.3 Ferrous Piping and Fittings.

Piping aboveground and piping less than 3 inches in size, below grade shall be Schedule 40 galvanized steel. Fittings shall be galvanized malleable iron. All galvanized pipe and fittings below grade shall be coated and wrapped with Concoat 22 factory-wrap or John Mansville PVC 10 tape with minimum lap as specified by the manufacturer.

21.11.4 Plastic Pipe and Fittings.

21.11.4.1 PVC Pipe of 6 inches or less diameter may be used for domestic water connections to service lines. Material shall be Type II, Grade I, when pipe exposure below 40° F. is expected. Chlorinated PVC (Type IV, Grade I,) may be used for interior domestic water distribution with a limit of 180° F. maximum operation temperature. Use of PVC pipe and fittings for process water or other fluids shall require the approval of the COR. All fittings shall be the same material as the pipe and shall match the pressure rating of the pipe.

21.11.4.2 Use of Piping of other thermoplastic or similar nonmetallic materials such as PE (Polyethylene) ABS, CAB (Cellulose - Acetate - Butyrate), or reinforced epoxy shall require the approval of the COR, or as otherwise shown on the drawing.

21.11.5 Installation.

A stop-and-drain valve shall be installed on the service line inside the structure or as shown on the drawings. The piping shall be extended to all fixtures, outlets, and equipment from the valve. The cold-water system shall be installed with a fall toward the stop-and-drain valve. Outlets shall be capped or plugged until final connections are made.

21.11.5.1 Mains, Branches, and Runouts. Piping shall be installed as indicated on the drawings. Pipe shall be cut accurately to measurements established at the structure and shall be worked into place without springing or forcing. Care shall be taken not to weaken any structural members of the building or trailer. Piping aboveground shall be run parallel with the lines of the structure unless otherwise shown or noted on the drawings. Branch pipe from service lines may be taken off the top of the main, bottom of the main, or side of the main, using such crossover fittings as may be required by structural or installation conditions. Service pipe, valves, and fittings shall be kept a sufficient distance from other work and other services to permit not less than 1/2 inch between finished covering on the different services. No water piping shall be embedded in floors unless specifically indicated on the drawings. Changes in pipe size shall be made with reducing fittings. The use of long screws and bushings will not be permitted.

21.11.5.2 Pipe Drains indicated on the drawings shall consist of 1/2-inch globe valves with renewable disks and 3/4-inch hose nipples. Additional drains shall be installed at low points on the piping, and all piping shall grade down to the drains.

21.11.5.3 Expansion and Contraction of Piping. Allowance for pipe expansion and contraction shall be made throughout. Horizontal runs over 50 feet long shall be anchored to the wall or to the structural members about midway on the run to force the expansion movement to divide equally. Sufficient flexibility shall be provided on all branch runouts from mains to risers to provide for expansion and contraction of piping. Flexibility shall be provided by installing one or more turns in the line so that the pipe will spring enough to allow for expansion without straining.

21.11.5.4 Air Chambers shall be provided on all hot-and-cold supplies near each faucet, control valve, or flush valve, except wall hydrants, and hose faucets. Where not shown on the drawings, air chambers shall consist of a 12-inch capped length of pipe of same diameter as the branch supply line. Factory-fabricated air chambers may be used and installed in accordance with manufacturer's recommendations.

21.11.6 Joints.

21.11.6.1 Threaded Pipe. After cutting and before threading, pipe shall be reamed and shall have burrs removed. Screw joints shall be made with graphite or inert filler and oil or with an approved tape compound applied to male threads only. Calking of threaded joints to stop or prevent leaks will not be permitted. Unions shall be provided where

required for disconnection of exposed piping. Unions shall be provided where required for disconnection of exposed piping. Access shall be provided where unions are permitted. Dielectric unions shall be provided at all connections between ferrous and nonferrous metallic piping, except at fixtures, to break galvanic couple and prevent metallic corrosion.

21.11.6.2 Bell-and-Spigot Pipe. Lead joints shall be made by centering the spigot within the bell and packing the joint with braided or twisted hemp so as to leave a 1-inch depth for the lead. Yarn or packing material shall consist of one of the following:

Molded or tubular rubber rings, oakum, hemp, or jute. The materials shall be handled with care to prevent contamination, shall be dry when placed in the joint, and shall be free of oil, tar, and grease. Hemp and jute shall be used only on pipe having roll-on joints and shall be placed between the round rubber gasket and bituminous joint compound. Each joint shall be made in one continuous pouring from the ladle. Joints shall be poured full, then thoroughly calked at least three times around with calking tools of the proper width, and shall contain not less than 99.7 percent pure lead.

21.11.6.3 Flared or Sweated Tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool before sweating. Care shall be taken to prevent annealing of fittings and hard-drawn tubing when making connections. Installation shall be made by competent craftsmen and in accordance with manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for soldered fittings shall be made with a noncorrosive paste flux and 50-50 for cold water 95- 5 for hot water solid string or wire solder. Cored solder will not be permitted. Joints in copper pipe and tubing 2 1/2-inch diameter and larger shall be made with heat applied uniformly around the entire circumference of the pipe and fittings by a multiflame circular torch.

21.11.6.4 PVC Plastic Pipe Socket-Type Fittings shall be solvent-welded using a solvent cement or an equivalent compound furnished by the pipe manufacturer. Threading of PVC pipe will be permitted only on Schedule 80, 120, and 160 PVC pipe.

21.11.6.5 Cast-Iron "No-Hub" Soil Pipe Fittings shall conform to the requirements of CISPI Std. 301.

21.11.7 Disinfection.

The entire potable water system shall be disinfected with chlorine before acceptance for domestic operation. Disinfection shall be accomplished as described by the system prescribed by the American Water Works Association Standard C 601. The amount of chlorine applied shall be such as to provide and maintain a dosage of not less than 50 parts per million (ppm) free residual. Lines shall be thoroughly flushed before introduction of the chlorinating materials. After a chlorine contact period in the

lines for at least 24 hours, the treated water shall contain not less than 25 ppm free chlorine residual throughout the length of the main. The system shall be flushed with potable water until the free chlorine residual is less than 0.5 ppm. All valves in the lines being disinfected shall be opened and closed several times during the contact period.

21.11.8 Protective Coatings for Service Pipe.

Threaded galvanized and ungalvanized ferrous water pipe and fittings installed underground and through exterior concrete walls or floors shall be given one coat of coal-tar primer and two coats of coal-tar enamel conforming to AWWA Std. C 203, or factory-wrapped with Concoat No. 22, or field-wrapped with John Mansville 10 PVC tape with minimum lap as specified by the manufacturer. Piping shall be tested and thoroughly cleaned of foreign matter by wire-brushing and solvent-cleaning before the protective coating is applied.

21.11.9 Reduced-Pressure-Type Backflow-Prevention Device.

Reduced-pressure-type backflow-prevention device shall be installed as indicated, so located that no part of the device will be submerged, and in such manner as to permit access for maintenance and testing. Each device shall be a standard commercial unit of size and capacity as indicated on the drawings.

21.12 VALVES.

21.12.1 Valves.

Valves shall be provided on all supplies to fixtures. Valves indicated on drawings in connection with runouts, risers, branches, and mains shall be in accordance with the drawings. No valve shall be installed on any line with its stem below the horizontal plane. All shutoff valves shall be gate valves unless otherwise indicated. Gate valves up to and including 3 inches shall be all brass and threaded ends for ferrous pipe and sweat-type connections for tubing, and shall have finished trimmings. Valves 4 inches and larger in diameter shall have iron bodies, brass mountings, and either screw or flange ends for ferrous pipe, and shall be of brass design for sweat connections for installation with tubing.

21.12.2 Pressure-Reducing Valves.

All service connections to water mains and operating pressure in excess of 80 psi shall be fitted with a pressure-reducing station consisting of one or more P. R. valves sized in accordance with the drawings.

21.13 UNIONS.

Unions on ferrous pipe 2 inches in diameter and smaller shall be malleable iron, zinc coated. Unions on copper tubing 2 inches in diameter and smaller shall be brass. Unions on water piping 2 1/2 inches in diameter and larger shall be flange pattern and shall be brass or bronze 150-pound

Class on copper tubing and 125-pound Class on ferrous pipe. Gaskets for flanged unions shall be of the best quality fiber, plastic, or leather. Unions shall not be concealed in walls, ceilings, or partitions. Install dielectric unions or couplings between all copper and ferrous metal lines or systems.

21.14 HOSE FAUCETS AND HOSE BIBBS.

Hose faucets and hose bibbs shall be brass with 12-inch male inlet threads, hexagonal shoulder, and 3/4-inch hose connection. They shall be installed on the building side of the main shutoff valve. Outside hose bibbs shall be nonfreeze-type with vacuum breaker or antisiphon feature.

21.15 DRINKING-WATER DISPENSERS

Drinking-water dispensers shall be of the type and size indicated on drawings and in accordance with the ANSI A112.11.1. Where handicapped requirements are established ANSI A117.1 shall apply.

21.16 ELECTRIC WATER HEATERS.

Each tank shall be glass-lined and equipped with magnesium anodes. The size, capacity, voltage, and combined wattage of heating elements shall be not less than indicated on the drawings. Wiring shall be so arranged that, when required by thermostats, both heating elements will operate simultaneously. Heaters shall be glass fiber insulated.

21.17 RELIEF VALVES.

Temperature and pressure relief valves of the size and type shown on the drawings shall be ASME approved and installed where indicated. The discharge piping from the relief valves shall be extended over, but not into, the nearest drain, or to the building exterior, as indicated on drawings; piping shall be the same material as used for cold water.

21.18 INSULATION.

After tests have been completed and surfaces cleaned, insulation, unless otherwise noted on the drawings, shall be installed on all water pipe, fittings, and valves. Insulation and vapor-barrier materials shall be U.L. Class 0 or 1, with a maximum flame-spread rating of not more than 25, and fuel contributed and a smoke-developed rating of not more than 50, as defined in the (NFPA) Standard 255 (ASTM, E-84).

21.18.1 All Pipe Insulation.

All pipe insulation shall conform to ASTM C 547 or C 592 except vapor-barrier jackets shall be provided and installed as specified hereinafter. Where exposed fixture supplies drop from overhead in toilet rooms, the insulation shall be fitted with a metal protector supported by a ceiling plate secured by means of a setscrew. Cold water insulation thickness shall not be less than 1/2 inch for piping up to 1 inch in diameter, and

3/4 inch for piping 1 1/4 inches through 14 inches in diameter unless otherwise specified on the drawing. Hot water thickness shall not be less than 1 inch for piping 1/4 inch through 1 1/2 inches in diameter, 1 1/2 inches for piping 2 inches through 4 inches and 2 inches for piping over 4 inches unless otherwise specified on the drawing.

21.18.2 Insulation on Valves and Fittings.

All valves and fittings shall be insulated with factory premolded, prefabricated, or field fabricated segments of insulation of the same material and thickness as the adjoining pipe insulation or may be coated with insulating cement to a thickness equal to the pipe insulation.

21.18.3 Vapor-Barrier Jackets.

Vapor-barrier jackets shall be installed over all cold water and chilled water insulation, including valves and fittings. The insulation shall be provided with a factory-applied noncombustible vapor-barrier jacket consisting of a lamination of not less than 0.70-mil aluminum foil, fiber reinforcing, and kraft paper. The vapor-barrier jacket shall be lapped not less than 1 1/2 inches at each joint and sealed with an approved noncombustible adhesive suitable for the jacket material. Insulation shall be secured in place with outward clinch staples on 4-inch centers after which the staples shall be coated with vapor-barrier mastic. The covering shall be continuous through pipe hangers. At hangers where the pipe is supported by the insulation, semicircular galvanized-steel saddles 8 inches long and not less than 0.019-inch thick shall be fastened to the insulation with two bands. High intensity inserts, the same thickness as the adjacent insulation, shall be installed at the hanger supports. Insulation inserts shall be 180 degrees and not less than the length of the saddle. Coverings shall be applied to the pipe with end joints tightly butted. Ends of the pipe insulation shall be sealed off with vapor-barrier adhesive or mastic at all flanges, valves, and fittings and at intervals of not more than 12 feet of continuous runs of pipe. Flanges, valves, and fittings shall be insulated with factory premolded, prefabricated, or field-fabricated segments of insulation and sealed with an approved vapor-sealing tape and a hard, smooth surface of insulating cement. Covering shall be terminated neatly on the ends of the unions with insulating cement. On jacket facing to receive finish painting, the aluminum foil shall not be exposed and the exposed kraft paper facing shall conform to the fire-resistance rating specified.

21.19 UNDERGROUND COLD PIPE WRAPPING.

Underground cold pipe wrapping shall be factory-wrapped Conway No. 22, No. 50 Scotchwrap, 10 mil, or field wrapped with Tapecoat No. 20, lap as specified by the manufacturer.

21.20 PIPE SLEEVES, HANGERS, AND FIXTURE SUPPORTS.

21.20.1 Pipe Sleeves.

Unless otherwise shown on the drawings, pipe sleeves shall be installed

for pipes passing through concrete and other cast-in-place construction. Clearance between sleeves and pipe covering and/or pipes shall be approximately 1/2 inch. Where cutting of construction is necessary, the construction shall be repaired to match its original condition. Sleeves located in exterior walls and floors on and below grade shall be sealed to make the space between pipe and sleeve watertight with a sealing compound of plastic bituminous cement. Sleeves shall not be installed in structural members except where indicated or where approved by the COR. Terminate sleeves flush with walls, partitions and ceiling. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor. In all areas where pipes are exposed, extend sleeves 1/4 inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inch above floor.

21.20.1.1 Sheet Metal or Fiber Sleeves. Sleeves of No. 24 gage galvanized sheet steel or fiber sleeves not less than 1/4-inch-thick shall be installed where pipes pass through floors on and above grade, except as specified hereinafter for toilet rooms and laboratories, and shall be installed in interior walls and partitions.

21.20.1.2 Steel Iron-Pipe-Size Pipe Sleeves shall be installed for pipes that will pass through exterior walls and floors in toilet rooms and laboratories. The space between sleeve and pipe and/or pipe covering shall be sealed with plastic bituminous cement or silicone caulking compound per General Electric sealant No. 1200, or equal.

21.20.2 Pipe Hangers, Inserts, and Supports.

Hangers shall be installed before the concrete is poured. Beam clamps shall be standard, commercial types. For wood construction, bridge the joints where necessary and use pipe-threaded coach screws of same diameter as the hanger rod, complete with coupling. Hangers and supports shall be installed at dimensions not exceeding the maximum limits specified below, and at intervals to keep the pipe in alignment and to carry the weight of the pipe and contents. All piping shall be supported from building structural members.

21.20.2.1 Horizontal Piping. Hangers and supports shall be installed as specified hereinafter, and at locations not more than 3 feet from the end of each runout. A hanger shall be installed not over 1 foot from each change in direction of piping. Hangers shall be adjustable type. Hanger types with adjustable, swivel nuts may be used to support pipes from toilet rooms to main stacks when space does not permit the use of turnbuckles or adjustable clevis-type hangers. Brackets shall be used for support of piping at walls. In lieu of separate hangers, trapeze hangers with turnbuckles on rods and a solid or split-ring clamp for each pipe may be used. Rings shall have a diameter large enough to include the covering and a protective saddle.

Cast iron soil pipe shall be supported at not more than 5-foot intervals, and supports shall be located near each hub.

Threaded pipe shall be supported at 10-foot intervals.

Copper tubing shall be supported at not more than 5-foot intervals for tubing up to 1 1/2 inches in size and 10-foot intervals for tubing 2 inches and larger. Hangers for copper tubing shall have proper size rings to suit outside of packing or plastic insert over tubing.

Underground piping shall be laid as specified in Paragraph 21.3.1.

21.10.2.2 Vertical Piping. Supports shall be spaced as specified herein-after. Pipe clamps shall be floor-support type.

Cast iron and threaded pipe shall be supported at intervals of not more than 20 feet and not more than 8 feet from end of riser.

Copper tubing shall be supported at intervals of 10 feet by stays or braces to prevent rattle and vibration.

21.20.3 Supports and Fastenings for Fixtures and Equipment.

Fixtures and equipment shall be supported and fastened in a manner satisfactory to the COR. Commercial wall hangers or wall/floor carriers matched to the related fixture shall be installed wherever specified on drawings or in these specifications. Where hangers are not practical, the following methods may be used, subject to approval of the COR. Where secured to solid masonry, fixtures and equipment shall be fastened with brass bolts or machine screws in lead or corrosion-resisting-metal, sleeve-type anchorage units, or with brass expansion bolts. Expansion bolts shall be 1/4-inch brass bolts with 20-threads-to-the-inch and of sufficient length to extend at least 3 inches into solid masonry construction, and shall be fitted with sleeves of proper length to bring expansion sleeves into the solid concrete or brick wall. Where secured to cellular masonry construction, fixtures and equipment shall be fastened with 1/4-inch brass toggle bolts or through-bolts. Where secured to wood studs with plywood facing, fixtures and equipment shall be fastened with brass wood screws. Where fixtures and equipment are secured to steel stud partitions, two 4 x 3 x 1/4-inch steel angles shall be clamped to the studs by 1/4-inch hook bolts; the smaller leg shall be turned inward with approximately 3/8-inch space between the angles; the angles shall extend the full width of the fixture and be clamped to at least two studs. The fixture hangers shall be secured to the angles by means of not less than four 1/4-inch toggle bolts. Exposed nuts and heads of bolts shall be hexagonal with rounded tops finished and chromium-plated; exposed ends of bolts shall be concealed by chromium-plated hexagonal cap nuts. Exposed nuts and heads of screws shall be provided with chromium-plated brass washers.

21.21 IDENTIFICATION TAGS.

Identification tags made of brass, or laminated plastic disc, indicating function of the valve, size, and working pressure shall be installed on all valves except valves on plumbing fixtures. Tags shall be 2 inches in diameter and wired to valve.

21.22 FLOOR, WALL, AND CEILING PLATES.

Exposed insulated and uninsulated pipes through floors, finished walls, or finished ceilings shall be fitted with chromium-plated, enameled cast iron or steel plates. Plates shall be large enough to completely close the hole around the pipes and shall be square, octagonal, or round, with the least dimension not less than 1 1/2 inches larger than the diameter of the pipe. Plates shall be secured in a manner as shown on the drawings unless otherwise approved by the COR.

21.23 CIRCULATING PUMPS.

Circulating pumps shall be electrically driven, single-stage, centrifugal, enclosed-impeller type suitable for the intended service and as shown on the drawings. Capacities shall be as shown on the drawings. Pumps and motor may be integrally mounted on a cast iron or steel subbase, or direct-connected by a flexible coupling, or closed-coupled with an overhung impeller. Impeller shall be bronze, mechanically and hydraulically balanced. The shaft shall be one-piece heat-treated stainless steel with runners and gland of bronze, and smooth-surfaced housing of bronze. Motors shall have sufficient horsepower for the service required. Pumps shall be hydraulically balanced and shall conform to the Standards of Hydraulic Institute. Each pump motor shall be provided with a suitable manual switch with red running light and overload protection.

21.24 EQUIPMENT CONNECTIONS.

The Constructor shall furnish all pipe, fittings, and specials required to make connections to heating, air conditioning, and other equipment installed under the various sections of the specifications. Connections shall be as indicated on the drawings.

21.25 ELECTRICAL WORK.

Motors, controls and switching, protective devices, and other electrical devices required for the proper operation of equipment shall be installed in conformance with Section 23 "Interior Electrical Work."

21.26 PAINTING.

Piping and equipment to be painted, labeled, and color coded as specified under Section 18 "Painting."

21.27 FIRE PROTECTION SYSTEMS

See Section 42.

21.28 FIXTURES AND FIXTURE TRIM.

Fixtures and fixture trim shall be of the types, sizes, and specifications noted hereinafter. Generally, all fixtures except water closets and urinals shall have the water supply above the rim. Fixtures with the

supply discharge below the rim or with the faucet lip threaded shall be equipped with backflow preventers. Angle stops, straight stops, stops integral with the faucets, or concealed-type of lock-shield, loose-key pattern stops for supplies shall be installed with fixtures. Exposed traps and supply pipes for all fixtures and equipment shall be connected to the rough piping systems at the wall, unless otherwise specified on the drawing. Floor plates, wall plates, and escutcheons shall be as required by the specified equipment. Exposed fixture trim and fittings shall be chromium-plated on nickel-plated brass with polished, bright surfaces, unless otherwise shown on the drawings.

21.28.1 Plumbing Fixtures and Accessories.

Plumbing fixtures and accessories shall comply with the applicable requirements of the Uniform Plumbing Code. Fixtures and accessories shall be as follows or shall be as shown on the drawings unless otherwise approved by the COR.

21.28.1.1 Shower Compartments, Fiat Model S-86, Commander 36-x 36- x 82-inch, vitreous porcelain walls, precast terrazo receptor, chromium-plated brass trim including drain, valves, shower head, and soap dish. Install a standard size tempered glass door with chrome-plated glass frame. Keystone key construction 90 or equal.

21.28.1.2 Water Closets, American-Standard elongated water-saver cadet Model 2019.016 with 5334.065 Moltex open-front white seat and cover. Water closets to be complete with 3019.015 free-standing, elongated siphon-jet bowl, 4059.028 close-coupled tank with cover, 3154.010 flush valve, 3137.155 water control, 3524.014 trip lever. Trim shall be chromium-plated brass.

21.28.1.3 Flush-Valve Toilets, American-Standard Aftwall No. 2477.016, with No. 5320.114 Moltex open-front white seat. Toilet to be complete with elongated, siphon jet-action bowl, 1 1/2-inch top spud, two No. 481310-100 bolt caps with retainer clips, and 110 FVYO Sloan royal flush valve, chromium lever handle, screwdriver stop and vacuum breaker. Use Wade carrier W-411 or equal for mounting.

21.28.1.4 Lavatories, American-Standard Ledgewood, No. 4300.117, 22-x 19-inch with Heritage faucet and pop-up drain. Lavatories shall be acid-resisting enameled cast iron, front overflow, and wall hanger.

21.28.1.5 Urinals, wall-hung type, American-Standard Washbrook, No. 6500-011, Vitreous china, with wall hanger, Sloan valve Royal 186.11, chromium-lever handle, screwdriver angle stop, and vacuum breaker. Pipe and fittings shall be chromium-plated brass.

21.28.1.6 Service Sinks, American-Standard Lakewell, No. 7692.049, 22-x 18-inch with 8341.075 exposed double faucet, bucket hook and vacuum breaker, 8379.018 rim guard and 7798.176 3-inch trap standard. Sinks shall have acid-resisting enamel over cast iron and drilled back.

21.28.1.7 Stainless Steel Sinks, American-Standard Harvest Line No. 4286.332, self-rimming double bowl countertop sink, with soft, satin finish on rim and bowl area. Stainless steel shall be type 304, 20 gage, and each compartment bowl shall be 14 x 15 1/2 x 6 1/2 inches deep. Sinks shall be complete with 4200.085 single-lever faucet, two 4331.013 crumb cup strainers, chromium-plated brass tail-piece, P-trap, and accessories.

21.28.1.8 Wall Hydrant, nonfreeze type, Wade No. W-8620, 3/4-inch NPT inlet connection, with key handle and vacuum breaker, for wall thickness as shown on drawing.

21.28.1.9 Floor Cleanout, Wade No. W-8013, 3-inch, cast iron, adjustable threaded housing and collar, round polished nickel brass frame and scoriated nonskid cover.

21.28.1.10 Wall Cleanout, Josam No. 58513-19, 3-inch cast iron tee with cast iron countersunk plug, with stainless steel cover plate with countersunk screw, Josam No. 58604.

21.28.1.11 Hose Bib, Nibco No. 763, 1/2-inch inside sweat connection with 3/4-inch male hose connection, brass body construction. Where required on drawings, use 3/4-inch hose bib vacuum breaker, Muessco No. 7B, brass with set screw.

21.28.2 Plumbing Fixtures and Accessories for the Handicapped

Plumbing fixtures and accessories for the handicapped shall comply with ANSI Specification A17.1-1961.

21.28.2.1 Drinking Fountains/Water Coolers, Halsey Taylor, WT-14FL with side-mounted fountain with drinking height of 32 inches from floor.

21.28.2.2 Lavatories, Bobrick, B-5731 or Bradley, Model 1026, 22-inch extension from wall with concealed drain and hot water pipes, adjustable tilt mirror, paper towel and cup dispenser, interior shelf, light fixture, switch, and receptacle.

21.28.2.3 Shower Seats, Hall Mack Model 3050 or Bradley Model 9543 retractable shower seat, 1-inch stainless steel tubing, 16-inch width, 14-inch depth, 18-inch height.

21.28.2.4 Toilets, American Standard, elongated Cadet toilet, 2108.058 with 3088.010 bowl, 4049.052 tank, and 5330.063 seat 18-inch high with elongated siphon jet action bowl.

21.28.2.5 Grab Rails, Bobrick or Bradley to be provided at 33 inches on both sides of toilets and at 36 inches in shower stalls.

21.29 INSPECTION AND TESTS.

Soil, waste, drain, vents, and water piping shall be tested upon completion of the installation. Underground soil and waste piping shall be tested

before backfilling. All materials and equipment used for tests shall be provided by the Constructor. All tests shall be made in the presence of the COR.

21.29.1 Drainage and Venting System Piping.

Drainage and venting system piping shall be tested with water or air before the fixtures are installed. After the plumbing fixtures have been set and their traps filled with water, the entire drainage and venting system shall be submitted to a final test with smoke or peppermint.

21.29.1.1 Water Test shall be applied to the drainage and venting system either in its entirety or in sections. If the entire system is tested, all openings in the pipes shall be tightly closed except the highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening except the highest opening of the section under test shall be tightly plugged, and each section shall be filled with water and tested with at least a 10-foot head of water. The water shall be kept in the system, or in the section under test, for at least 15 minutes before the inspection starts and for a 4-hour period thereafter. The system shall be tight at all joints.

21.29.1.2 Air Test. If tests are made with air, a pressure of not less than 5 pounds per square inch shall be applied with a force pump and maintained at least 15 minutes without leakage. A mercury-column gage shall be used in making the air test.

21.29.2 Water System.

When the roughing-in is completed and before the fixtures are set, the entire hot-and-cold water piping system shall be tested at a hydrostatic pressure of not less than 50 psig greater than the established working pressure, but not less than 100 pounds per square inch gage, and proved tight at this pressure for not less than 4 hours in order to permit inspection of all joints. Where a portion of the water-piping system is to be concealed before completion, this portion shall be tested separately as described for the entire system. Isolation shall be provided to prevent interconnection with fire protection systems which are tested at 200 psig minimum.

21.29.3 Defective Work.

If inspection or test shows defects, such defective work or material shall be replaced and inspection and tests repeated. Repairs to piping shall be made with new material. No calking of screwed joints or holes will be acceptable.

21.29.4 Cleaning and Adjusting.

At the completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipes, valves, and fittings shall be cleaned of grease, metal cuttings, and sludge that may have accumulated

from operation of the system during the test. When the work is complete, the hot-water system shall be adjusted for uniform circulation. Flush valves, automatic control devices, and other parts of the work shall be adjusted for quiet operation. All damaged or defective materials, fixtures, or equipment shall be replaced with new items.

21.29.5 Acceptance.

After completion of all tests, adjustments, and cleaning, satisfactory to the COR, final acceptance will be given to the Constructor, in writing, by the COR.

21.30 SHOP DRAWINGS.

The Constructor shall submit shop drawings, catalog cuts, design data, and wiring-control data, to the COR, prior to procurement. Three copies of the submittal will be retained by the COR and the remainder of the copies will be returned to the Constructor. Equipment shall not be delivered to the jobsite prior to the approval of the shop drawings.

SECTION 22

AIR CONDITIONING & HEATING SYSTEMS

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SECTION 22

AIR CONDITIONING & HEATING SYSTEMS

22.1 GENERAL.

This section covers the requirements for the furnishing and installation of packaged-type air conditioning and heating systems as noted on the drawings and as specified.

Wherever there are UL/FM listed products that serve the desired function, only UL or FM products will be acceptable. Where there are no products that are UL/FM listed for the desired function, certification by another recognized testing laboratory may be accepted if the manufacturer attests, in writing, that the product, as currently manufactured, is identical to that which was originally tested.

22.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

22.2.1 Acoustical and Insulating Materials Association (AMA):

Bulletin No. Architectural Acoustical Materials,
XXXII Performance Data

22.2.2 Air Conditioning and Refrigeration Institute (ARI):

450-74 Water-Cooled Refrigerant Condensers, Remote Type
480-74 Refrigerant-Cooled Liquid Coolers, Remote Type
495-74 Refrigerant Liquid Receivers
590-76 Reciprocating Water-Chilling Packages

22.2.3 Air Moving and Conditioning Association, Inc. (AMCA):

99 Standards Handbook
210 Laboratory Methods of Testing Fans for Rating Purposes-
1974

22.2.4 American Society of Heating, Refrigeration, and Air- Conditioning Engineers (ASHRAE):

Handbook of Fundamentals; Guide and Data Book - Systems;
Guide and Data Book - Equipment; Guide and Data Book -
Applications

- 14 Positive Displacement Condensing Units, Methods of Testing for Rating
- 20 Remote Mechanical-Draft Air-Cooled Refrigerant Condensers, Methods of Testing for Rating
- 23 Positive Displacement Refrigerant Compressors, Methods of Testing for Rating
- 90-75 Design and Evaluation Criteria for Energy and Conservation in New Buildings

22.2.5 American Society of Mechanical Engineers (ASME):

Boiler and Pressure Vessel Code, Section VIII: Pressure Vessels & Section IV: Heating Boilers.

22.2.6 American Society for Testing and Materials (ASTM):

- A 177 High-Strength Stainless and Heat-Resisting Chromium-Nickel Steel Sheet and Strip
- A 366 Steel, Carbon, Cold-Rolled, Sheet, Commercial Quality
- A 525 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, General Requirements
- A 569 Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial Quality
- A 570 Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
- A 611 Steel, Cold-Rolled Sheet, Carbon, Structural
- B 209 Aluminum-Alloy Sheet and Plate

22.2.7 Association of Home Appliance Manufacturers (AHAM):

- RAC-1 Room Air Conditioners (ANSI Std. Z234.1)
- RAC-2SR Room Air Conditioner Sound Rating Standard

22.2.8 Federal Specifications (FS):

- F-F-300A Filter, Air-Conditioning/Viscous-Impingement and Dry Types, Cleanable
- F-F-310A Filter, Air-Conditioning/Viscous-Impingement and Dry Types, Replaceable
- BB-C-101B Carbon-Dioxide (CO₂); Technical and U.S.P.

BB-F-1421A	Fluorocarbon Refrigerants
GG-D-76D	Gages, Pressure and Vacuum, Dial Indicating, (for Air, Steam, Oil, Water, Ammonia and Chloro-Fluoro Hydrocarbon Gases and Compressed Gases)
HH-I-551E	Insulation Block, and Boards, Thermal (Cellular Glass)
HH-I-554A	Insulation, Thermal, Magnesia: Block, Pipe, and Tubing
HH-I-558B	Insulation, Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)
QQ-B-613D	Brass, Leaded and Nonleaded; Flat Products (Plate, Bar, Sheet, and Strip)
QQ-B-626D	Brass, Leaded and Nonleaded; Rod, Shapes, Forgings, and Flat Products and Finished Edges (Bar and Strip)
QQ-S-561	Solder, Silver
RR-W-365	Wire Fabric, (Insect Screening)
RR-W-370B	Wire Fabric, Steel Hot-Dipped Galvanized
SS-B-755A	Building Board, Asbestos-Cement: Flat and Corrugated
TT-V-51F	Varnish, Asphalt
TT-W-571I	Wood Preservation: Treating Practices
WW-F-406	Flanges, Cast-Iron (Classes 125 and 250) and Bronze (Classes 150 and 300)
WW-H-191B	Heater, Fluid, Industrial (Instantaneous, Steam, Water Converter Type)
WW-N-351C	Nipples, Pipe, Threaded
WW-P-377C	Pipe, Copper, Seamless, Standard Sizes
WW-P-404D	Pipe, Steel, (Seamless and Welded, Black and Zinc-Coated) (Galvanized)
WW-P-406D	Pipe, Steel (Seamless and Welded) (for Ordinary Use)
WW-P-521F	Pipe Fittings, Flange Fittings, and Flanges, Steel and Malleable Iron (Thread and Butt-Welding) 150 Pound
WW-T-799E	Tube, Copper, Seamless, Water and Refrigeration (for Use and Solder-Flared-Tube- or Compression-Type Fittings)

WW-U-531E	Unions, Pipe Steel or Malleable Iron, Threaded Connection, 150 Pounds, and 250 Pounds
WW-V-51E	Valve, Angle, Check, and Globe, Bronze, (125, 150 and 200 Pound) (Threaded End, Flange Ends, and Brazed End for Land Use)
WW-V-54D	Valve, Gate, Bronze, (125, 150 and 200 Pound, Threaded Ends, Flange Ends, Solder End, and Brazed Ends for Land Use)
WW-V-58b	Valves, Gate, Cast-Iron, Threaded and Flanged (for Land Use)

22.2.9 Military Specifications (MIL):

MIL-T-704	Treatment and Painting of Material
MIL-F-16081	Fan, Ventilating, Propeller
MIL-S-16293	Strainer, Sediment, Pipeline, Water, Air, Gas, Oil or Steam
MIL-V-20064	Valve, Nonferrous, for Use with Halogenated Refrigerants
MIL-I-22023	Insulation Felt, Thermal and Sound Absorbing Felt, Fibrous Glass, Flexible

22.2.10 National Electrical Manufacturers' Association (NEMA):

ICS	Industrial Controls and Systems
MG-1	Motors and Generators

22.2.11 National Fire Protection Association (NFPA):

30	Flammable and Combustible Liquids Code
31	Oil Burning Equipment
70	National Electrical Code
89M	Clearances for Heat Producing Appliances
90A	Air Conditioning and Ventilating Systems
90B	Air-Conditioning Systems and Warm-Air Heating
91	Blower and Exhaust Systems for Dust, Stock, Vapor Removal
214	Water Cooling Towers
220	Building Construction, Standard Types of

22.2.12 Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA):

Low and High Velocity Duct Construction Standards

Architectural Sheet Metal Standards

22.2.13 Underwriters' Laboratories, Inc., (UL):

Building Materials Directory

Electrical Appliance and Utilization Equipment Directory

Electrical Construction Materials Directory

Gas and Oil Equipment Directory

22.2.14 Uniform Mechanical Code:

Part III Heating, Ventilating, Cooling

22.2.15 American National Standards Institute (ANSI):

B 70.1 Refrigeration Flare Type Fittings

C 33.14 Room Air Conditioners, Safety Standard

22.3 PACKAGED AIR-CONDITIONING SYSTEMS.

22.3.1 General.

Each air-conditioning unit shall be a complete self-contained packaged type system with air-cooled condensing section. Units shall be designed to have the heating and/or cooling capacities at design conditions noted on the drawings, or as specified. Each unit shall be factory assembled and tested, complete with refrigerant charge, ready to operate. Air-conditioning units shall be ARI rated and listed. All units shall conform to the publications listed above, as applicable.

Unit shall contain an evaporator coil section, compressor-condenser coil section, fans, drive motors, and all necessary electrical controls, high and low pressure cut-out switches and optional low ambient controls; all enclosed in a weatherproof casing either split or combined as indicated and mounted on vibration isolators. Roof-mounted units shall be mounted on steel frames shown on the drawings. Vibration isolators shall be bolt on type.

22.3.2 Split System Type.

22.3.2.1 The Condensing Unit shall consist of a compressor, condenser coil and fan motor, filter-drier, liquid receiver, factory-wired controls, and optional low ambient controls.

22.3.2.2 Compressor shall be of the welded hermetic or serviceable hermetic type with internal or external spring vibration isolators and crankcase oil heater.

22.3.2.3 Coils shall be of nonferrous construction with aluminum plate fins mechanically bonded to a seamless copper tube with all joints brazed.

22.3.2.4 Fans. Condenser fans shall be a direct driven propeller fan or V-belt-driven centrifugal forward curved blade type. The fan shall be driven by a heavy-duty, permanently lubricated motor of not less than the indicated horsepower. Fan shall be statically and dynamically balanced. Centrifugal fan, if selected, shall be mounted with sealed, permanently lubricated ball bearings.

22.3.2.5 Evaporator-Blower Unit shall consist of a base unit enclosing evaporator coil, fan, fan motor, distributor, expansion valve, condensate collectors, and filter-drier, or other approved equipment. A fan motor starter shall be provided with three-phase units.

22.3.2.6 Fans. Evaporator-Blower fans shall be of the centrifugal double inlet forward or backward curved blade type. Fan shall be statically and dynamically balanced, and shall have sealed, permanently-lubricated bearings. The fan drive shall be of the V-belt type with variable pitch pulley on the fan motor. All fans shall be AMCA rated.

22.3.2.7 Filters furnished shall be of the disposable-type of a standard size required or as indicated on the drawings, and shall be readily accessible for filter removal. Provide one spare set, as required for each unit.

22.3.2.8 Casing. The cabinet shall be constructed of galvanized steel, bonderized, and finished with baked enamel or acrylic lacquer. The top, bottom, and sides of the cooling section shall be fully insulated to prevent sweating and to muffle sounds. There shall be provisions for draining the base pan through a drain connection. An opening shall be provided for power connections. Panels shall be removable to provide access for servicing.

22.3.2.9 Controls. The electrical control assembly shall contain a low voltage control circuit transformer, compressor relay, fan relay, and a compressor motor timer circuit. All relays shall be heavy-duty type. The timer circuit for the compressor motor shall prohibit restarting of the compressor motor for five minutes of interruption of power to the control circuit. Compressor protection devices shall be of the automatic reset type. All controls shall be mounted in dustproof enclosures. Magnetic starters shall have properly sized heaters. Provide timed defrost control for heat pump operation.

22.3.2.10 Refrigerant Piping and Accessories.

22.3.2.10.1 Pipe. Refrigerant piping shall be copper pipe or copper tubing. Copper tubing shall be Type K or L, bright annealed, dehydrated,

and sealed. Soft-temper tubing shall be used where bending is required and where flare joints are used. Hard-drawn tubing shall be used where no bending is required and silver-brazed joints are used.

22.3.2.10.2 Copper Tube Fittings for flare joints shall be standard Society of Automotive Engineers forged-brass flare type conforming to ANSI B70.1 with short-shank flare units. Fittings for brazed joints shall be wrought-copper or forged brass sweat fittings. Cast sweat-type fittings will not be allowed for brazed joints.

22.3.2.10.3 Vibration Absorbers of the all-metallic bellows and woven-wire type shall be provided on suction and discharge lines where connections to compressor are made.

22.3.2.10.4 Refrigerant-Service Valves shall be designed for use with the refrigerant used and shall have pressure ratings compatible with system working pressures encountered. Gate valves will not be acceptable.

22.3.2.10.5 Valves shall be all-brass packless-type globe valves, wrench-operated with brass or steel seal caps.

22.3.2.10.6 Solenoid Valves shall be brass or steel body, packless type, with stainless-steel trim, rated for continuous-duty service, direct or pilot operated, provided with manual lift stems and designed for use with type of refrigerant used. The valve capacities shall be sufficient for the requirements of the installation.

22.3.2.10.7 Pipe Supports. Brackets or clamps may be used where piping runs along walls. Pipe hangers or brackets shall be properly isolated to prevent noise transmission. Supports or hangers for uninsulated copper lines shall be copper coated. Lead sleeves shall be provided between pipe and supports, when specified.

22.3.3 Single Package Pad-Mounted Air-Conditioners.

Single package pad-mounted air-conditioners shall be compact, pad-mounted type or as shown on the drawings. The air-conditioning units shall be vibration free, easy to maintain, and with all serviceable components accessible. Each unit shall be provided with fan, coil, factory-mounted automatic blower controls, remote-mounted thermostat, and low voltage easy starting kit. Operation shall be suitable to meet electrical current characteristics as noted on the drawings. Installation of units shall be made weatherproof and in accordance with manufacturer's instructions.

22.3.3.1 Controls shall be factory wired and shall include compressor and fan starters with overload protection, compressor motor thermal protection, high and low pressure controls, control transformer, terminal board, and necessary relays. Thermostat shall be remote automatic change-over type. Mount all controls in dustproof enclosures. Relays shall be heavy-duty type. Magnetic starters shall have properly sized heaters. Provide timed defrost control.

22.3.3.2 Fans shall be multiblade, centrifugal, forward or backward curved blades with heavy-duty pillow block self-aligning permanently sealed ball bearings, wheels statically and dynamically balanced, and shall operate at rated capacities at designated static pressure. Condenser fans may be propeller type.

22.3.3.3 Coils shall be nonferrous construction with aluminum plate fins mechanically bonded to copper tubes with all joints brazed.

22.3.3.4 Casings shall be heavy gage galvanized steel or fiberglass, completely weatherproof. Casing shall be completely removable for access to all components and controls for maintenance and service. Provide 1-inch vinyl coated glass fiber insulation in evaporator section.

22.3.3.5 A Filter Casing section for return air shall be supplied as an integral part of the supply air box. Filters shall be of the throwaway or renewable media type. Provide one spare set for each unit.

22.3.4 Window Air-Conditioning Units.

Window air-conditioning units shall be the packaged wall-mounted type. The unit furnished shall be capable of delivering the indicated cooling and heating capacity when operating during the prevailing weather conditions. Each unit shall be furnished with a weathertight wall sleeve, corrosion-resistant support brackets, and balanced circuits. Operating current shall be as noted on the drawings.

22.3.4.1 Sound Levels. Where sound levels are specified on the drawings, such data shall be considered as maximum, and the units shall be certified by the manufacturer to match such data or have lower sound power levels on all bands. In the absence of the data specifically shown on the drawings the units shall conform to the AHAM Standard RAC-2SR with an indoor rating index "J" and an outdoor rating index "20", or lower indexes.

22.3.4.2 Units shall be UL listed in accordance with "Standard for Room Air Conditioners, UL484 (ANSI C33.14).

22.3.4.3 Filters shall be throwaway type. Provide one spare set of filters for each unit.

22.4 EVAPORATIVE COOLERS.

22.4.1 General.

The evaporative cooling unit shall have the air capacity noted on the drawings, or as otherwise specified. The type of unit and the manufacturer is optional with the Constructor, subject to the approval of the Contracting Officer's Representative (COR). The unit shall be self-contained, and shall be of weatherproof construction for outside installation. Unit shall have an automatic bleed-off kit.

22.4.2 Fan Unit.

Fan unit shall be of the type approved for installation and shall be complete with motor, drive, and vibration-isolation supports. The fan shall deliver the specified air capacity against an external static pressure of 1/2-inch water column, and shall be constructed and rated in accordance with AMCA 210. Outlet velocities shall conform within a tolerance of 2 1/2 percent with static pressure and tip speeds as recommended by ASHRAE. The fan shall be connected to the motor by means of approved V-belt drive and grooved pulleys. The drive pulley shall be of the variable-pitch type. Both the drive and driven pulleys shall be of cast iron construction to prevent wear and belt slipping. The V-belt drive shall be designed for not less than 50 percent overload capacity.

22.4.2.1 The Motor shall be drip-proof type and designed to suit the available electric service. The brake horsepower requirements of the fan shall not exceed the motor manufacturer's nameplate horsepower rating.

22.4.2.2 The Blower Wheel shall be of the multiblade type, with forward curved blades, die stamped, and die formed. It shall be hot-dipped galvanized after fabrication, accurately balanced both statically and dynamically, and shall be free from objectionable vibrations or noise. The fan housing shall be given a suitable corrosion-resistant coating.

22.4.2.3 Fan Shaft shall be of steel, coated with a corrosion-resistant material to prevent rusting, and shall be provided with keyseats and keys for blowers and drive sheave.

22.4.2.4 Each Fan outlet shall be equipped with flanges for attaching the connecting ductwork.

22.4.3 Evaporative and Eliminator Filters.

The evaporative and eliminator filters shall be fabricated of No. 18-gage galvanized frames and No. 18-gage galvanized wire mesh. The pad media shall be fibrous glass with insoluble binder. The filters shall be rigid, corrosion-resistant, mineral suitable for the purpose. The filter pads are to be the removable type to facilitate servicing and inspection. The velocity through the evaporative filters shall not exceed 300 fpm.

22.4.4 Slinger-Type Water-Handling Equipment.

Slinger-type water-handling equipment shall thoroughly atomize the water and continuously flush all evaporative surfaces of the filter material. The water shall be picked up by a high speed statically and dynamically balanced slinger wheel partially immersed in the water and shall completely flood the evaporative filters with a fine atomized spray. On units 7,000 cfm and larger, two slinger wheels must be furnished. The water must be sprayed on the evaporative surfaces evenly and at a minimum rate of 3 gallons/hour per 1,000 cfm of capacity. The slinger motor enclosure shall be deep drawn from one piece to a depth of 5 inches and then locked to the bottom of the water tank. A 4-inch diameter hole through the

bottom of the water tank and motor enclosure shall be provided for the ventilation of the slinger motor. Unit shall have an automatic bleed-off kit.

22.4.5 Immersion-Type Water-Handling Rotary Equipment.

Immersion-type water-handling rotary equipment shall consist of a cylindrical rotor of alternate layers of corrugated and flat bronze screen, tightly wound on a corrosion-resistant drum. The cooler shall operate by having the revolving rotor continuously wetted through immersion of its lower portion in the water tank. Unit shall have an automatic bleed-off kit.

22.4.6 Trough-Type Water Dispersion.

22.4.6.1 Pumped Water Feed shall consist of a corrosion-resisting pump of adequate capacity, water-feed tubing, and all necessary accessories and float valve assembly. The pump case may be of a durable thermoplastic material. Tubing may be vinyl-plastic of durable composition. The recirculating pump shall be of the type especially designed for evaporative coolers and shall maintain a constant flow of water at even pressure. The water shall be pumped into V-shaped, slotted troughs. Two tiers of troughs shall be provided for each pad-frame, one at the top and one at the center to provide uniform saturation of each pad. Unit shall have an automatic bleed-off kit.

22.4.6.2 Pumpless Water Feed shall consist of corrosion-resistant tubing terminating at the troughs, and with a special tip that will compensate for variations in water pressure and assure even flow to all troughs. The tips shall aerate the water to preclude splashing. Troughs shall be as specified for pumped water feed. Unit shall have an automatic bleed-off kit.

22.4.7 Cabinets.

The cabinets shall be constructed of not less than No. 20-gage galvanized steel up to 8,000 cfm capacity and No. 18-gage galvanized steel for over 8,000 cfm capacity. The cabinets shall have service doors for easy access to motor and blower. The galvanized cabinet shall be chemically scoured and phosphatized, then sprayed with zinc chromate primer, and finished with a durable baked-on enamel. The fresh-air inlet shall be provided with die stamped intake louvers to prevent the entry of birds. The water tank shall be no lighter than No. 18-gage steel with all welded seams, then hot-dipped galvanized after fabrication, and the tank interior shall be given a suitable underbody coating. The water tank shall be provided with a makeup containing a float-operative valve, an over-flow connection, and drain connection. The float valve shall be designed for a water working pressure of 125 pounds per square inch, and both valve stems and disk seats shall be renewable and constructed of corrosion-resistant materials.

22.4.8 Chemical Treatment.

Chemical treatment shall be in accordance with manufacturer's recommendation.

22.4.9 Efficiency Requirements.

The evaporative cooler shall have a continuous cooling efficiency of not less than 80 percent of rated air flow. Efficiency shall be determined by the following formula using entering air of approximately 90° F. dry bulb and 70° F. wet bulb.

$$\text{Efficiency} = \frac{T_1 - T_2 \times 100}{T_1 - T_W}$$

Where: T_1 is the entering dry-bulb temperature in degrees F.

T_2 is the leaving dry-bulb temperature in degrees F.

T_W is the entering wet-bulb temperature in degrees F.

22.5 ELECTRIC HEATING SYSTEMS.

22.5.1 Slip-In Blast Coil Type.

22.5.1.1 Electrical Resistance Heaters. The indoor air section of the ductwork shall house the electrical resistance heaters noted on the drawings. Heaters and duct sizes shall be matched so that all air flows through the heaters. Heaters shall be so constructed as to slip into an opening in the ductwork or air handling unit; removal for maintenance shall not entail disassembly of related ductwork. Heaters selected shall be of electrical characteristics indicated and shall have the load balanced between all phases. Heaters shall be NEMA- and/or UL-listed, and installed in conformance with NFPA Pamphlets 90A and 90B. Unit shall be weather-proof if installed outside.

22.5.1.2 Controls. Each unit shall be equipped with a terminal box, built-in magnetic contactor, control transformer, fan interlock contact, thermal links, and high-limit switch. All units shall be factory prewired to easily accessible terminal strips for line and control connections in the field. Limit switches shall conform to the NEC. Control enclosure shall be weatherproof if installed outside.

22.5.2 Surface-Mounted Ceiling Heaters.

Surface-mounted ceiling heaters shall be fan-forced, surface-mounted ceiling type. All units shall be furnished with automatic resetting overheat protector and provided with a wall-mounted thermostat control. Heaters shall operate on electrical current characteristics noted on the drawings and shall be NEMA and/or UL listed. Units shall be installed with adequate insulation between heaters and any combustible material.

22.5.3 Wall Heaters.

Wall heaters shall be furnished as indicated on the drawings and be NEMA approved and UL listed.

22.5.3.1 Convactor-Type electric heater shall be surface direct, wall-mounted, with grille-type openings at the bottom and individual thermostat control.

22.5.3.2 Fan-Forced electric heaters shall be wall-mounted type. Each heater shall be furnished with built-in thermostat controls, unless wall-mounted remote thermostat is shown on the drawings, thermal limit switch at the bottom of the heating grid, and a fan delay switch at the top of the grid. Propeller-type fan and motor shall be one assembly, all completely enclosed in heater housing, suitable for recessed wall mounting with surface-mounted air diffuser grille. Adjustable thermostat knob with positive OFF position shall be installed on the grille.

22.5.3.3 Electric Unit Heaters. All heater units shall be prewired except for field connection of thermostats, shall have built-in contactors which shall be series connected to automatic thermal cut-out with reset button to protect against overheating.

Electric heating elements shall be of Fintube type, of specified KW rating, with continuous spiral fins permanently brazed to metal sheath.

Motor shall be totally enclosed, continuous heavy-duty, all angle operation with built in thermal overload protection and shall have sleeve or ball bearings.

Fan wheels shall be aluminum bladed direct-connected to fan motor; of specific design for efficient electric heater performance and shall be dynamically balanced by manufacturer.

Horizontal unit heater shall be provided with two threaded holes for field mounting and shall have provisions for one-point suspension.

Horizontal unit heaters shall have louver panels to adjust flow direction.

Horizontal unit heater suspension bracket shall include adapter to convert to one-point suspension, wall hanger bracket and cover to match cabinet styling.

All metal surfaces shall be treated for corrosion resistance and shall be finished in smooth baked enamel. All heater units shall have built-in transformer to step down supply voltage to control circuit. Unit shall be furnished complete with remote mount thermostat.

22.5.4 Baseboard Heaters.

Baseboard heaters to be installed shall be the perimeter wall-mounted type with steel fins, casings shall be built of marclad steel, finished with custom high-gloss, baked enamel on the visible areas. Unit shall be equipped with baseboard-mounted thermal cutoff with junction boxes at each end, and shall be NEMA and/or UL listed.

22.5.5 Boilers.

Boilers shall be of heavy-duty low pressure (15 psig) industrial type, self-contained, steam or hot water ready to be connected to electrical supply source and piping.

22.5.5.1 Controls shall be modulating step control, built-in contactors, proper circuit protection fuses, necessary transformers, low water cut-off, pressure relief valve, pressure and temperature gauges, safety controls, temperature or pressure controls, and with control panel enclosure.

22.5.5.2 Vessels shall be per ASME Boiler and Pressure Vessel Code, Section IV, Heating Boilers.

22.5.5.3 Heating Surface shall have minimum of 5 square feet of fireside heating surface per rated horsepower.

22.6 OIL-FIRED SPACE HEATERS.

Oil-fired spaced heaters shall be of the heavy-duty industrial type of the configuration as shown on the drawings, complete with oil-fired burner for No. 2 fuel oil (heating), factory-wired controls, fans, motors and drives, combustion air and induced draft blowers, filter section, and mixing damper section.

22.6.1 Entire Unit.

Entire unit shall be factory assembled and tested and shall be listed by Underwriters' Laboratories, Inc. Capacities shall be as indicated on the drawings.

22.6.2 Units.

Units shall be furnished with high-low-off burner control and with 2-speed fan motors. Temperature control shall be by a room thermostat. Normal heating operation will be at low fan speed and minimum outside air. The heater fan shall switch to high speed and burner at high operation when the entering air temperature drops to 45° F. The return air and outside air dampers shall modulate under the control of a mixed air thermostat so that the mixed air temperature is never lower than 35° F.

22.6.3 A Diesel Oil Storage Tank and Oil Piping.

A diesel oil storage tank and oil piping shall be provided in accordance with Section 31, "Fuel Supply Systems". Capacity shall be as noted on the drawings.

22.6.4 Filters.

Filters unless otherwise specified shall be the throwaway type with integral retainer using 2-inch-thick media pads.

22.7 SHEET METAL WORK.

22.7.1 General.

Ductwork shall be constructed of galvanized steel, aluminum sheets or fiberglass as shown on the drawing. Unless otherwise approved, ducts shall conform accurately to the dimensions indicated and shall be straight and smooth on the inside with joints neatly finished. Ducts shall be anchored securely to the building in an approved manner and shall be so installed as to be completely free from vibration under all conditions of operation. Curved elbows shall have a centerline radius not less than 1 1/2 times the width of the duct. Joints shall be made substantially airtight and no dust marks from air leaks shall show at duct joints or connections to grilles and diffusers. Laps shall be made in the direction of the airflow. Edges and slips shall be hammered down to leave a smooth interior duct finish. Button or bolt connections in standing seams shall be spaced at fixed centers not greater than 7-inch spacing. Transitions shall be made with a slope ratio of 5:1, or in a specifically approved manner. Ducts shall have cross break of sufficient center height to assure rigidity in the duct section. Construction shall be in accordance with SMACNA standards. All duct materials shall be constructed of Class 0 or Class 1 duct materials as tested in accordance with Standard for Factory Made Air Duct Materials and Air Duct Connectors, (U.L. 181-1974).

22.7.2 Conventional Low Velocity Ducts.

Conventional low velocity ducts and stiffeners shall be constructed of galvanized steel or aluminum sheet of thickness and fabrication as recommended in the latest edition of the ASHRAE Guide and in Tables 1 and 2.

TABLE 1
Sheet Metal Thickness for Rectangular-Duct Construction¹

Aluminum thickness (inch) and (B&S gage)	Galv. sheet gage	Maximum side (inches)	Type of Transverse joint connections ²	Minimum Reinforcing Angles/and Maximum Longi- tudinal Spacing Between Tran- verse Joints and Reinforcing
0.0201 (24)	26	Up thru 12	S, drive, pocket, or bar slips	None
		13 thru 18	S, drive, pocket, or bar slips	None
0.0253 (22)	24		10' centers ³	
		19 thru 30	S, drive, 1-in. pocket or 1-in. bar slips on	1x1x1/8-in. angles 60 in. C.C.

Table 1 (Continued)

Aluminum thickness (inch) and (B&S gage)	Galv. sheet gage	Maximum side (inches)	Type of Transverse joint connections ²	Minimum Reinforcing Angles/and Maximum Longi- tudinal Spacing Between Tran- verse Joints and Reinforcing
0.0320 (20)	22	31 thru 42	Drive, 1-in. pocket or 1-in. bar slips on 5' centers ³	1x1x1/8-in. angles 60 in. C.C.
		43 thru 54	1 1/2-in. angle connec- tions, 1 1/2-in. pockets, or 1 1/2-in. bar slips with 1 3/8- in. x 1/8-in bar	1 1/2x1 1/2x1/8- in. diagonal angles, or 1 1/2x 1 1/2x1/8- in. angles 60 in. C.C.
0.0403 (18)	20	55 thru 60	1 1/2-in. angle connec- tions, or 1 1/2-in. pocket or 1 1/2-in. bar slips with 1 3/8-in x 1/8-in. bar	1 1/2x1 1/2 x1/8-in. diagonal angles, or 1 1/2x1 1/2 x1/8-in. 60 in. C.C.
0.0403 (18)	20	61 thru 84	1 1/2-in. angle connec- tions or 1 1/2-in. pockets, 1 1/2-in. bar slips 3-ft. 9-in. max. centers with 1 3/8-in. x 1/8-in. bar reinforc- ing	1 1/2x1 1/2 x1/8-in. diagonal angles, or 1 1/2x1 1/2 x 1/8-in. angles 30 in. C.C.

Table 1 (Continued)

Aluminum thickness (inch) and (B&S gage)	Galv. sheet gage	Maximum side (inches)	Type of Transverse joint connections ²	Minimum Reinforcing Angles/and Maximum Longi- tudinal Spacing Between Tran- verse Joints and Reinforcing
0.051	18	85 thru 96 ⁴	1 1/2-in. angle slip, or 1 1/2-in. companion angle, or 1 1/2-in. angle reinforced pocket lock, or 1 1/2-in. angle reinforced standing seam	1 1/2x1 1/2x 3/16 angles 30 in. C.C.
.051	18	96 UP ⁴	1 1/2-in. angle slip, or 1 1/2-in. companion angle, or 1 1/2-in. angle reinforced pocket lock, or 1 1/2-in. angle reinforced standing seam	2x2x1/4 angles 30 in. C.C.

¹ For normal pressures and velocities used in typical ventilating and air-conditioning systems. Where special rigidity or stiffness is required, ducts shall be constructed of metal two gages heavier. Crossbreaking may be omitted on uninsulated ducts if metal, two gages heavier than required, is used.

² Other joint connections of equivalent mechanical strength and air-tightness may be used.

³ Duct sections of 3 feet 9 inches length may be used with bracing angles omitted.

⁴ Duct 91 inches and larger require special field study for hanging and supporting methods.

TABLE 2

Sheet Metal Thickness for Circular Ducts

(Except for Local Exhaust Systems)

Aluminum thickness (inch) and (B&S gage)	Galvanized sheet gage	Diameter of duct(inches)
0.0201 (24)	26	Up to 14
0.0253 (22)	24	Over 14 thru 22
0.0320 (20)	22 (Spiral Lock)	Over 23 thru 36
0.0403 (18)	20 (Spiral Lock)	Over 36 thru 57

22.7.3 Splitters and Dampers.

Dampers shall have accessible operating mechanism, and where operators occur in finished portions of the building, operators shall have all exposed edges rounded. Splitter dampers shall be operated by quadrant operators of 3/16-inch rod brought through the side of the duct with locking setscrew and bushing. Two rods are required on splitters over 8 inches. Manual volume-control dampers shall be operated by locking-type quadrant operators. Dampers and splitters shall be two gages heavier than the ducts in which installed. Multileaf dampers shall be opposed-blade type with maximum blade width of 12 inches. Splitter dampers shall be of sufficient length to close off either branch duct.

22.7.4 Air Deflectors.

Air deflectors shall be provided in all square elbows, duct-mounted supply outlets, and tap-in branch-takeoff connections. Air deflectors shall be fabricated and assembled. Airfoil vane sections shall be provided where available.

22.7.5 Fire and Smoke Dampers.

Fire and smoke dampers shall be provided in accordance with the National Fire Protection Association Standard 90A. Dampers shall be installed with sufficient tension to prevent rattling or vibration.

22.7.6 Duct Access Doors.

Hinged doors shall be provided at all automatic dampers, fire dampers, smoke dampers, heaters, thermostats, and other apparatus requiring service and inspection in the duct system. Doors shall be 15 by 18 inches unless indicated otherwise. Where size of duct will not accommodate this size, the doors shall be made as large as practical. Doors shall be rigid, and shall be provided with airtight felt gaskets. Doors shall be provided with galvanized hinges with bronze pins and two approved brass fasteners.

Doors in insulated ducts shall be of the insulated type. Unless otherwise indicated, doors shall swing so that fan pressure or suction holds the door closed.

22.7.7 Duct Test Holes.

Holes with patches in ducts and plenums shall be provided where directed or necessary for using Pitot tubes for taking air measurements to balance the air systems. At each of these locations where ducts or plenums are insulated, an extension shall be provided with plug fittings.

22.7.8 Flexible Connections.

Where sheet metal connections are made to mechanical equipment or where ducts of dissimilar metal are connected, a 30-ounce per square yard glass fabric double coated with neoprene, conforming to NFPA 90A, approximately 6 inches in width, shall be installed. Flexible connections shall be securely fastened by zinc-coated iron clinch-type draw bands or a supported edge using pop rivets or screws.

22.7.9 Duct Sleeves.

Duct sleeves and flanges shall be fabricated from 22 gage galvanized sheet steel unless otherwise indicated. Flanges not less than 4 inches wide shall be installed tight against the wall on each side, and fastened to the sleeve. Sleeves shall be 2 inches larger than the duct. Frame openings shall be provided for ducts larger than 12 inches in diameter and for all square and rectangular ducts. The space between the duct or duct insulation and the opening or sleeve shall be packed.

22.7.10 Duct Supports.

Duct supports shall be as specified on drawings or as required. No support shall be less than 1-inch by 16 gage galvanized strap-iron hangers. Spacing shall be in accordance with SMACNA Standards or as noted on the drawing. All ducts shall be supported from building structural members.

22.8 FLEXIBLE FIBERGLASS DUCTS.

22.8.1 General.

Insulated flexible ducts shall be factory fabricated, consisting of a rust resistant spring steel wire helix insulated with a mineral fiber thermal insulation with a K factor not greater than 0.24 (at 75° F.), 1 inch thick and encased in a vapor jacket sealed at both ends of any one section. The flexible duct shall be Owens-Corning or equal, fiberglass, flexible duct. Duct shall conform to the requirements of the NFPA Standard 90A, and shall be U.L. listed, Class 1. Air friction shall not exceed 1.2 times that of comparable sheet metal duct.

22.8.2 Flexible Duct Connections.

Flexible duct connections shall be UL-listed, Class 1, with coated fabric, connections shall be furnished complete with all necessary angles, bolts,

and clips to make connections to other ducts, mechanical equipment, diffusers, registers; and grilles. All transverse or longitudinal seams and joints shall be tapped.

22.8.3 Hangers, Brackets, and Supports,

Hangers, brackets, and supports shall be of rust resistant materials, or be finished with an approved inhibiting treatment.

22.9 DIFFUSERS, GRILLES, REGISTERS, AND LOUVERS.

22.9.1 General.

Diffusers, grilles, registers, and louvers shall be factory-fabricated of steel or aluminum and shall distribute the specific quantity of air evenly over the space intended, without causing noticeable drafts, air movement in excess of 50 fpm in occupied zones, or dead spots anywhere in the conditioned area. Diffusers and registers shall be provided with volume controls and an accessible operator. After the system is in operation, if drafts, dead spots, or excessive noise are noticeable in the conditioned spaces due to improper selection of type or size of diffuser, grille, or register, the unit shall be changed to the proper size and type.

22.9.2 Diffusers.

Diffusers shall be round, half-round, square, rectangular, or strip shape as indicated, and shall be of the expanding-cone type, plaque type, or a combination of the two types. Diffusers shall be fixed pattern unless otherwise indicated, and ceiling-mounted units shall be mounted with rims or antismudge rings tight against the ceiling. A sponge-rubber gasket or antismudge ring shall be provided between ceiling and diffuser. Duct collars connecting the ducts to diffusers shall fit inside of the diffuser neck.

22.9.3 Grilles.

Grilles shall be of size and type specified on the drawings, without volume control dampers unless noted on the drawing. Exhaust and non vision door grilles shall be of fixed pattern design; supply air grilles shall be the directional-control type and control achieved by adjustment of horizontal and vertical vanes. Each grille shall be provided with sponge-rubber gasket between flange and wall or ceiling. Wall supply and exhaust grilles shall be installed at least 6 inches below the ceiling, unless otherwise specified.

22.9.4 Registers.

Registers shall be the directional-control type except that return and exhaust registers may be of fixed pattern design similar to supply-register face. Each register shall be provided with a face-operated opposed-blade volume-control damper. Registers shall be provided with sponge-rubber gasket between flange and wall or ceiling. Wall supply

registers shall be installed at least 6 inches below the ceiling. Return and exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Free area of all registers shall be not less than 75 percent of face area. Four-way directional-control may be achieved by a grille core that can be inserted in the grille face in four positions or by adjustment of horizontal and vertical vanes. Removable cores shall have movable vertical vanes.

22.95. Louvers.

Fresh air intake louvers shall be of the size and type indicated on the drawings. The louvers shall be constructed of galvanized steel sheets of not less than 24 gauge, or of sheet aluminum of equal strength. The edges of louver blades shall have neoprene or felt strips to prevent rattling. Louvers shall be mounted on steel or aluminum frames. Provided means of mounting air filters of the type indicated on the drawings. Provide insect screens at openings.

22.10 FLASHING AND COUNTERFLASHING.

All roof or wall duct penetrations shall be flashed and counterflashed and shall be weathertight.

22.11 DUCT INSULATION AND ACOUSTICAL DUCT LINING.

22.11.1 Interior Duct Insulation.

Furnish and install duct insulation in or on interior heating and cooling, supply and return air ducts as indicated on the drawings. All duct materials shall be constructed of Class 0 or Class 1 duct materials as tested in accordance with Standard for Factory Made Air Duct Materials and Air Duct Connectors, (U.L. 181-1974).

22.11.1.1 Certain-Teed Ultra Liner insulation or approved equal shall be installed not less than 1 inch thick, 2-to 3-pound density fibrous glass with glazed coating on the air-side surface. The material shall meet the fire hazard requirement of NFPA 90A. The lining shall be fastened to the interior of the duct with approved, non-combustible, low-toxicity adhesive. Duct panels over 24 inches wide shall have lining additionally secured with stick clips and washers and be installed in accordance with manufacturer's recommendation. Top and bottom pieces shall lap the side pieces. Noise-reduction coefficient shall be not less than 0.60. All joints in the insulation shall be sealed in a manner applicable to the insulation used to seal out circulation of air, and to give continuity of insulation.

22.11.1.2 Johns-Manville Microlite Fiberglass Blanket or approved equal shall be installed 1 1/2 inch thick 0.75 pounds density for temperature difference from 50° F., and 2 inches thick for temperature difference from 151° F. to 300° F. material shall meet the fire hazard requirement of NFPA 90A and 90B Standards. Insulation shall be wrapped entirely around ducts with all joints overlapped at least 2 inches, secured with 18 gauge galvanized wire on 12-inch on centers. Insulation shall cover all surfaces, including standing seams. Underside of ducts pins welded to the duct 18 inches on centers, and attached with speed washers. If the pin method is impossible due to size restrictions, the insulation shall be secured to the ducts with fire resistant adhesive.

NOTE: Certain conditions as indicated on the drawings may require a FSK (Foil Scrim Kraft) vapor barrier facing. This facing is secured with 16 gauge copper clad wire.

22.11.1.3 Johns-Manville No. 814 Spun Glass Rigid Type Insulation or approved equal shall be installed 1 inch thick for temperature differences from 50° F. to 150° F. and 1 1/2 inch thickness for temperature differences from 151° F. to 200° F., applied with edges tightly butted.

Insulation facing shall be FSK (Foil Scrim Kraft) aluminum foil reinforced with fiberglass yarn mesh and laminated to 40 pounds. The kraft shall be chemically treated for fire resistance, meeting the requirement of NFPA 90A and 90B Standards.

Insulation shall be impaled on mechanical fasteners or pins welded to the duct spaced on 12 inches on centers and secured with speed washers. If stiffeners are higher than specified insulation thickness, increase insulation thickness to at least equal the stiffener height. All right angle duct insulation shall have corner angles. These angles shall be covered with 8-ounce canvas jacket, which will be tightly stretched and sized with flame-resistant lagging adhesive.

22.11.2 Exterior Duct Insulation.

Furnish and install duct insulation in or on exterior heating and cooling, supply and return-air ducts as indicated on the drawings.

22.11.2.1 Certain-Teed Ultra Liner Insulation or approved equal shall be installed in the duct 2 inches thick as described in Section 22.11.1.1.

22.11.2.2 Johns-Manville No. 814 Spun Glass Rigid Type Insulation, or approved equal, shall be applied 2 inches thick secured with stick clips and speed washers. Insulation shall be weatherproofed with 8-ounce canvas and sized with fire-resistant lagging adhesive, or use 1-inch galvanized hex mesh, laced tightly over insulation, with Johns-Manville Insulkote weather protective coating, or approved equal. Coating should be troweled onto a thickness of approximately 1/4 inch. The mesh should not be exposed to the weather at any point.

22.12 TESTING AND BALANCING.

The Constructor shall test, adjust, and, where applicable, balance each system. This work shall be accomplished in the presence of, and to the satisfaction of, the COR. Submit two copies of balancing report to COR.

22.13 SHOP DRAWINGS.

The Constructor shall submit shop drawings catalog cuts, design data, and wiring and control data to the COR prior to procurement. Three (3) copies will be retained by the COR, and the remaining copies returned to the Constructor. Equipment shall not be delivered to the jobsite prior to the approval of the shop drawings.

22.14 OPERATING AND MAINTENANCE INSTRUCTIONS.

Operating and maintenance instructions, complete for each piece of equipment and bound in book form, shall be furnished. Approved wiring diagrams, refrigerant and waterflow diagrams, and control diagrams of the entire system framed under glass shall be posted at locations designated by the COR. Operating instructions explaining preventive-maintenance procedures, methods of checking the system for normal safe operation, and procedure for safely starting and stopping the system shall be prepared in typed form, framed under glass, and posted beside the wiring, flow, and control diagrams.

22.15 ELECTRICAL WORK.

Electrical work shall conform to Section 23, "Interior Electrical Work."

22.16 EQUIPMENT SUPPORTS.

Details of equipment supports for the various systems are shown on the drawings.

22.17 TEST DATA.

22.17.1 General.

The Constructor shall provide to the COR with typewritten schedules of readings taken by qualified personnel, or certified Subcontractor during the balancing and testing operations indicating the required or specified readings, the first reading taken, and the final balanced reading for the following items:

22.17.1.1 Fans. Size, type, speed (r.p.m.), static pressure (H_2O), air quantity (c.f.m.), and motor load (amperes).

22.17.1.2 Air Balance.

22.17.1.2.1 Air Outlets and Inlets. Size, velocity (f.p.m.) and air quantity (c.f.m.).

22.17.1.2.2. Coils. Size, face velocity (f.p.m.) air condition On and Off (WB and DB degrees F.), water temperature leaving coil (degrees F.), and water temperature entering coil (degrees F.).

22.17.1.2.3 Ducts. Size, velocity (f.p.m.), and air quantity (c.f.m.).

22.17.2 Control Settings.

The actual on-site setting of all automatic controls including thermostats, humidity controls safety controls, minimum damper settings, fire-safety controls, pressure controls, temperature controls, and other similar items shall be provided in the form of a typed tabulated list indicating type of control, location, setting, and function.

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SECTION 23

INTERIOR ELECTRICAL WORK

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SECTION 23

INTERIOR ELECTRICAL WORK

23.1 GENERAL

This standard specification covers the engineering design of interior electrical work, their components and installations. It is intended to provide a basic guide for recurring electrical design and installation problems and to inform the engineers, designers, inspectors, and constructors of minimum standards for electrical work. These specifications generally cover greater areas than are required for a specific project. Therefore, only the applicable sections shall be considered.

23.2 APPLICABLE PUBLICATIONS

The electrical work and equipment shall be in accordance with the latest edition of the following codes and recommended standards:

- 23.2.1 National Fire Protection Association (NFPA)
- 70 National Electrical Code - (NEL)
- 23.2.2 American National Standard Institute (ANSI)
- C2 National Electrical Safety Code
- 23.2.3 National Electrical Manufacturers' Association (NEMA)
- 23.2.4 Occupational Safety & Health Administration (OSHA)
- 23.2.5 Underwriters' Laboratories, Inc. (UL)
- 23.2.6 Institute of Electrical & Electronic Engineers (IEEE)
- 23.2.7 Insulated Power Cable Engineers Association (IPCEA)
- 23.2.8 Certified Ballast Manufacturer (CBM)
- 23.2.9 Electrical Testing Laboratories (ETL)
- 23.2.10 Factory Mutual System (FM)

23.3 COORDINATION

The electrical drawings are diagrammatical in nature and indicate the general layout of the electrical work. The Constructor shall check the drawings of other trades to avoid possible conflicts and, should changes from original plans be necessary, to resolve such conflicts. The Constructor shall notify the Contracting Officer's Representative (COR) and shall secure from him written approval and agreement concerning necessary changes and adjustments before altered installation work is started.

23.4 APPROVAL OF MATERIAL AND EQUIPMENT

Only those materials or items so noted on the electrical construction drawings shall require approval before installation. The Constructor shall submit shop drawings or clearly marked catalog data, prior to procurement, to the COR. The COR will retain three (3) copies of each drawing, catalog cut, or other descriptive material submitted and return the remainder of the copies to the Constructor. All material and equipment used shall be UL listed and/or FM approved.

Preliminary material, such as descriptive literature or catalog data received by the Constructor from proposing vendors, need not be submitted unless the Constructor requires an engineering evaluation to determine that the proposed vendor will meet specified standards of quality. In such case, the Constructor shall require the proposing vendor to identify completely the items he proposes to furnish in the event he is awarded a purchase order or subcontract. This will allow an engineering evaluation to be made expeditiously.

Each submittal shall contain identification for each separable piece of material or equipment literature with respect to job title, procurement authorization, drawing number, and work order number under which the item is to be furnished. All interior electrical conductors shall be copper unless specified otherwise.

23.5 WORKMANSHIP

All electrical work shall be installed in a neat workmanlike manner. All material and equipment shall be installed in accordance with the manufacturer's recommendations by skilled workmen in the electrical trade.

23.6 GROUNDING

Grounding shall be installed in accordance with Article 250 of the NEC and as shown on the drawings.

23.6.1 Service Grounding

The enclosure for service equipment shall be grounded in the manner specified in the NEC. The system neutral shall be grounded only at the main service switch.

23.6.2 Equipment Grounding

A bare or green insulated, soft drawn copper wire, securely connected and sized as shown on the drawings, No. 12 Min., shall be installed from each current consuming device, panelboard, cabinet, motor controller, switch, etc., to the equipment grounding block located in its panelboard, to form a continuous grounding system. These equipment grounding wires may be spliced or interconnected to serve common units.

23.6.3 Generators

Generator frames shall be connected to the grounding conductor unless specifically designed as isolated equipment and effectively insulated from ground.

23.6.4 Ground Rods

Ground rods shall be copper-clad steel not less than 3/4 inch in diameter, 10 feet long, driven vertically full length plus 1 foot below surface of earth.

23.7 CONDUIT AND RACEWAY SYSTEMS

23.7.1 General

All wiring shall be installed as shown on the drawings. Minimum conduit size below grade or in earth below slabs on grade shall be 3/4 inch. All other conduit shall be 1/2-inch minimum size.

Conduit in concrete may be rigid steel, intermediate metal conduit (I.M.C.), PVC type 1 or A, or PVC type 40 conduit. Steel conduit shall be galvanized or sherardized (zinc coated).

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 three diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the COR. Raceways crossing expansion joints in concrete slabs 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.

Conduit run in earth below concrete slabs on grade or in the ground may be rigid steel, I.M.C. or PVC type 40. The steel shall have a corrosive protection coating and shall be field wrapped or shall have a factory applied coating (corrosive coating may be omitted) with a minimum thickness as listed below:

Low or medium density plastic020 inch
Epoxy Resin008
Coal Tar enamel or equal063

The field applied wrapping shall be done with .010-inch thick polyvinyl plastic tape, or approved equal, applied with a 50% overlap.

Electrical metallic tubing (EMT) shall be used within the interior of the building only above grade and on the building exterior only with weather-proof fittings.

Raceways shall not be installed under the fire pits of boilers and furnaces and shall be kept a minimum of 6 inches from parallel runs of flues, steam pipes, and hot water pipes.

Raceways shall be concealed where possible within finished walls, ceilings, and floors other than slabs-on-grade.

Two locknuts and a bushing shall be used to provide firm contact with boxes and enclosures.

Insulating and/or insulated bushings shall be installed at the end of conduits to protect the wire from abrasion unless the design of the box or fitting provides equivalent protection. Grounding bushings or locknuts shall be installed where required.

Compression type fittings shall be used for EMT. Set screw or indent type fittings shall not be permitted.

A pull wire (No. 14 AWG zinc-coated steel or equal) having 200-pound tensile strength or nylon cord of equivalent strength shall be left in all empty conduits which are greater than 150-feet in length or have four 90-degree bends in more than 50-feet in length. Not less than 10 inches of slack shall be left at each end of the pull wire.

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings.

Changes in direction of runs shall be made with symmetrical bends, junction boxes, or cast-metal fittings. Field-made bends and off-sets 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.

23.7.2 Supports

Raceways shall be securely supported and fastened in place with pipe straps, wall brackets, hangers, beam clamps, or ceiling trapeze. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts or through-bolts with backing plates as application may require on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, or spring-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a power charge and provided with lock washers and nuts may be used in lieu of expansion bolts, or machine or wood screws. Raceways or pipestraps shall not be welded to steel structures. Holes cut to a depth of more than 1 1/2-inch 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 with appropriate material such as cement in a concrete wall. In partitions of light steel construction, sheet metal screws may be used, and bar hangers may be attached with baffle ties of not less than No. 16 AWG double-strand zinc-coated steel wire. In suspended ceiling construction, only lighting-system-branch-circuit raceways shall be fastened to the ceiling supports unless specifically otherwise indicated in Section 17.

23.7.3 Exposed Risers

Exposed risers in building shall be adequately supported at intervals not to exceed 10-feet.

23.7.4 Exposed Lengths of Conduit

Exposed lengths of conduit containing power conductors operating at more than 600 volts shall have two blue bands spaced 8 inches apart, painted near each coupling, except at factory ells; the intervening space between the blue bands shall be painted white, and on the white space the voltage shall be stenciled on the conduit in black. Other types of markers may be used only on approval by the COR.

23.7.5 Telephone and Signal-Systems Raceways

Telephone and signal-systems raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirement that additional pull or junction boxes shall be installed so that no length of pull shall be greater than 75-feet for 1/2- and 3/4-inch sizes and 150-feet for 1-inch or larger.

23.8 BUSWAY SYSTEMS

Busway systems (vertical or horizontal) within 6 feet of the floor shall have solid enclosures. Busways shall be braced properly to prevent lateral movement. Plug-in units shall be of the circuit breaker type..

23.9 UNDERFLOOR DUCT SYSTEMS

Underfloor duct systems shall be of the type indicated, and shall consist of steel or fiber duct, so installed that the tops of inserts are flush with the finished surface. Each telephone outlet shall be a horizontal housing suitable for the application, with a 1-inch bushed side opening and shall have provisions for mounting a 10-wire telephone terminal block. Each receptacle outlet shall be a horizontal housing suitable for the application with a duplex receptacle as specified hereinafter. One telephone and one receptacle outlet shall be furnished for each 15 linear feet of corresponding duct. Receptacle outlets, branch circuit wiring, and telephone outlets shall be installed as indicated. Outlets in excess of those indicated to be installed shall be delivered to the COR for installation by others. Junction box covers shall be suitable for the floor finish encountered.

A complete set of tools suitable for the installation of the outlets shall be furnished to the COR. A magnetic induction device shall be provided to indicate the exact location of each insert.

23.10 CABLE TRAYS

Cable trays shall form a wireway system and shall be of the type indicated. Trays shall include splice and end plates, dropouts, and miscellaneous

hardware. Trays shall have suitable strength and rigidity to provide adequate support for all contained wiring with supports to manufacturer's recommendation or as indicated on the drawing. All edges, fittings, and hardware shall be finished free from burrs and sharp edges. Cable trays shall be aluminum or zinc-coated steel. Fittings shall have not less than the load-carrying ability of straight tray sections and shall have manufacturer's minimum standard radius unless otherwise indicated. A No. 2 AWG bare copper or equivalent aluminum conductor shall be laid throughout the cable tray system and bonded to each section thereof. This conductor shall be connected to the building ground. Bonding of the No. 2 conductor to the cable tray system shall be made by bolted-type connections.

23.11 BOXES AND SUPPORTS

Boxes for mounting lighting fixtures shall be not less than 4-inches except that smaller boxes may be installed as required by fixture configuration, as approved. Boxes installed for concealed wiring shall be provided with suitable extension or plaster rings, as required. Boxes for use in masonry-block or tile walls shall be square-cornered, tile type, or standard boxes having square-cornered tile type covers. 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 pendants for surface-mounted fixtures on suspended ceilings shall be indicated on the drawings. Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and expansion bolts on concrete or brick, with toggle bolts or through bolts with backing plates as application may require on hollow masonry units, and with machine screws or welded studs on steel work. Threaded studs driven in by powder charge and provided with lock-washers and nuts, or nail-type nylon anchors may be used in lieu of expansion bolts, wood screws, 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 or by hangers. Where bar hangers are used, the bar shall be attached to building structure on opposite sides of the box. Penetration of more than 1 1/2-inch deep into reinforced concrete beams or more than 3/4-inch deep into reinforced concrete joists shall avoid cutting any main reinforcing steel.

23.11.1 Boxes

Boxes for use with raceway systems shall not be less than 1 1/2-inch deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be not less than 4 inches, except that 4- by 2-inch boxes may be used where only one raceway enters the outlet.

23.11.2 Boxes

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

23.11.3 Pull Boxes.

Pull boxes shall be constructed of code-gage aluminum or galvanized sheet except where cast-metal boxes are required, and nonmetallic boxes may be used with nonmetallic wiring systems. 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.

23.11.4 Clock Outlet

Clock outlet for use in other than a wired clock system shall consist of an outlet box, a plaster cover where required, and a single receptacle with a clock outlet plate. The receptacle shall be recessed sufficiently within the box to allow the complete insertion of a standard cap, flush with the plate. A suitable clip or support for hanging the clock shall be secured to the top of the plate. Material and finish of the plate shall be as specified in Paragraph 23.14.

23.11.5 Floor Outlets

Floor outlets shall be adjustable and each outlet shall consist of a stamped or cast-metal body with threaded openings for conduits, adjustable ring, brass flange ring, and cover plate with 1/2-inch threaded plug. Each telephone outlet shall consist of a horizontal housing suitable for application with 1-inch bushed side opening. Outlets shall have provisions to accommodate a 10-wire telephone terminal block. Each receptacle outlet shall consist of a horizontal housing with a duplex receptacle as specified hereinafter. Gaskets shall be used where necessary to ensure a watertight installation and must be UL listed or FM approved for floor use.

23.11.6 Conduits

Conduits stubbed-up through concrete floors shall be extended, where required, with suitable conduit pipe to equipment except that where required, flexible metal or liquidtight flexible metal conduit may be used 6 inches above the floor. Screwdriver-operated threaded flush plugs shall be installed in conduits from which no equipment connections are made.

23.12 GUTTERS AND WIREWAYS

Gutters and wireways shall be constructed of code gauge galvanized sheet steel. Covers shall be hinged and provided with captive machine screws or removable and fastened with brass machine screws spaced not over 12 inches apart. Elbows and fittings shall be made without sharp edges or projections which could damage insulation of conductors.

23.12.1 Gutters, Wireways, and All Fittings

Gutters, wireways, and all fittings shall be of the same manufacture and finished with the manufacturer's standard enamel or lacquer finish. Ends not terminating in cabinets or pull boxes shall be closed with fittings designed for the purpose. Sections shall be firmly attached to each other and to cabinets or boxes that enter with good electrical and mechanical continuity throughout the system, and shall be securely attached to the building structure at points not over 5 feet apart. Gutters or wireways with covers on the bottom shall have removable wire supports 3 feet minimum on centers.

23.12.2 Outdoor Locations

All wireway for outdoor and similar locations shall be NEMA Type 3, weatherproof or NEMA Type 4, Watertight Sectional wireway as indicated on the drawings. Each length shall be a completely enclosed unit with a removable cover, with provisions for sealing, and suitably finished for outdoor use.

23.12.3 Special Areas

Where wireway is required to protect continuous runs of wiring from oil, water, coolants, dust or dirt it shall be NEMA Type 12 (Type JIC) Sectional wireway. All lengths and fittings shall be welded steel construction with all welds ground and polished. Flanges shall be a minimum of 10-gage steel to assure good mechanical strength. Each length shall have a hinged cover with gasket and external screw clamps to assure a tight seal.

23.13 CONDUCTOR SYSTEMS

23.13.1 General

Unless otherwise specified, wiring shall consist of 600 volt THW conductors installed in approved raceways as described below:

23.13.2 Conductors

Conductors and cables shall be of 98 percent conductivity copper unless otherwise specified. Wire connectors of insulated materials solderless pressure connectors, properly taped, or wirenuts, shall be utilized for all splices where possible. Soldered mechanical joints insulated with tape shall be kept to a minimum. Solid copper through No. 10 and stranded copper for larger conductor sizes.

23.13.2.1 Sizes shall be not less than indicated. Branch circuit conductors shall be not smaller than No. 12 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 low-energy remote control and signal circuit conductors shall be not less than No. 16 AWG.

23.13.2.2 Insulation Conductor insulation shall be Type THW, or as indicated on the drawings, except that No. 16 AWG conductors for Class 2 remote control and signal circuits other than fire alarm circuits may be commercial fixture wire, Type AF or TFF. Conductors of all sizes for temperatures in excess of 75° C., shall be Type THHN or SA for dry locations only.

23.13.2.3 Conductor Identification of Branch Circuits Conductor identification shall be made by color-coded insulated conductors; plastic-coated self-sticking, printed markers; permanently attached, stamped, metal foil markers; or equivalent means, as approved by the COR. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made. Terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved shop drawings.

23.13.2.4 Phase Identification Conductors shall be identified at terminals by position. Phases A, B, and C shall be from left to right, from top to bottom, or front to back when the terminals are viewed from the front or normal position. In addition, phase and voltage shall be identified with colored insulation, colored tape or paint according to the following schedule.

<u>VOLTAGE</u>			<u>PHASE</u>			
			<u>A</u>	<u>B</u>	<u>C</u>	<u>N</u>
208	3-Ø,	3-wire	Black	Red	Blue	-
120/208	3-Ø,	4-wire	Black	Red	Blue	White
120/240	3-Ø,	4-wire	Black	Orange	Blue	White
120/240	1-Ø,	3-wire	Black	Red	-	White
277/480	3-Ø,	4-wire	Brown	Yellow	Purple	White
480	3-Ø,	3-wire	Brown	Yellow	Purple	-

23.13.2.5 Neutral Conductors Where neutral conductors of two different systems are installed in a common enclosure, the higher voltage shall be identified by an outer covering of white with an identifiable stripe colored other than green or some other means of identification.

23.13.3 ALS and MI Cable

Type ALS or mineral-insulated cable system, Type MI may be used in lieu of exposed conduit and wiring when approved by the COR. Conductor sizes shall be not less than those indicated for the conduit installation. Cables shall be fastened within 12 inches of each turn or offset. Cable terminations shall be made in accordance with manufacturer's recommendations immediately upon stripping of sheath. Individual conductors in all outlets and cabinets shall be color-coded.

23.13.4 Cable System

NM cables 600 volts and less shall be installed concealed behind ceiling or wall finish, where practicable. Cables shall be threaded through holes bored on the approximate centerline of wood members; notching will not be permitted. Sleeves shall be provided through bond beams of masonry- block walls for threading cables through hollow spaces. Exposed cables shall be installed parallel or at right angles to walls or structural members. In rooms or areas not provided with ceiling or wall finish, cables and outlets shall be installed so that a room finish, such as ceiling tile and gypsum-board, may be applied in the future without disturbing the cables or resetting the boxes. Exposed NM-sheathed cables less than 8 feet above floors shall be protected from mechanical injury by installation in conduit or tubing.

23.14 DEVICE PLATES

Device plates of the one-piece type shall be provided for all outlets and fittings to suit the devices installed. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast metal, or plastic, having rounded or beveled edges. Plates on finished walls shall be of satin finish of corrosion-resistant steel, or satin finish chromimum- plated brass, or plastic. 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 finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. 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 or outdoors shall be gasketed with lift covers. Device plates for telephone and intercommunication outlets shall have a 3/8-inch opening in center opening to be bushed in metal plates. Plastic device plates need not be bushed.

23.15 RECEPTACLES

23.15.1 Receptacles

Receptacles shall be brown phenolic compound or molded plastic supported by mounting straps having plastic ears. 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, or shall have pressure type screwless terminals with a suitable conductor release arrangement. The blade receptable configuration shall be in compliance with NEMA Standards.

23.15.2 Weatherproof Receptacles

Weatherproof receptacles shall consist of a single or duplex receptacle as specified on drawings mounted in a cast-metal plate with lift covers over each receptacle opening sized per receptacle. Each lift cover shall be provided with a spring to snap shut automatically. The lift

cover furnished and means of mounting shall be such as to provide protection from rain.

23.15.3 Power Receptacles and Plugs

Power receptacles and plugs shall have four pins and sockets. Remove ground strap from Terminal G in both pins and sockets. Interior shall be so arranged that when withdrawn, the pin contacts shall be deenergized before the ground connection. Conductors identified with green insulation or bare copper shall be connected to plug and receptacle case. The cord shall be NEMA Type G, SO, ST, SJ, or SJO cord.

23.15.3.1 The 120/208 volt, 3-phase receptacles and plugs shall be Russel & Stoll Type LHS plugs in the 30, 60, 100, and 200 ampere sizes.

23.15.3.2 The 277/480 volt, 3-phase receptacles and plugs shall be Appleton Electric Series AE in the 30, 60, and 100 ampere range and Appleton's Powertite Series in the 200 ampere size.

23.16 WALL SWITCHES

Wall switches shall be of the totally enclosed tumbler type with bodies of phenolic compound. Handles shall be brown. Wiring terminals shall be of the screw type or of the solderless-pressure type having a suitable conductor-release arrangement. Not more than one switch shall be installed in a single-gang position. Switches shall be specification grade, rated 15-ampere, 277-volt, for use on alternating current only. Pilot lights shall be provided as indicated on the drawings. Switches shall be provided with weatherproof cover plates for outdoor installation or as indicated on the drawings.

23.17 SERVICE EQUIPMENT

Service disconnecting means shall be of the enclosed circuit breaker or fusible safety-switch type with external handle for manual operation and lockable. Enclosures shall be code gauge galvanized sheet metal with hinged cover for surface mounting, unless otherwise indicated.

23.18 LOAD CENTER PANELS

Load center panels shall be circuit breaker equipped as indicated on the drawings. Single-pole breakers shall be full module size; two poles shall not be installed in a single module.

23.19 PANELBOARDS

Lighting and appliance branch circuit panelboards shall be circuit breaker equipped. Distribution, power, or feeder panelboards shall be circuit breaker equipped, or fusible-switch equipped, as indicated on drawings. Circuit-breaker interrupting capacities shall conform to Federal Specification W-C-375 unless otherwise indicated on the drawings. Busses shall be copper unless otherwise noted. All breakers shall be of

the bolt-on or plug-in type. Multipole fusible-switches shall be of the hinged-door type; single-pole fusible-switches shall be of tumbler switch and fuse type. Switches serving as motor-disconnect means shall be horsepower rated as indicated on the drawings. Circuit breakers and switches used for motor-circuit disconnects shall be capable of being locked in the open position. Panelboards shall not exceed 78 inches in height and shall be so mounted that the height of the top operating handle will not exceed 6 feet, 6 inches from the floor. Locks shall be keyed alike. Fusible panelboards of the multipole type may have doors over individual circuits and trim over wiring gutter only, provided each circuit is arranged for locking in the open and closed positions and each branch circuit has an individual identification card in a cardholder with a clear plastic covering. Directories shall be typed to indicate load served by each circuit and mounted in holder behind protective covering.

23.20 POWER-SWITCHGEAR ASSEMBLIES

Power-switchgear assemblies shall be metal-enclosed, low-voltage, air circuit breaker type. Enclosures shall be freestanding, ventilated general purpose type or as indicated on the drawings. Busses shall be copper unless otherwise noted. The design of the switchgear assembly and application of circuit breakers shall be low-voltage power circuit breakers or molded case circuit breakers with each pole equipped with inverse-time and instantaneous over-current tripping devices. The application of low-voltage power circuit breaker shall conform to NEMA Standard SG 3. Breakers shall be electrically operated in all cases required by the application standards; otherwise, breakers shall be manually operated.

23.21 CABINETS

Cabinets shall have boxes constructed of code gage zinc-coated sheet steel. Paint with prime coat and finish coat of enamel color as stated on drawings. Cabinets shall be constructed with interior dimensions not less than those indicated. Each trim shall be fitted with hinged door and flush catch. Doors shall provide maximum size openings to the box interiors. Removable interior panel boxes for telephone and signal systems shall be provided with a metal backboard.

23.22 FUSES

The Constructor shall furnish a complete set of fuses for all switches, panels, bus-duct plug-in switches, switchgear, and control centers as indicated on the drawings.

23.22.1 Cartridge Fuses

Cartridge fuses shall have an interrupting rating not less than 10,000 amperes or as noted.

directly, a double-throw, 3-position tumbler or rotary switch shall be provided for the manual control; when the automatic control device actuates the pilot control circuit of a magnetic starter, the latter shall be provided with a 3-position selector switch marked Hand-Off-Auto-matic. Connections to the selector switch shall be such that only the normal automatic regulatory control devices will be bypassed when the switch is in the Manual position; all safety control devices, such as low or high pressure cutouts, high temperature cutouts, and motor overload protective devices shall be connected in the motor control circuit in both the Hand and the Automatic position of the selector switch.

23.26.1 Reduced Voltage Starters

Reduced voltage starters (when required) shall be of the single- step autotransformer type. Wye-Delta reduced voltage starter or part winding increment starter having an application of voltage to first and second windings of the motor may be used in lieu of the reduced voltage starter specified above for starting motor-generator sets, centrifugally operated equipment, or reciprocating compressors provided with automatic unloaders. Protection should be provided on both stages of two stage starters.

23.26.2 Motor Control Centers

Motor control centers shall be mounted on floor sills or mounting channels. Each circuit shall have a suitable metal or laminated plastic nameplate with white cut letters. Combination starters shall be provided with fusible switches or circuit breaker as indicated on drawings. Class 1 type A shall be provided unless otherwise specified.

23.27 MOTOR DISCONNECT MEANS

A means shall be provided to disconnect the motor and controller from all ungrounded supply conductors. The disconnect means shall be horsepower rated in conformance with the drawings.

23.28 TRANSFORMERS

Transformers shall be of type, and rating as shown on the drawings. Full capacity NEMA standard taps shall be provided in the high-voltage winding. Transformers with sound levels greater than 45 decibels shall be installed on resilient vibration isolating mountings to prevent amplification of sound. Audible sound levels shall be in accordance with NEMA Standard ST 20.

23.29 LAMPS AND LIGHTING FIXTURES

Lamps and lighting fixtures of types and sizes as indicated shall be furnished and installed complete.

23.29.1 Lamps

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

23.29.1.1 Incandescent Lamps shall be for 120-volt operation unless otherwise specified.

23.29.1.2 Fluorescent Lamps shall have standard cool-white color characteristics and shall be of a type that will not require starter switches.

23.29.1.3 H.I.D. Lamps shall be as indicated on the drawings.

23.29.2 Fixtures

Fixtures shall conform to the following specifications, and shall be as indicated on the drawings. Fixtures of similar designs and equivalent light distribution and brightness characteristics, and/or equal finish and quality, will be acceptable, if approved by the COR. All lighting diffusers shall be shatterproof glass.

23.29.2.1 Suspended Fixtures shall be installed so conduit is vertical. Pendants 4 feet or longer shall be braced to limit swinging. Single-unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple unit or continuous row fluorescent units shall have a tubing or stem for wiring at one point, and a tubing or rod suspension provided for each unit length of chassis including one at each end. Rods shall be of not less than 3/16 inch diameter.

23.29.2.3 Recessed Fluorescent Fixtures. Fixtures shall be installed in suspended ceiling openings. Fixtures installed in fire-resistive type suspended ceiling construction shall be boxed in with fireproofing materials of the same fire rating as the ceiling panels in conformance with the Building Materials Directory and Fire Resistance Index of Underwriters' Laboratories, Inc.

23.29.2.4 Fluorescent Lamp Ballasts shall be of the thermally protected, Class "P", automatic resetting type. Ballasts shall be 118 or 277 volts with a sound-level rating of "A." They shall further be HPF and manufactured under standards as set down by CEM, tested by ETL, and UL listed.

23.29.2.5 H.I.D. Lamp Ballast. Ballast housing shall be cast aluminum and be finned for heat dissipation.

Ballast shall be capable of properly starting and operating the (metal halide) (mercury vapor) (high pressure sodium) lamp in ambient temperatures up to 150° F. Ballast crest factor shall not exceed 2.0. Core and coil shall be totally encapsulated in a proven non-melt resin compound with entire system rated Class H. Temperature rise shall be at least one full class lower than the rating of the insulation system. Capacitor shall be outside the encapsulation, and shall be isolated by a double-walled heat shield. Ballast shall be high power factor, and shall have a circuit of the reactor type.

23.30 EQUIPMENT CONNECTIONS

All wiring for the connections of motors and control equipment as indicated on the electrical drawings shall be furnished and installed under this section of the specifications. Except as otherwise specifically noted, automatic control wiring, signaling, and protective devices are included in this section of the specifications and shall be furnished and installed under this section of the specifications. Control wiring, not shown on the electrical drawings, shall be furnished under this section of the specifications. Flexible connections of short length shall be provided for equipment subject to vibration or movement and for all motors. Liquid-tight flexible conduit shall be used in wet locations.

23.31 PAINTING AND FINISHING

Field-applied paint, on exposed surfaces, and conduit identification, shall match surroundings.

23.32 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance. Where cutting, channeling, chasing, or drilling of floors walls, partitions, ceilings, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, this work shall be carefully done. Any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved.

23.33 SYSTEM CHECKOUT

Upon completion of the work covered under this section of the specifications, the Constructor shall test and check out the entire electrical system. The Constructor shall notify the COR 24 hours in advance of the system checkout so that a representative of the COR will be present during the entire checkout. Faulty work shall be corrected to the satisfaction of the COR.

23.34 IDENTIFICATION OF EQUIPMENT

Identification of equipment shall be clearly identified as to labeling light switches, convenience outlets, and all devices fed from panelboards to match assigned circuits. Disconnect switches and other controlling devices shall be labeled to indicate voltage and all feeds. Panelboards and loadcenter shall have voltage, phase (1Ø or 3Ø) and panel identification (P1 or LP1). Surface shall be clean to assure good bonding for aluminum self-sticking tape with the required information embossed.

* * * * *

SECTION 24

ELECTRICAL DISTRIBUTION SYSTEMS--AERIAL

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SECTION 24

ELECTRICAL DISTRIBUTION SYSTEMS--AERIAL

24.1 GENERAL

This standard specification covers the engineering design of aerial electrical work, their components and installations. It is intended to provide a basic guide for recurring design and installation problems and to inform the engineers, design, inspectors, constructors of minimum standards. These specifications cover greater areas than are required for a specific project, therefore, only applicable sections shall be applied.

24.2 APPLICABLE PUBLICATIONS

The electrical work and equipment shall be in accordance with the latest edition of the following applicable codes and standards.

24.2.1 National Fire Protection Association (NFPA) 70

24.2.2 American National Standards Institute (ANSI)

24.2.3 National Electrical Manufacturer's Association (NEMA)

24.2.4 Occupational Safety and Health Administration (OSHA)

24.2.5 American Wood Preservers' Association (AWPA)

24.2.6 Edison Electric Institute (EEI)

24.2.7 Standards of Institute of Electronic & Electrical Engineers (IEEE)

24.2.8 Standards of the Insulated Power Cable Engineers Association (IPECA)

24.2.9 NTS Overhead Power Line Standards

24.2.10 Federal Specifications (FS)

24.2.11 American Society for Testing Materials (ASTM)

24.2.12 Underwriters' Laboratories Electrical Equipment and Materials Directories

24.3 GENERAL REQUIREMENTS

The electrical drawings are diagrammatic in nature and indicate the general layout of the electrical work. Field verification is required by

the Constructor since actual location, distances and levels are governed by local conditions. The Constructor shall thoroughly familiarize himself with all details of the work, working conditions, and dimensions.

24.3.1 Nameplates

Each major component of equipment shall have as a minimum, the manufacturer's name, address, and catalog or style number on a nameplate securely attached to the item of equipment. Nameplates for reclosers, sectionalizers, switches, and transformers shall conform to NEMA Standards.

24.3.2 Prevention of Corrosion

All metallic materials shall be protected against corrosion. Transformer cases shall be given rust-inhibiting treatment and standard finish by manufacturer. Aluminum shall not be used in contact with earth, and, where connected to a dissimilar metal, shall be protected by approved fittings and treatment. All ferrous metals and miscellaneous parts not of corrosion-resistant steel, shall be hot-dip galvanized in accordance with ASTM A 123 or A 153, except where other equivalent protective treatment is specifically approved by the Contracting Officer's Representative (COR).

24.3.3 Standard Products

Materials and equipment to be provided shall be essentially the cataloged products of a manufacturer regularly engaged in the manufacture of the products. Materials and equipment shall meet the applicable requirements of the specification, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

24.3.4 Unusual Service Conditions

Items furnished under this section shall be specifically suitable for the following unusual service conditions:

24.3.4.1 Altitude: 3,500 to 7,500 feet. This shall apply to lighting arrestors, transformers, reclosers and switches.

24.3.4.2 Ambient Temperature: -10° F. to +120° F.

24.3.4.3 Dust Storms: 36 hours/year, visibility 100 feet.

24.4 APPROVAL OF MATERIAL AND EQUIPMENT

Only those materials or items so noted on the electrical construction drawings shall require approval before installation. The Constructor shall submit shop drawings or clearly marked catalog data, prior to procurement, to the COR. The COR will retain three (3) copies of each

drawing, catalog cut, or other descriptive material submitted and return the remainder of the copies to the Constructor.

Preliminary material, such as descriptive literature or catalog data received by the Constructor from proposing vendors, need not be submitted unless the Constructor required an engineering evaluation to determine that the proposed vendor will meet specified standards of quality. In such case, the Constructor shall require the proposing vendor to identify completely the items he proposes to furnish in the event he is awarded a purchase order or subcontract. This will allow an engineering evaluation to be made expeditiously.

Each submittal shall contain identification for each separable piece of material or equipment literature with respect to job title, procurement authorization, drawing number, and work order number under which the item is to be furnished.

24.5 WORKMANSHIP

All material and equipment shall conform to the contract documents and to the above codes and standards that are applicable. They shall be installed in accordance with the manufacturer's recommendations by skilled workmen in the electrical trade.

24.6 PROVISION FOR COMMUNICATION SERVICES

Communication space shall be considered for all pole-line construction in accordance with the requirements of the National Electrical Safety Code. A vertical pole space of not less than 2 feet shall be reserved for signal cables and telephone cables.

24.7 POLES

Poles shall conform to ANSI Standard 05.1 and shall be butt-treated Western Red Cedar, Douglas Fir, or equal as approved by the COR. Poles other than Western Red Cedar shall be full length pressure treated. The preservative treatment shall conform to AWWA Standard C7. The preservative shall be oil-base pentachlorophenol conforming to AWWA P8 and P9. Poles shall be of the length and class indicated, and shall be seasoned four seasoning months before treating. All clearances specified by the National Electrical Safety Code shall be maintained. Footnote reductions to tables shall not apply and clearances shall not be reduced except where authorized in writing by the COR. Pole markings shall be located approximately 10 feet from the ground line of the pole, except where other locations standard with the pole manufacturer are approved. The poles shall be machine trimmed by turning.

24.8 STORAGE AND HANDLING OF POLES

Poles held in storage for more than two weeks shall be stored in a storage yard. Pointed tools capable of producing indentations more than 1 inch in depth shall not be used for handling poles.

24.9 POLE SETTING

In normal firm ground, minimum pole setting depths shall be as listed in the NTS Overhead Power Standards. Poles in straight runs shall be in a straight line. Curved poles shall be placed with the curvature in a line with the lead. Poles shall be set to maintain as even a grade as practicable. When the average ground run is level, consecutive poles shall not vary more than 5 feet in height. When the ground is uneven, poles differing in length shall be kept to a minimum by locating poles to avoid the highest and lowest ground points. If it becomes necessary to shorten a pole, a piece shall be sawed off the top end. Where poles are set on hilly terrain, along the edge of cuts or embankments, or where the soil may be washed out, special precautions shall be taken to ensure durable foundations, and the setting depth shall be measured from the lower side of the pole. Holes shall be dug large enough to permit the proper use of tampers to the full depth of the hole. Earth shall be thrown into the hole in 6-inch maximum layers, then thoroughly tamped before the next layer is thrown in. Surplus earth shall be placed around the pole in a conical shape and packed tightly to drain water away from the pole.

24.10 CROSSARMS

Crossarms shall conform to details shown on the applicable drawing. Climbing space, wire clearances, and vertical longitudinal strength of crossarms shall conform to the National Electrical Safety Code. Crossarms shall be straight and free of twists to within 1/10-inch per foot of length. Bend or twist shall be in one direction only. Crossarms shall be in accordance with NTS Jobsite Standard Specification JS-24 and shall be pressure treated. Crossarms shall be machined, chamfered, trimmed, and bored for all pins and bolts required before pressure treatment. Crossarms shall be set at right angles to line for straight runs, and shall bisect the angle of turns of 60 degrees or less. Dead-end assemblies shall be used for turns greater than 60 degrees. Buckarms shall be installed at all corners and junction poles as shown or noted. Double crossarms shall be provided at ends of joint use or conflict sections, at dead ends, at angles as indicated at corners, and elsewhere as required to provide adequate vertical and longitudinal strength. Double crossarms shall also be provided at each crossing structure where communication cables or conductors cross below the electrical distribution system and are attached to the same pole, double crossarm shall not be provided, unless another condition requires double crossarms for the distribution system conductors. Double crossarms shall be securely held in position by means of not less than 5/8-inch double-arming bolts. Each double-arming bolt shall be equipped with four nuts, four square washers, and spring steel washers. Crossarms shall be bolted to poles with not less than

5/8-inch through-bolts with square washers at each end. Bolts shall extend not less than 1/8-inch, nor more than 2 inches beyond the nut. At the option of the Constructor and with approval by the COR, metal crossarms may be provided.

24.11 CROSSARM BRACES

Crossarm braces shall be provided on all crossarms and shall be zinc-coated structural steel in conformance with ASTM Standards A 475, A 36, A 575, or A 576. Braces shall be 60-inch span by 18-inch drop, formed in one piece from a 1 1/2-inch by 1 1/2-inch by 3/16-inch angle. Angle braces shall be bolted to crossarm with 5/8-inch through-bolts. Wood crossarm braces only shall be used for 34.5 kv lines, and may be used on some applications and shall be approved by the COR.

24.12 PINS

Pins shall be zinc-coated forged steel with lead thread height to suit the insulator provided, but not less than 4 1/2 inches high by 5/8-inch diameter. Shoulder shall be not less than 2-inch diameter, designed to distribute load uniformly to the crossarm. Shank shall be not less than 5/8-inch diameter by 5 3/4-inch length, except when using steel crossarms, then length shall be for the application, equipped with 2-inch washers, nut, locknut, and shall project not less than 1/8-inch nor more than 2 inches beyond locknut. Broad-base corner pins, of drop-forged welded steel or malleable iron, may be used for turning small angles.

24.13 INSULATORS

Insulators for use on the primary distribution system shall conform to ANSI Standards C29.2, C29.4, C29.5, or C29.7, as applicable for the installation, with testing in accordance with ANSI Standard 29.1. Suspension-type insulators shall be used on the primary system at corners and at angles indicated on the drawings, for suspended buses, at dead ends, and wherever else pins do not provide adequate strength. Pin insulators shall be radio-noise free. Mechanical strength of suspension and strain insulators shall exceed the ultimate strength of the conductor or guy attached thereto. Insulators for various uses shall have ratings not lower than the classes indicated on the drawings. Pin-type insulators shall not be used on 69 JV or 138 KV lines.

24.14 SECONDARY RACKS

Secondary racks shall be three- or four-wire, as required, complete with spool insulators. Racks shall meet the strength and deflection requirements of EEI Specifications TDJ-7 for heavy-duty steel racks, and shall be either galvanized steel or aluminum alloy. The top of insulator points shall be rounded and smooth to avoid damage to conductor insulation. Insulators shall be held in place with a 5/8-inch button-head bolt equipped

with a nonferrous cotter pin, or equivalent, at the bottom. Racks for dead-ending four No. 4/0 or four larger conductors shall be attached to poles with three 5/8-inch through-bolts. All other secondary racks shall be attached to poles with at least two 5/9-inch through-bolts. The minimum vertical spacing between conductors shall be as shown in table:

Minimum Vertical Spacing Between Conductors

<u>Spools</u>	<u>Span length, max. feet</u>	<u>Vertical spacing between conductors, inches</u>	<u>Max. Voltage</u>
2,3, or 4	0 to 200	8	480 V.
2 or 3	200 to 300	12	480 V.

24.15 GUY STRAIN INSULATORS

Guy strain insulators shall be provided in each guy for 4,160 V. and 12,500 V. lines. Guys for 34,500 V. and higher lines shall be grounded. Where a single guy will not provide the required strength, two or more guys shall be provided. Approved guy grips 3-bolt clamps or preformed guy grips shall be provided at each guy terminal. Treated log or swamp anchors shall be provided at each guy terminal. Treated log or swamp anchors shall be provided in marshy ground; rock anchors in rock; elsewhere, anchors shall be a strength exceeding the required guy strength. Thimble--eyes shall be provided on all anchor rod and eye-bolt guy attachments to protect the strand. If exposed to traffic, an approved half-round steel guy protector, not less than 8 feet long, shall be provided at each guy, securely clamped to the guy or anchor rod at bottom and guy at top. When field conditions prevent the indicated guy lead, anchors shall be placed in a location approved by the COR, and the guy strength increased by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided, except that the lead angle shall be not less than 15 degrees. Guy strand shall be seven-strand, zinc-coated steel, high strength or extra-high-strength grade with a breaking strength not less than 15,000 pounds, nor less than indicated on the drawings.

24.16 LINE CONDUCTORS

Line conductors for primary lines shall be bare aluminum conductors, steel reinforced, ACSR of the size indicated on the drawings. Splices under tension shall be mechanically and electrically secure with a strength not less than the conductor. Splice materials, sleeves, fittings, and connectors shall be noncorrosive and shall not adversely affect the conductor with which they are used. Conductors shall be tied to insulators as per the applicable drawing. Preformed ties or tie wires for ACSR shall be No. 6 AWG strong aluminum alloy or No. 4 annealed aluminum.

ACSR conductors shall be armored at all supports with approved armor rods recommended by the manufacturer. All dead ends shall be made with approved clamps or other types of devices designed for the purpose, with a strength not less than the conductor. Care shall be taken in handling and stringing of conductors to guard against cuts, scratches, and kinks. Conductors shall not be drawn over rough or rocky ground, nor around sharp bends. When drawn by machine power, conductors shall be drawn from the mounted reel through approved stringing sheaves in approximately straight lines and clear of all obstructions. The design criteria for initial stringing sags and tensions shall be, light-loading conditions for lines up to 5,500 feet elevation and medium-loading conditions for lines over 5,500 feet elevation.

24.17 SECONDARY CONDUCTORS

Secondary conductors shall be of an approved type specifically intended for the application. Secondary conductors shall be carefully installed, taking due care to avoid abrasions, sharp bends, cuts, kinks, or any possibility of damage to the insulation or conductors. Bend radius shall at no time be less than IPCEA recommendation. Where run on structures or vertically on poles, cables shall be protected by heavy wall PVC or rigid conduit secured at intervals not exceeding 5 feet, and within 12 inches each side of any bend or termination. All connectors, supports clamps, and ties shall be designed for the particular purpose, shall be of the proper material and size, and installed strictly in accordance with approved methods. Connectors shall be solderless pressure type. All connections of insulated conductors shall be smoothly taped to provide a waterproof insulation equivalent to the original. Drip loops shall be formed on conductors at all entrances to buildings, cabinets, or conduits. Conductors shall be of the size indicated on the drawings, but not smaller than No. 6 AWG.

24.17.1 Secondary Conductors and Service Drops

Secondary conductors and service drops shall be stranded.

24.17.2 Service Drop Conductors

Service drop conductors may be neutral supported, secondary, and service drop cable, either neoprene- or polyethylene-insulated with a bare ACSR neutral or as indicated on the drawings. Installation of neutral supported or conventional service cables shall be as indicated on the drawings.

24.17.3 Connections to Buildings

Service drops shall be attached to buildings approximately at the point indicated on the drawings, and shall be connected to the building service entrance conductors. Service drip cables shall be securely attached to the buildings by fittings approved for that purpose. Where the service

mast is used for the support of service connections it shall be of adequate strength and be supported by guys where necessary. Drip loops shall be formed in all conductors. Connections shall be insulated with approved tape.

24.18 POLE-LINE HARDWARE

Pole-line hardware shall be in accordance with NTS Overhead Power Line Standards and shall be hot-dip-galvanized per ASTM 123. Suitable washers shall be installed under bolt heads and nuts on wood surfaces. Washers used on through-bolts and double-arming bolts shall be approximately 2 1/4 inches square and 3/16-inch thick. The diameter of holes in washers shall be the correct standard size for the bolts on which the washers are used. Carriage bolts shall not be used. Eyebolts, bolt eyes, eye nuts, strain-load plates, lag crews, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to adequately support and protect the poles, crossarms, guy wires, and insulators.

24.19 LIGHTNING ARRESTERS

Lightning arresters shall be provided at all aerial-to-underground connections, reclosers, and over 600-volt transformers. Classification of arresters according to use, shall be as described by NEMA LA 1. Arresters for use at elevations in excess of 6,000 feet above sea level shall be rated for that purpose. Arresters shall be equipped with suitable mounting brackets for the applicable method of mounting. Arresters shall be connected by means of No. 6 AWG softdrawn copper conductors. The down conductors shall extend from the crossarm to a plate attached to the bottom of the pole. See NTS Overhead Power Line Standards.

Where ground rods are installed, the rod shall be copper-clad steel not less than 3/4-inch diameter and 10 feet long. The ground rod shall be driven full length plus 1 foot into the ground approximately 5 feet out from the base of the pole. The total ground resistance shall not exceed 25 ohms. Where this condition cannot be obtained with one rod, a longer rod, deep-driven sectional rods, or an additional rod connected in parallel shall be installed. The Constructor shall make it known to the COR that there is reasonable doubt the grounding tolerance cannot be satisfied. The COR then can make criteria provisions for payment of extra rods. Ground resistance shall be measured in normally dry conditions not less than 48 hours after rainfall. The ground conductor shall be protected by plastic molding from the ground line to a point 6 inches below the crossarm. The plastic molding shall be stapled to the pole at intervals not exceeding 18 inches, with one staple not more than 3 inches from each end. Single-point serrated staples of a type suitable for use with the plastic molding shall be used for stapling molding to the pole. The ground conductor shall be stapled to the pole at intervals not exceeding 12 inches. All connections shall be made with solderless connectors. Where wholly self-protected transformers are provided, separate lightning arresters are not required.

24.20 POWER AND DISTRIBUTION TRANSFORMERS

Power and distribution transformers shall be of the mineral-oil-insulated, silicone insulated or air insulated two-winding type, and shall be in accordance with applicable NTS Jobsite Standard Specifications for Power and Distribution Transformers. They shall be suitable for outdoor installation in every respect and rated as indicated on the drawings. High-voltage transformers shall be manufactured and tested in accordance with all applicable ANSI and NEMA Standards. Six certified copies of factory test reports shall be furnished to the COR.

24.20.1 Transformer Mounting Installations

Transformers or transformer banks having a total capacity of 150 KVA or less shall be pole- or cluster-mounted as shown on the drawings. Transformers or transformer banks having a total capacity of 225 KVA or less may be radial- or cluster-mounted. Three-phase transformers or transformer banks having a total capacity in excess of 225 KVA shall be platform-mounted between a two-pole structure, or shall be mounted on concrete pads as shown on the drawings. Mounting shall be on low profile racks or concrete pads, regardless of KVA size.

24.20.2 Fence-Enclosed Concrete Pad

Pad-mounted transformers or transformer banks shall be mounted on a fence-enclosed concrete pad shown in NTS Overhead Power Line Standards. Transformers totally enclosed in a tamper-proof enclosure suitable for concrete pad mounting may not require a fence enclosure.

24.21 AUTOMATIC CIRCUIT RECLOSERS

Automatic circuit reclosers shall be outdoor, three-pole oil-type rated 14.4 kilovolts, 560 amperes continuous, 10,000 amperes interrupting rating for 4.16 and 12.5 KV service, and 34.5 kilovolt, 560 ampere continuous, 12,000 ampere interrupting rating for 34.5 KV service. All reclosers shall be complete with all devices, attachments, and accessories required for installation and operation, as indicated on the contract drawings. The recloser shall include provisions for not less than three automatic reclosing operations, followed by lockout if circuit fault persists, and for manual opening, closing, and lockout by use of a hook-stick. The operating sequence shall be adjustable for one, two, three, and four operations to lockout, and for combinations of instantaneous openings followed by time delay openings to secure coordination with reclosers and fuses in the electrical distribution system. The recloser shall automatically reset within a definite time interval after successful reclosure. Necessary operating power shall be provided. Reclosers shall be equipped with ground-fault tripping, shunt closing, auxiliary switch, tank lifter, and tank drain and sampling valve.

24.22 PRIMARY FUSE CUTOUTS

Primary fuse cutouts shall be extra heavy-duty, porcelain enclosed, indicating nondropout type, rated 5.2 KV minimum for 4.16 systems or open-type rated 13.8 KV minimum for 12.5 KV systems. Open-link rural type cutouts are not acceptable. Fuse ratings shall be as indicated on the drawings and coordinated to the transformers provided.

24.23 POLE-TOP SWITCHES

Pole-top switches shall be of the type and rating indicated on the drawings. Disconnect switches shall be horizontal, three-pole, single-throw, gang operated, rotating-insulator type. Switches shall be designed to break a 3/4-inch coating of ice before contacts are open or closed. Switches for 34.5 KV service shall be mounted on two-pole structures, complete with gang-operating mechanism and padlock. Operating handle shall be located approximately 3 feet 6 inches above ground. Mechanism shall be insulated and grounded. Padlock mechanism shall be arranged to lock switch in both the open and closed position.

24.24 GROUNDING

Cable messengers, and noncurrent-carrying parts of equipment, each transformer, pole-top switch, and regulator shall be grounded at each pole, except in areas where in conflict with User requirements. In those specific areas grounding is individually designed for each installation and drawings are to be followed. Any violations of Paragraph 24.2 of these specifications shall be called to the attention of the COR. Ground conductor shall be No. 6 copper. The ground conductor shall be connected to a copper pole bottom ground plate 10 inches in diameter with a No. 6 brazed copper pigtail 8 feet long. The ground conductor shall be protected by wood molding from the ground line to a point 6 inches below the crossarm. The molding shall be secured to the pole at intervals not exceeding 18 inches, and secured not more than 3 inches from each end. The ground conductor shall be stapled to the pole at intervals not exceeding 12 inches. All connections shall be made with solderless connectors. Where the ground wire is connected to aluminum conductors, specially treated or lined connectors suitable for this purpose shall be utilized. Equipment and neutral ground shall be connected to the lightning arrester ground. Resistance of the ground shall be measured and approved by the COR before connecting.

24.25 TEST

After the installation is completed, and at such time as the COR may direct, the Constructor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this section of the specifications. The test shall be performed in the presence of the COR. The Constructor shall furnish all

instruments and personnel required for the test, and the Government will furnish the necessary electric power. The Constructor shall submit in writing to the COR upon completion of the project, the measured ground resistance of each ground rod, indicating the location of the rod, and the resistance and the soil conditions at the time the measurements were made. Production line impulse tests on transformers shall be in accordance with Paragraph 24.20.

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SECTION 25

ELECTRICAL DISTRIBUTION SYSTEMS - UNDERGROUND

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SECTION 25

ELECTRICAL DISTRIBUTION SYSTEM - UNDERGROUND

25.1 SCOPE

This standard specification covers the engineering design of underground electrical distribution systems, their components and installations. It is intended to provide a basic guide for recurring electrical design and installation problems and to establish minimum standards for engineers, design, inspectors, and constructors of electrical work. These specifications generally cover greater areas than are required for a specific project. Therefore, only applicable sections shall be considered.

25.2 APPLICABLE PUBLICATIONS

The electrical work and equipment shall be in accordance with the latest edition of the following codes and applicable standards of the following organizations:

25.2.1 Federal Specifications (FS)

25.2.2 American Society of Testing and Materials (ASTM)

25.2.3 American National Standards Institute (ANSI)

C2-National Electric Safety Code

25.2.4 Occupational Safety and Health Adm. (OSHA)

25.2.5 National Fire Protection Association (NFPA)

25.2.6 Institute of Electrical and Electronic Engineers (IEEE)

25.2.7 National Electrical Manufacturers' Association (NEMA)

25.2.8 Insulated Power Cable Engineers' Association (IPCEA)

25.2.9 Edison Electric Institute (EEI)

25.2.10 Underwriters' Laboratories (UL)

Building Materials Directory

Electrical Appliance and Utilization (Equipment Directory)

Electrical Construction Materials Directory

25.2.11 NTS Overhead Power Line Standards

25.3 GENERAL REQUIREMENTS

The electrical drawings are diagrammatical in nature and indicate the general layout of the electrical work. Field verification is required since actual location, distances, and levels are to be governed by local field conditions. The Constructor shall check the drawings of other trades to avoid possible conflicts and should changes from original plan be necessary to resolve such conflicts, the Constructor shall notify the Contracting Officer's Representative (COR) and shall secure from him written approval and agreement concerning necessary changes and adjustments before altered installation work is started.

25.4 APPROVAL OF MATERIAL AND EQUIPMENT

Only those materials or items so noted on the electrical construction drawings and/or specifications shall require approval before installation. The Constructor shall submit shop drawings or clearly marked catalog data, prior to procurement, to the COR. The COR will retain three (3) copies of each drawing, catalog cut, or other descriptive material submitted and return the remainder of the copies to the Constructor. All material and equipment used shall be UL or FM listed.

Preliminary material, such as descriptive literature or catalog data received by the Constructor from proposing vendors, need not be submitted unless the Constructor requires an engineering evaluation to determine that the proposed vendor will meet specified standards of quality. In such case, the Constructor shall require the proposing vendor to identify completely the items he proposes to furnish in the event he is awarded a purchase order or subcontract. This will allow an engineering evaluation to be made expeditiously.

Each submittal shall contain identification for each separable piece of material or equipment literature with respect to job title, procurement authorization, drawing number, and work order number under which the item is to be furnished.

25.5 WORKMANSHIP

All material and equipment shall conform to the contract documents and to the applicable codes and standards listed above. They shall be installed in accordance with the manufacturer's recommendations by skilled workmen in the electrical trade.

25.6 CABLE

All cable shall be new and suitable for the use intended. It shall be the product of manufacturers regularly engaged in the manufacture of cable, and shall be in accordance with NTS Standard Jobsite Specifications and applicable standards of the IPCEA. Underground cable used shall be

rated for 600, 5,000, 15,000, and 34,500 volts. All cable rated for 5,000 volts and above shall be shielded. Aluminum wire shall not be used unless specifically shown on drawings.

25.7 SPLICING AND TERMINATING

25.7.1 Splicing and Terminations.

Splicing and terminations shall be in strict accordance with this specification and recommendations of the manufacturer of the cable.

25.7.2 Splices in Buried Cable

Splices in buried cable for new installations will not be permitted (1) for service entrance cables and (2) at less than 500-foot intervals, except to avoid obstructions or damage to the cable, unless otherwise directed by the COR.

25.7.3 Low-Voltage Feeder Cable

Low-voltage feeder cable splices shall preferably be protected by weather-proof enclosures aboveground, and shall be installed in conformance with manufacturer's recommendations as approved by the COR for below-ground installations. When available, preformed unit kits containing all necessary material for a complete splice may be used on approval by the COR. All branch circuits shall be terminated only in dry, accessible junction boxes, switches, circuit breakers, or other approved enclosures.

25.7.4 High-Voltage Cable

Where splices belowgrade are necessary as described in Paragraph 25.7.1, the splices shall be clearly and permanently located and identified by a surface marker above grade. Conductor splicing sleeves shall be of the tapered type such as manufactured by Andersen, Burndy, or an approved equal and installed with a circumferential crimp. Indent crimp is not acceptable.

25.7.5 Qualified Cable Splicers

Qualified cable splicers, only, shall make high-voltage cable splices and terminations. Satisfactory proof shall be provided that each splicer has had at least two years' experience in splicing high-voltage cables, and is experienced with the type and rating of cables to be spliced. In addition, each cable splicer may be required to make an approved dummy splice of the type proposed in the presence of the COR before the splicer is approved to splice cable covered by this specification. All material for dummy splices shall be furnished by the Constructor.

25.7.6 High-Voltage Terminations and Splices

High-voltage terminations and splices shall meet the following requirements:

25.7.6.1 Replace the factory insulation, equaling it in 60-hertz and pulse voltage strength, in resistance to ozone cutting, and in temperature rating.

25.7.6.2 Exclude moisture and air

25.7.6.3 Cable ends shall be properly sealed to exclude moisture and contamination. If reels are broken, cables shall be cut back until a dry and contamination-free section of cable is reached before a splice or termination is made.

25.7.7 Procedure

Splicing and terminating shall be done in a space protected from dust and dampness. Cleanliness is vital during the construction of a splice. The splicer's tools, hands, and splicing materials must be clean, and kept clean during the construction of a splice or termination. Perspiration and moisture shall be kept out of the materials and only those materials shall be used which are undamaged from storage. No work shall be started which cannot be completed the same day. Work shall be protected during short interruptions.

Radius of bends in the cables shall not be less than the minimum specified by the manufacturer. When manufacturer's recommendations are not available and if not in conflict with IPCEA requirements, radius of bends shall be not less than twelve times the cable diameter. The finished work shall provide sufficient off-sets to allow for cable movements during heat cycling or ground shocks.

Detailed instructions and diagrams covering the most effective techniques for splicing and terminating the cables used shall be obtained from the cable manufacturer. When available, complete splice kits containing the proper amount of all of the necessary material to make one complete splice or termination shall be used. The Constructor may propose, at his option, alternate methods in lieu of splice kit to the COR for approval.

25.7.8 Terminations

Terminations on shielded cable for 2,000 volts and above shall have stress cones with ample creepage distance to ground surfaces. Rain shields shall be used on outdoor terminations where creepage distance is less than 24 inches. Shielding tape shall be grounded. Terminals exposed to the weather shall be such that no moisture will enter the cable through the conductor strands. When using terminal lugs which do not have closed sockets, the exposed strands shall be sealed with a sleeve or other means before the lug is pressed on.

Preformed termination kits containing all necessary material for a complete termination are preferred for high-voltage terminations.

25.7.9 Shielded Cable

Electrical continuity shall be maintained through a splice in shielded cable. All metallic cable sheaths shall be grounded to the best system ground available. The shield shall be grounded at each termination.

25.7.10 Splicing Materials

Splicing materials for joints and terminals, when kits are not available, shall be as follows:

25.7.10.1 Semiconducting Tape, equivalent to Scotch 13, shall be used to fill connector indents and irregularities over the conductor, connector, and the cable strand shielding. High-voltage rubber tape shall be used to insulate 5,000-volt joints. The tape shall be ozone resistant, self-fusing, and waterproof in accordance with ASTM D 1373. The tape may be either oil-base rubber or butyl rubber. High-voltage splices shall have an outer protective cover of vinyl tape equal to Scotch 33. High-voltage terminals shall have an outer protective cover of silicone rubber tape equal to Scotch 70 to resist cracking and corona cutting.

25.7.10.2 Shielding Braid shall be tinned and woven copper tinsel, 3/4-inch wide. Braid shall be packaged dry.

25.7.10.3 Vinyl-Backed Electrical Tape, 3/4-inch wide, may be used for enclosed low-voltage splices and terminations. It shall also be used for the outer wrapping of high-voltage splices to form the splice jacket. The tape shall be Scotch 33 or shall conform to ASTM D 1000, with the following minimum characteristics:

Color	Black
Backing	Vinyl
Thickness, Mils	7
Breaking Strength, lb./in. width	20
Elongation, minimum percent	175
Adhesion to packing, oz./in. width	24
Adhesion to steel, oz./in. width	25
Dielectric breakdown, minimum volts	9,500
Insulation resistance, minimum megohms	0.2 total
Electrolytic corrosion	1.0

25.7.10.4 Friction Tape, 3/4-inch wide, shall conform to the requirements of ASTM D 69. The tape shall be used where a binder is required and to provide mechanical protection at conduit entrances, duct end bells, and similar areas. In severe environments and when exposed to the weather, the tape shall be painted with a rubber-base or asphaltic paint, such as Scotchkote electrical coating, Okolite weatherproof paint, or GE "Glyptal."

25.7.11 Resin Terminations

Resin terminations shall be a free-flowing epoxy type, using preformed conducting stress cones; or clear, longitudinally split tongue-and-groove molds in conjunction with rain shields in weather-exposed or in highly conductive contaminated atmospheres; or mold extension tubes in weather-protected or low-conductive contaminated atmospheres. The cable shielding shall be grounded by connections provided through the mold. Terminations shall be properly assembled to prepared cable and filled with resin, all as recommended by the termination manufacturer.

25.7.12 Aluminum to Copper Connections

Aluminum to copper connections shall be avoided wherever possible. When necessary in connecting to existing cable, UL listed aluminum to copper fittings shall be used, and shall be submitted to the COR for approval before installation. For Y or T splicing aluminum to copper conductor, a copper stud shall be straight spliced to the aluminum utilizing a "terminal adapter," which has a spring-like serrated copper sleeve prefilled with Penetrox "A" oxide inhibitor paste, or approved equal.

25.7.13 Cable Connectors and Lugs

Cable connectors and lugs shall be mechanically and electrically secure with smooth surfaces to make taping easy. They shall be compact, but able to maintain cool low-resistance joints under load cycling. Conductors shall be thoroughly cleaned and treated before connection.

25.7.13.1 Sleeves

Compression sleeves for aluminum splices and terminals shall be the type which are filled with corrosion inhibiting paste by the manufacturer of the sleeves.

25.7.13.2 Split-Bolt Connectors shall not be used with taped joints of cable above 600 volts. Application is acceptable at low voltage for copper conductors only.

25.7.13.3 Taped Mechanical Splices will be acceptable only for cable 600 volts and below.

25.7.13.4 Mechanical Connectors with molded insulating covers are suitable for taping cable buses 600 volts and below in large boxes and gutters.

25.7.13.5 For Low-Voltage Conductors and smaller wire nuts, and spring connectors, such as Scotchlok Type L, are acceptable for splicing in junction boxes.

25.7.13.6 Aluminum Conductor Terminals shall not be made with "universal-type" lugs unless UL listed and approved by the COR. High-strength aluminum lugs and bolts shall be used. Connections shall be liberally coated with corrosion-inhibiting paste.

25.7.13.7 Irregular Shapes and small depressions in compression-type connectors used for high-voltage cable shall be carefully filled to completely eliminate voids. Good adhesion of the tape shall be assured by buffing the cable insulation and the jacket with a nonconducting abrasive cloth or paper such as flint or garnet, No. 150 grade. All surfaces shall be thoroughly cleaned with a solvent and metallic surfaces shall be made tacky for taping by an application of Okonite 92-60, or equal, rubber cement.

25.8 DIRECT BURIED CABLES

25.8.1 Depth of Burial

Depth of burial shall be in accordance with the NEC or ANSI-C2 unless otherwise indicated on the drawings.

25.8.2 Method of Laying Cables

Cables shall be placed in a single horizontal layer with conductors and neutrals of the same circuit grouped together.

A minimum spacing of 4 inches shall be maintained between circuits of the same voltage. High- and low-voltage cables shall be laid on opposite sides of the trench with a minimum horizontal spacing of 12 inches.

25.8.3 Cable Crossings and Separations

Crossing of high- and low-voltage cables and crossings of power and communication or signal cables shall have a vertical separation of not less than 12 inches. A wooden plank, redwood or treated hardwood, 2 inches by 10 inches by 4 feet long or an equivalent concrete slab shall be placed over the upper cable at each crossing point. The crossing of cables shall be avoided to the greatest extent possible. Cables shall be laid in the trench in a manner that will provide easy identification of each circuit when the trench is reopened for cable repair or modification. Power cables shall, in general, be separated from parallel runs of communication and signal cables by at least 3 feet; crossings shall be made at as nearly right angles as possible.

25.8.4 Cable Runs

Under hard surface roads, taxiway crossings, and within 5 feet of structures, roads, and at all other locations where the cable may be subjected

to damage shall be installed in rigid conduit or protected with 2-inch concrete. Conduit sections shall be kept as short as possible for better cooling of the cable, but shall extend at least 5 feet beyond each side of the roadway or structure.

25.8.5 Installation of Buried Cables

Installation of buried cables shall be by unreeling in place along the side of or in the trench. The cables shall be carefully placed on the bottom. Dragging of cables into the trench from a fixed reel position will not be permitted, except to pull cables into conduits, ducts, and buildings. If the cables must be pulled, they shall be supported by lagging, trays, and cable rollers sufficient to assure no damage will occur to jackets, insulation, or conductors. Lay cables loose in trench to allow for contraction and earth movement. The radius of bends in cables shall be not less than 10 times the diameter of the cable. In no case shall cables be left under longitudinal tension. The first 3-inch layer of backfill shall be of sand or stone-free earth (1/16-inch diameter maximum grain size). A 1-inch redwood plank, not less than 6 inches wide; or concrete slab; or approved equal protection shall be placed over 4 inches of bedding above the cable as directed by the COR. Where cuts are made in paving, the paving and subbase shall be restored to original condition or as directed by the COR. Direct burial cable shall be centered in an entrance to a conduit or duct line. An approved waterproof, nonhardening, mastic compound shall be used to facilitate the centering. Buried cable splices shall be in accordance with Paragraph 25.13 of these specifications.

25.9 TRENCHING

25.9.1 Trenches

Trenches shall be excavated without sharp changes in direction or grade. Cables shall not be installed in trenches containing other utilities. Excavation, trenching, and backfilling shall be in accordance with Section 1 of these specifications, except as required herein, for electrical systems.

Trenches shall be of adequate width for installation of cables, conduit, and/or ducts as specified or required. Trench depths shall be sufficient to provide for placement of bedding material for direct buried cables and ducts.

25.9.2 Trench Bottoms for Ducts

Trench bottoms for ducts shall be graded to provide uniform bearing and support for each spacer, with the ducts on a constant grade or slope. Except where rock is encountered, care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the material shall be excavated to a minimum of 4 inches below the specified trench depth. Overdepths in rock excavation shall be backfilled with loose, granular, moist soil and shall be thoroughly tamped and brought

to the proper elevation. Wherever wet or other unstable soil is encountered, such material shall be removed to the depth determined by the COR. The trench shall then be backfilled to the proper grade, as specified above for rock.

25.9.3 Backfilling of Trenches

No backfill shall be placed until installation of the ducts or direct burial cables has been completed, inspected, and approved by the COR. Cable trenches shall then be backfilled and compacted as specified under Section 1. Backfill for direct burial cables shall be as described in Paragraph 25.8.5.

25.9.4 Pavement

Pavement which has been cut shall be restored to at least its original condition. The subgrade, base, and surface courses shall match the existing in materials, compaction, and thickness.

25.9.5 Pull Boxes

Pull boxes for duct runs shall be installed as indicated on the drawings. Pull Boxes shall be precast or poured-in-place concrete and complete with all appurtenant equipment as indicated on the drawings.

25.10 UNDERGROUND CONDUIT AND DUCTS

25.10.1 Conduit

Conduits for underground installation shall be as indicated in Paragraph 23.8.1.

25.10.2 Conduit Systems

Conduit systems shall be installed in accordance with Articles 345, (except 3/4-inch minimum) and 347, of the National Electrical Code. Raceways shall be kept a minimum of 6 inches away from parallel runs of steam or hot water piping. 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. Clogged raceways shall be entirely freed of obstructions or shall be replaced. Raceways shall be pitched towards manholes or handholes. Bushings shall be installed on the ends of all exposed conduits. Fittings installed in concrete shall be concrete tight, and where installed in wet locations or exposed to weather, fittings shall be watertight.

25.10.3 Ducts

Ducts for installation in underground systems shall be with concrete encasement or Type II (heavy-wall) PVC or wrapped rigid metal conduit as described in Section 23.7 for installation without concrete encasement,

as indicated on the drawings. Ducts shall be provided with tapered sleeve joints and waterproofed with sealing compound. Tapers which are chipped or broken during installation shall be removed and retapered. Ducts shall be installed so that they drain into pull boxes or pits, with a slope of at least 4 inches in 100 feet. Particular care shall be taken to maintain the interior of ducts clean and dry during installation.

25.10.3.1 Concrete Encasement. Duct spacers shall be plastic or other suitable nonmetallic, nondecaying material and shall have a spacing of 2 inches. Spacers for duct tiers shall be staggered longitudinally at least 6 inches to prevent weakened planes in the concrete. Ducts shall be securely anchored to prevent movement during placement of concrete. Care shall be taken during placement and compaction of concrete to preclude damage to the ducts. A red dye shall be added to the concrete used for high-voltage ducts.

25.10.3.2 Coarse Aggregate used in the concrete mix shall be 1/2 inch maximum. Slump shall not exceed 6 inches. The concrete shall develop a minimum compressive strength of 3,000 psi at 28 days.

25.10.3.3 Duct Banks comprising Type II single conduits shall be buried directly in the earth. The width of the trench shall be approximately the width of the duct bank plus 6 inches, with depth of cover over the top of the duct bank not less than 24 inches.

25.11.3 Conduit Enclosing Heavy-Loaded Cables

Conduit enclosing heavy-loading cables shall be on the outside row of conduit banks wherever possible. High-voltage riser conduits shall be spaced on a minimum of 15 inches from low-voltage riser conduits.

25.11.4 Conduit Risers

Conduit risers shall be securely mounted and provided with structural supports, as shown on the drawings, to assure stability under ground-shock conditions.

25.11.5 High-Voltage Transitions

High-voltage transitions from conduit to open cabling shall be made with approved terminators. Condulets and weather heads shall not be used for high-voltage cable.

25.11.6 Junction, Termination, Pull, and Splice Boxes

Junction, termination, pull, and splice boxes shall be arranged to permit work on the cables without exceeding the specified bending radii. They shall conform to the minimum size and locations as required by the National Electrical Code or as indicated on the drawings. Pull boxes, condulets, and outlet boxes exposed to the weather shall be weatherproof types with threaded raintight hubs and gasketed screw-fastened covers. Boxes and enclosures not designated by the manufacturer approved as

raintight or weatherproof shall be protected from snow and direct rain with a field-fabricated sloping roof or cover.

25.11.7 Interior of Conduit and Ducts

Interior of conduit and ducts shall be clean and dry before pulling in wire and cable.

25.12 INSTALLATION OF CABLE IN CONDUIT

25.12.1 Cable

Cable shall be installed in such a manner that will preclude damage. No kinks shall be permitted. Jackets of high-voltage cables shall be thoroughly cleaned of oil and grease before installation.

25.12.2 Petroleum Grease

Petroleum grease or other injurious lubricants shall not be used in pulling cables. For low-voltage and shielded high-voltage cables only, the cable jackets or the conduit may be lubricated with approved pulling compounds listed by the Underwriters' Laboratories, Inc.

25.12.3 Lashings

Lashings used for temporary bunching of wires shall be removed before they enter the conduit or duct. Cables shall be fed straight into the conduit by hand or over a large diameter sheave to avoid sharp bends, sharp edges, and crossovers. Duct mouth shall be protected with wire guides, cable feeders, skids and sheaves, or similar tools.

25.12.4 Tensions in Cable

Tensions in cable during pulling operations shall not exceed the maximum pulling tension as recommended by the cable manufacturer and/or the IPCEA when using pulling eye formed in each conductor or maximum tension with using woven wire grip. If the duct run includes a bend, the cable shall be fed into the end with the bend.

25.12.5 Support of Cables

Support of cables in underground pits and pull boxes shall be adequate to avoid weight and strain at the duct or conduit opening. Cables shall also be reasonably accessible with clear working spaces. Where wear may occur to exposed cables, such as rubbing on supports or duct end bells, they shall be protected with wrappings of friction tape painted with a protective coating of GE "Glyptal" or other electrical insulating paint, or they shall be wrapped with vinyl tape such as Scotch 33.

25.12.6 Circuit Segregation

Circuit segregation in underground pits and pull boxes shall provide for location of different voltage classes on opposite sides of the pit. Power cables shall not be installed in the same pull box or cable pit with communications and signal cables. High-voltage cables in manholes and pits shall be fireproofed.

25.13 MANHOLES AND JUNCTION BOXES

Manholes and junction boxes shall be provided where indicated and shall be of size and shape shown on the drawings. Manholes shall be composed of reinforced concrete. Walls and bottom shall be of monolithic construction. Concrete shall be Class B or 3,000 psi at 28 days. Concrete, forms, mixing, pouring, and reinforcing bars shall conform to Section No. 2. The Constructor may, at his option, submit precast-concrete manholes having the required strength and inside dimensions to the COR for approval. Frames and covers shall be made of gray cast iron, and together shall form a watertight joint. In paved areas, the top of manhole covers shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 1/2 inch above finished grade. Junction boxes and covers shall be watertight and shall be made of cast iron with zinc-coated or aluminized finish. A suitable gasket shall be installed between the box and cover. A sufficient number of cover screws shall be installed to hold the cover firmly in place along its entire contact surface. Unless otherwise indicated, the minimum inside dimensions of these boxes shall be 12 inches square and 6 inches deep.

25.14 MARKING AND IDENTIFICATION

25.14.1 Cable Runs

Cable runs shall be clearly and permanently located by standard markers above the surface as shown on Figures 1 and 2. Markers shall be provided and installed by the Constructor. Spacing of surface markers shall be as shown on the plans and as directed by the COR. In open areas, the spacing shall be a maximum of 300 feet, but in areas where buildings and roads exist, the spacing shall be sufficiently close to clearly mark the cable route.

25.14.2 Markers

Markers shall face the cable on alternate sides of the trench edge. They shall indicate the cable terminations (not intermediate handholes or manholes) and each change of direction. Additional markers shall be installed to indicate existing runs when new construction is planned for the area.

25.14.3 Removal of Markers

Removal of markers to clear the surface for additional construction shall not begin until the circuit has been rerouted in accordance with construction drawings and specifications, or so directed by the COR.

25.14.4 Circuit Identification

Circuit identification shall be included on the surface markers using stamped metal labels affixed to signs with screws or bolts. Each circuit shall be identified at terminations, cable pits, and pull and splice boxes by permanent nonferrous metal tags.

25.14.5 Phase Identification

25.14.5.1 High-Voltage Conductors shall be identified at terminals by position. Phases A, B, and C shall be from left to right, from top to bottom, or front to back when the terminals are viewed from the front or normal position.

25.14.5.2 Low-Voltage Conductors shall be identified at terminals by position in the same sequence as above. In addition, phase and voltage shall be identified with colored tape or paint according to the following schedule.

<u>VOLTAGE</u>			<u>PHASE</u>			
			<u>A</u>	<u>B</u>	<u>C</u>	<u>N</u>
208	3-Ø,	3-wire	Black	Red	Blue	-
120/208	3-Ø,	4-wire	Black	Red	Blue	White
120/240	3-Ø,	4-wire	Black	Orange	Blue	White
120/240	1-Ø,	3-wire	Black	Red	-	White
277/480	3-Ø,	4-wire	Brown	Yellow	Purple	White
480	3-Ø,	3-wire	Brown	Yellow	Purple	-

25.15 GROUNDING

Grounding shall conform to applicable requirements in the National Electrical Code, the National Electrical Safety Code, and to requirements herein. Neutral conductors, cable shields, metallic cable sheaths and armor, metallic conduits, pothead bodies, junction boxes lightning arresters, fence enclosures, and all noncurrent-carrying metallic parts of equipment, shall be grounded. Ground rods shall be made of copper, or copper-clad steel, not less than 3/4 inch by 10 feet long.

25.15.1 Manhole Grounding

Ground rods installed for the electrical distribution system manholes shall be properly connected to neutral conductors and metallic cable sheaths and armor by means of No. 4 AWG tinned stranded copper cable or equivalent tinned braided copper conductor. Connection to ground rod shall be by means of bolted-clamp terminals or approved exothermic weld process. The ground wire shall be neatly and firmly attached to the manhole walls.

25.15.2 Connections Between Aerial and Underground Systems

Where the system changes from aerial to underground, the underground cable shall be extended up the pole in rigid or heavy wall PVC conduit to the crossarm and shall terminate in single-conductor capnut-type outdoor potheads, resin terminations, or positive-pressure-type terminations as indicated. Spreader head or resin-pressure terminations shall be used on multiple-conductor cable. Where spreader head is used with shielded cable, the shielding shall be continuous through the spreader head and lead tubes to the single-conductor terminations. On systems operating at 5,000 volts or less between phases, the Constructor may, at his option, utilize multiple-conductor potheads for terminating multiple-conductor cable, provided the pothead terminals and connections between the pothead and line conductors are so insulated or located that they will not create a hazard to linemen working on the pole.

25.16 ACCEPTANCE TESTS

25.16.1 Operating Test

After the installation has been completed, and at such time as the COR may direct, the Constructor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this section of the specifications. The test shall be performed in the presence of the COR.

25.16.2 Ground Resistance Measurements

Ground resistance measurements of each ground rod shall be taken and certified by the Constructor to the COR. The triangulation method for ground testing shall be used. The Constructor shall submit in writing to the COR upon completion of the project, the measured ground resistance of each ground rod and grounding system, indicating the location of the rod and grounding system, as well as the resistance and soil conditions at the time the measurements were made. When the building water service is used as a ground or part of the grounding system, ground-resistance measurements shall also be made of this connection in normally dry weather, not less than (24) hours after rainfall or as directed by the COR. The ground under test shall be isolated from other grounds.

25.16.3 Primary Cable Tests

After installation, and before the operating test specified hereinbefore, the primary cable system shall be given a high potential test by applying alternating or direct current voltage between each conductor of the system as one terminal and the other terminal consisting of the ground and the metallic (shielding) (sheath) of the cable connected together. Prior to making the test, the cables shall be isolated by opening applicable switches or cutouts and/or disconnecting equipment. The method, voltage, length of time, and other characteristics of the test shall be in accordance with the Insulated Power Cable Engineers' Association Publication No. S-19-81 for the particular type of cable installed. Should any cable fail during these tests due to a weak spot in the conductor insulation or due to defects or injuries incidental to the installation, improper installation, splicing, terminations, or connections, the Constructor shall make the necessary repairs or replace the cable as directed by the COR.

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SECTION 26

LIGHTNING PROTECTION SYSTEMS

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SECTION 26

LIGHTNING PROTECTION SYSTEMS

26.1 GENERAL

This standard specification covers the engineering design of lightning protection systems, their components and installation. It is intended to provide a basic guide for recurring electrical design and installation problems and to inform engineers, designers, inspectors, and constructors of minimum standards for this protection system. These specifications generally cover greater areas than are required for specific projects, therefore, only the applicable sections shall be considered.

26.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

26.2.1 National Electrical Safety Code (ANSI-C2)

C2-American National Standards Institute

26.2.2 National Fire Protection Association Standards (NFPA)

78, Lightning Protection Code

26.2.3 Underwriters' Laboratories, Inc., (UL)

26.3 GENERAL REQUIREMENTS

The drawings shall indicate the buildings and structures to be protected and the general arrangement of the lightning protection systems. Such structures shall have either electrically continuous or completely shielded protection as shown, or as specified for protection of an existing building or structure. Each installation shall comply with the requirements and recommendations of the NFPA Lightning Protection Code.

26.3.1 Standard Products, U. L. Listed

The system furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest approved design. The Constructor shall submit proof when requested by the Contracting Officer's Representative (COR) that the items furnished under this specification conform to such requirements. The Underwriters' Laboratories, Inc., label or seal, or listing in the Equipment List may not necessarily meet all job requirements and may not be acceptable.

26.3.2 Workmanship (same as 25.5)

26.4 MATERIALS

Only those materials or items so noted on the electrical construction drawings shall require approval before installation. The Constructor

shall submit shop drawings or clearly marked catalog data, prior to procurement, to the COR. The COR will retain three (3) copies of each drawing, catalog cut, or other descriptive material submitted and return the remainder of the copies to the Constructor.

26.4.1 Preliminary Material

Preliminary material, such as descriptive literature or catalog data received by the Constructor from proposing vendors, need not be submitted unless the Constructor requires an engineering evaluation to determine that the proposed vendor will meet specified standards of quality. In such case, the Constructor shall require the proposing vendor to identify completely the items he proposes to furnish in the event he is awarded a purchase order. This will allow an engineering evaluation to be made expeditiously.

26.4.2 Each Submittal

Each submittal shall contain identification for each separable piece of material or equipment literature with respect to job title, procurement authorization, drawing number, and work order number under which the item is to be furnished.

26.4.3 Conductors

Conductors shall consist of any of the following materials:

26.4.4.1 Copper shall be of the grade ordinarily required for commercial electrical work generally designated as being 98 percent conductive when annealed. If the conductor is of copper cable and for installations of other than nonmetallic stacks, the weight shall be not less than 187.5 pounds per thousand feet and the size of any wire of this cable shall be not less than No. 17 AWG (0.045 inch). Copper tube or solid section conductors of copper shall weigh not less than 187.5 pounds per thousand feet and any tube wall shall be not less than No. 20 AWG (0.032 inch). The thickness of any copper ribbon or strip shall be not less than No. 16 AWG (0.051 inch).

26.4.4.2 Copper-Clad Steel shall have a copper covering permanently and effectively welded to the steel core, and the conductance is not less than 30 percent of the conductance of an equivalent cross section of solid copper. The diameter of such solid wire or stranded cable shall be not less than 3/8 inch and the weight shall be not less than 187.5 pounds per thousand feet. The size of wires in stranded cable shall be not less than No. 14 AWG (0.064 inch).

26.4.5 Air Terminals

Air terminals shall be in accordance with the NFPA No. 78, Terminals shall extend not less than 10 inches above the object to be protected, or as indicated on the drawings. Terminals shall be tapered to a point and shall be, as a minimum, of equivalent weight and stiffness to a

copper tube of 5/8-inch OD and No. 20 AWG wall thickness. Air terminals over 48 inches in height shall be supported by a suitable brace.

26.4.6 Ground Rods

Ground rods shall be made of copper or copper-clad steel and shall be not less than 3/4 inch in diameter and 10 feet in length.

26.5 INSTALLATION OF THE LIGHTNING PROTECTION SYSTEM.

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

26.5.1 Air Terminals

Air terminals shall be at least 18 inches for 20-foot spacing, and, under certain conditions, higher as hereinafter specified. On open or hooded vents emitting explosive dusts or vapors under natural or forced draft, air terminals shall extend not less than 5 feet above the opening. 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. Metal projections and metal parts of inert buildings, smokestacks, and other metal objects that do not emit explosive dusts, vapors, gases, and that may be struck but not appreciably damaged by lightning, need not be provided with air terminals, but these objects shall be securely bonded to the lightning conductor through a metal conductor of the same unit weight per length as the main conductor. The air terminals at the ends, corners, and edges of the structures shall be set not more than 2 feet from the edge of the structure. The spacing of air terminals 2 feet in height 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. On large, flat, or gently sloping roofs, air terminals shall be placed at points of the intersection of imaginary lines dividing the surface into rectangles having sides not exceeding 50 feet in length. All air terminals shall be provided with at least two paths to ground. Where metal ventilators are installed, air terminals shall be mounted thereon. Any air terminal erected by necessity to one side of metal ventilator shall be bonded to the ventilator near the top and bottom thereof. Where nonmetallic spires or ventilators are present, air terminals may be mounted thereon or to the side, and direct connection shall be made between the air terminal and roof cable or ground.

26.5.2 Roof Conductors

Roof conductors may be connected directly to the roof or ridge roll. Sharp bends or turns in conductors shall be avoided. Necessary turns and taps shall have a radius of not less than 8 inches. Conductors

shall preserve a downward or horizontal course. Cables shall be securely fastened every 4 feet along the roof and down the building ground. Metal ventilators shall be securely connected to the ridge cable. All connections shall be electrical continuous. Roof connections 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. Roof conductors surrounding decks, flat surfaces, and flat roofs shall be connected to form a closed loop.

26.5.3 Down Conductors

Down conductors shall be electrically continuous from air terminals to ground connections. Down conductors shall be preferably be coursed over extreme outer portions of the building, such as corners, due consideration being given to the best places for making ground connections and the location of air terminals. Bends shall not exceed 90 degrees or have a radius of less than 8 inches. Every building or structure shall have not less than two down conductors as widely separated as practicable, preferably at diagonally opposite corners. On rectangular structures having gable, hip, or gambrel roofs, more than 110 feet long, there shall be at least one additional down conductor for each additional 50 feet of length or fraction thereof. On rectangular structures having French, flat, or sawtooth roofs exceeding 300 feet in perimeter, there shall be at least one additional down conductor for each 100 feet of perimeter or fraction thereof. On an ell- or tee-shaped structure, there shall be at least one additional down conductor; on an H-shaped structure, at least two additional down conductors; and on a wing-built structure, at least one additional down conductor for each wing. On irregularly shaped structures, the total number of down conductors shall be sufficient to make the average distance between them along the perimeter not greater than 100 feet. On structures exceeding 50 feet in height, there shall be at least one additional down conductor for each additional 60 feet of height or fraction thereof, except that this application will not cause down conductors to be placed about the perimeter of the structure at intervals of less than 50 feet. Additional down conductors shall be installed when necessary to avoid "dead-end" branch conductors. 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.

26.5.4 Ground Connections

Ground connections comprising continuations of down conductors from the structure to the grounding electrode shall be securely connected to the down conductors and ground in a manner to ensure electrical continuity between the two. There shall be a ground connection for each down conductor, preference being given to metal water pipes and other large underground metallic objects. 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 than contains chemical substances, especially those corrosive to metal.

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SECTION 28

WATERLINES

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SECTION 28

WATERLINES

28.1 GENERAL.

This section covers the requirements for the furnishing of all materials, labor, and equipment for the installation of all waterlines shown and noted on the drawings and specified, from a point 5 feet outside of the building.

28.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

28.2.1 American Society for Testing and Materials (ASTM):

A 47	Malleable Iron Castings
A 48	Gray Iron Castings
A 53	Welded and Seamless Steel Pipe
A 120	Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses
A 126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
B 32	Solder Metal
B 42	Seamless Copper Pipe, Standard Sizes
B 43	Seamless Red Brass Pipe, Standard Sizes
B 68	Seamless Copper Tube, Bright Annealed
B 75	Seamless Copper Tube
B 88	Seamless Copper Water Tube
B 135	Seamless Brass Tube
B 370	Copper Sheet and Strip for Building Construction
C 4	Clay Drain Tile
C-296	Asbestos-Cement Pressure Pipe
C 547	Mineral Fiber Preformed Pipe Insulation

- C 592 Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal Mesh Covered) (Industrial Type)
- D 1785 Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- D 2241 Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR and Class T)
- D 2464 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- D 2466 Socket-type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
- D 2467 Socket-type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- D 2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- D 2774 Underground Installation of Thermoplastic Pressure Piping Rec. Practic for.
- D 3036 Poly (Vinyl Chloride) (PVC) Plastic Line Couplings, Socket-Type

28.2.2 American Water Works Association (AWWA):

- C 100 Cast-Iron Pressure Fittings
- C 201 Fabricated Electrically Welded Steel Water Pipe
- C 202 Mill-Type Steel Water Pipe
- C 203 Coal-Tar Enamel Protective Coatings for Steel Water Pipe
- C 207 Standard for Steel Pipe Flanges
- C 400 Standard for Asbestos - Cement Water Pipe
- C 500 Gate Valves 3-inch through 48-inch for Water and Other Liquids
- C 601 Standard for Disinfecting Water Mains

28.2.3 International Conference of Building Officials:

Uniform Building Code (UBC)

28.2.4 Factory Mutual Engineering Corporation (FM):

Approval Guide

28.2.5 National Fire Protection Association (NFPA):

24 Outside Fire Protection

28.2.6 Underwriters' Laboratories, Inc. (UL):

Building Materials Directory

Fire Protection Equipment List

28.2.7 American National Standards Institute (ANSI):

A 21.4 Cement Mortar Lining for Cast-Iron and Ductile Iron Pipe and Fittings for Water

A 21.6 Cast-Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids

A 21.8 Cast-Iron Pipe Centrifugally Cast in Sand-Lined Molds, for Water or Other Liquids

A 21.11 Rubber-Gasket Joints for Cast-Iron and Ductile Iron Pressure Pipe and Fittings

B2.1 Pipe Threads (Except Dryseal)

B16.5 Steel Pipe Flanges and Flanged Valves and Fittings

B16.21 Nonmetallic Gaskets for Pipe Flanges

B16.23 Cast Bronze Solder Joint Drainage Fittings-DWV

B36.10 Welded and Seamless Wrought Steel Pipe

28.2.8 National Sanitation Foundation (NSF):

Standard No. 14 and 15

28.2.9 Occupational Safety and Health Administration (OSHA):

Title 29 1910.93a Asbestos

28.3 GENERAL REQUIREMENTS FOR MAINS AND BUILDING SERVICE CONNECTIONS.

Piping for water mains and building service connections shall be zinc-coated steel, copper, PVC, cast-iron, asbestos cement, or concrete-lined steel. PVC, or asbestos cement pipe must be run within a metal or concrete casing when installed under slabs, load-bearing walls, or through footings. Cast iron, asbestos cement, and concrete-lined steel shall be limited to piping sizes 3 inches and larger.

REQUIREMENTS FOR WATER MAINS 4 INCHES AND LARGER SHALL CONFORM TO NFPA STANDARD 24 AND SECTION 42 "FIRE PROTECTION SYSTEM - WATER".

PVC may not be used for fire protection service. Special requirements for installation of Process OR HVAC lines shall be detailed on the drawings. The pipe and accessories shall be new and unused unless otherwise approved by the Contracting Officer's Representative (COR). The interior of the pipe shall be thoroughly cleaned of foreign matter before being lowered into the trench, and shall be kept clean during laying operations by plugging or other approved method. The full length of each section of pipe shall rest solidly upon the pipe bed, with recesses excavated to accommodate bells and joints. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid. Pipe shall not be laid in water, on frozen trench bottom, or when trench or weather conditions are unsuitable for the work. Water shall be kept out of the trench until the material in the joints has hardened, or until calking is completed. When work is not in progress, open ends of pipe and fittings shall be securely closed so that no trench water, earth, or other substance will enter the pipes or fittings. Sections of pipe found to be defective before or after laying shall be replaced with sound pipe. Where the location of the water pipe is not clearly defined by dimensions on the drawings, the water pipe shall not be laid closer horizontally than 10 feet from a sewer pipe except where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, in which case the water pipe shall not be laid closer horizontally than 6 feet from the sewer pipe. Where water-lines cross under gravity sewer lines, the sewer pipe shall be constructed of pressure pipe, for a distance of 10 feet each side of the crossing, with no joint located within 3 feet of the crossing or shall be fully encased in concrete. The thickness of concrete around the pipe, including concrete at pipe joints, shall be not less than 4 inches. Where sewage force mains or inverted siphons cross water mains, the water mains shall in all cases be installed at least 2 feet above the sewer mains. Fittings at bends in the pipeline shall be provided with thrust blocks of adequate sizes to prevent the fittings from being blown off the lines when under pressure. Pipe ends left for future connections shall be valved, plugged or capped, and anchored, as shown on the drawings. Where connections are made between new work and existing mains, the connections shall be made by using specials and fittings to suit the actual conditions as shown on the drawings. Excavation, Trenching, and Backfilling is specified in Section 1.

28.4 CAST-IRON PIPE.

28.4.1 Material:

28.4.1.1 Cast-Iron Pipe and Fittings shall be cement lined and shall conform to ANSI A21.6 or A21.8, working pressure as indicated on the drawings.

28.4.1.2 Cast-Iron Specials and Fittings. Specials and fittings shall be Class D, conforming to AWWA C100 or ANSI A21.11. Tapping tees for connection to existing main shall be either the Compression "O" Ring Type or the Split-Sleeve Type as hereinafter described. The tees shall be

lined and coated with coal-tar enamel and construction shall be suitable for maximum working pressure indicated on the drawings. Tapping tees shall be the standard product of a reputable manufacturer regularly engaged in the production of cast-iron pipe fittings. Compression "O" ring type shall have flange at the outlet, with sleeve, clamping shoe, rubber "O" ring seal, and noncorrosive clamping bolts. Split-sleeve type shall have flange at the outlet, with bolts, nuts, follower rings, gaskets at each end of the sleeve and longitudinal gaskets as recommended by the manufacturer. Mechanical joints and gaskets shall be duck-tipped rubber. Bolts shall have square heads and hexagonal nuts; flange nuts shall be tightened gradually and in a manner to avoid overstressing flanges.

28.4.1.3 Joints shall be of the type indicated. Jointing material shall conform to the following requirements:

Calked Joints. Yarning or packing material shall consist of jute or other COR approved material. The materials shall be handled with care in order to prevent contamination and shall be dry when put into place in the joint. The material shall be free from oil, tar, or grease. Calking lead shall be standard commercial grade.

Mechanical Joints shall be of the stuffing-box type furnished with the pipe, and shall conform to ANSI A21.11.

Push-On Joint materials, including rubber ring gaskets, jute, and bituminous compound, shall be those furnished with the pipe.

28.4.1.4 Cement Lining. Pipe and fittings shall have cement lining conforming to ANSI A21.4.

28.4.2 Installation.

Pipe and accessories shall be handled in such manner as to ensure delivery to the trench in sound, undamaged condition. Particular care shall be taken not to injure the pipe coating. No other pipe or material of any kind shall be placed inside of a pipe or fitting after the coating has been applied. Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Cutting shall be done by means of an approved type of mechanical cutter. Wheel cutters shall be used when practicable. Before installation, the pipe shall be inspected for defects and tapped with a light hammer to detect cracks.

Defective, damaged, or unsound pipe will be rejected. Deflections from a straight line or grade, as required by vertical curves, horizontal curves, or offsets, shall neither exceed 6/D inches per linear foot of pipe for pipe less than 14 inches in nominal diameter, nor 4.5/D inches per linear foot of pipe for 14 inches and larger in diameter, where D represents the nominal diameter of the pipe expressed in inches between the extended center lines of any two connecting pipes. If the alignment requires deflections in excess of these limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to

provide angular deflections within the limit set forth. After a length of pipe is placed in the trench, the packing material for the joint shall be held around the bottom of the spigot so that the packing will enter the bell as the pipe is pushed into position, or a rubber gasket may be inserted in the bell before pushing the pipe into place. The spigot shall be centered in the bell and the pipe pushed into position and brought into the required alignment. Except where necessary in making connections with other lines, pipe shall be laid with the bells facing in the direction of laying. Except at closures, not less than two lengths of pipe shall be in position ahead of each joint, and earth fill tamped alongside the pipe, before the joint is poured.

28.4.3 Joints.

28.4.3.1 Calked Joints.

Before jointing bell-and-spigot pipe with calked joints, all lumps, blisters, and excess coating material shall be removed from the bell-and-spigot ends of the pipes. All oil or grease shall be removed. The outside of the spigot and the inside of the bell shall be wire-brushed and wiped clean and dry. Joint packing shall be carefully placed and tightly calked to a uniform thickness. No loose or frayed ends of fiber shall protrude into the space to be filled with joint filler. Each joint shall be carefully inspected and checked for proper depth before the joint runner is attached.

28.4.3.2 Lead-Filled Joints.

The depth of lead in lead-filled joints shall be not less than 2 1/4 inches back of the face of the bell. Lead shall be heated in a melting pot kept near the joint to be poured, brought to proper temperature so that when stirred the surface will show a rapid change in color, and when poured into the joint space, will ensure a perfect joint. Before lead is poured, scum shall be removed. The joint runner shall fit snugly against the face of the bell and the outside of the pipe, and shall be dammed with clay at the pouring gate to assure filling the joint even with the top of the bell. Each joint shall be made with one pour completely filling the joint space. The calking shall be done by competent craftsmen, in such manner as to secure tight joints without overstraining the bells. The calking shall progress toward to joint gate. If the packing has been insufficiently calked, permitting the lead to be driven during calking to a depth more than 1/4 inch from the face of the bell at any point, the lead shall be removed and the joint remade.

28.4.3.3 Mechanical Joints shall be installed in accordance with the recommendations of the joint manufacturer.

28.4.3.4 Push-On Joints shall be made in accordance with the recommendations of the pipe manufacturer.

28.5 STEEL PIPE.

28.5.1 Material:

28.5.1.1 Steel Pipe 4 Inches and Larger shall be welded or shall be seamless with plain or slip-bell ends and, when indicated on the drawings, shall be lined with a coat of coal-tar primer and a coat of hot coal tar enamel. The pipe shall be coated with a coat of coal-tar primer, coat of hot coal-tar enamel, a wrapper of asbestos felt impregnated with coal-tar, and a wrapper of kraft paper or a coat of water-resistant whitewash. The lining, coating, and wrapping shall be applied in the order named and shall conform to AWWA C203 for materials, method of application, tests, and handling. The pipe may be wrapped with Tapecoat CT or approved equal as an alternate method of protection.

28.5.1.2 Steel Pipe Flanges shall conform to AWWA C207. The pipe shall conform to the AWWA C201 and C202. The wall thicknesses of the various sizes of pipe shall be not less than those indicated on the drawings. Primer and other coating materials for field use shall also conform to AWWA C203.

28.5.1.3 Steel Pipe Less than 4 Inches shall be schedule 40 zinccoated steel and shall have screw joints. Screw joints shall be made perfectly tight with a stiff mixture of graphite and oil, inert filler and oil, with an approved graphite compound (applied with a brush to the male threads only), or teflon tape. Steel pipe and fittings shall be thoroughly cleaned of foreign matter by wire-brushing and solvent-cleaning and, when indicated on the drawings, shall be given one coat of coaltar primer and two coats of coal-tar enamel. After installation and testing in final position, coatings, where damaged, shall be given a hot-applied touchup coat of enamel. An alternate method of protection is wrapping with Tapecoat CT or approved equal.

28.5.1.4 Specials and Fittings for pipe 4 inches and larger shall be of the same material and thickness as the pipe. Specials and fittings may be made of standard steel Tube Turns with ends to accommodate the type of couplings specified for the pipe. When indicated on the drawings, fittings shall be lined, coated, and wrapped as specified for the pipe. Specials and fittings that cannot be mechanically lined, coated, and wrapped shall be lined, coated, and wrapped by hand, using the same materials as are used for the pipe, with the same number of applications of each material carefully and smoothly applied. Specials and fittings for pipe less than 4 inches in diameter shall be galvanized malleable iron.

28.5.1.5 Couplings may be of the sleeve or split-sleeve type, and shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight settling and shifting in the ground, minor variations and trench gradients, and traffic vibrations.

28.5.1.5.1 Sleeve-type couplings shall be used on plain-end pipe. The couplings shall be properly gasketed and of a diameter to fit the pipe. Each coupling shall consist of one steel middle ring, two steel followers, two gaskets, and the necessary steel bolts and nuts to compress the gaskets.

28.5.1.5.2 Split-sleeve type couplings shall consist of one gasket and a housing in two or more sections and the necessary bolts to compress the gasket.

28.5.2 Installation.

While being shipped, delivered, stored, and installed, pipe and accessories shall be handled in a manner to ensure a sound undamaged condition. Particular care shall be taken not to injure the pipe coating. No other pipe or material or any kind shall be placed inside a pipe or fitting after the coating has been applied.

28.5.2.1 Field Coating. After assembly, the paper wrapper shall be stripped back a few inches at the joints, and the exposed pipe surface shall be reprimed with a small hand brush. When the primer is dry, coating material, as specified hereinbefore for steel pipe, shall be applied to provide a coating the approximate thickness of the original coating. Center rings, bolts, and follower rings of couplings shall be carefully cleaned and reprimed before assembling. The interior surface of the middle ring of each mechanical coupling, for a distance of approximately 1 inch on each side of, and over, the circumferential rib or pipe stop of the ring, shall receive a heavy brush coat of primer, as specified hereinbefore for steel pipe. When the pipes are in position in the coupling ring, the space between the pipe stop of the middle ring and the ends of the pipes shall be sealed, except where angular deflections occur and the pipe ends are not in contact with the pipe stop. The edges of pipe ends shall be coated with primer. The primer shall not be applied in such amount that it will run or sag into the pipe. The seal coat shall be applied when the couplings are installed. After the primer is dry on the coupling and pipe assembly, a heavy coat of hot enamel, as specified for the pipe, shall be applied by pouring and with the use of a sling. Exposed surfaces of pipe flanges, except surfaces that have been previously coated with enamel, shall receive a coating of primer after completion of the flanged connections. Flange bolts, except the threads, shall be coated with primer by dipping. The primer shall be dry when the bolts are installed. The threads of the bolts shall be coated immediately prior to installation of the nuts.

28.5.2.2 Repairs to Pipe Coating. Abrasions in the pipe coating or wrapping shall be repaired. The coating and wrapping shall be cut back to the point of undisturbed coating, and the upper wrapper pulled back from the edges of the damaged area. The surface of the pipe shall be cleaned and reprimed with primer specified hereinbefore for steel pipe. One coat of hot enamel shall be applied with a dauber to a piece of felt of adequate size, and, while the enamel is still hot, the enameled side of the felt shall be applied to the prime coat and "gloved" down smooth.

The entire repaired surface shall be covered with an outer coat of hot enamel, applied with a dauber or sling. Damaged lining at the ends of the pipe shall be filled in smoothly, to a depth equal to the original coating. The material for repairing the coating shall be of the same manufacture as the coating on the pipe. The material for repairing may be a coal-tar tape or coating approved by the COR.

28.5.2.3 Placing Pipe. Pipe shall be carried into position and not dragged. Pinch bars and tongs, for aligning or turning the pipe, shall be used only on the bare ends of the pipe. Care shall be taken to keep the paper wrapper intact and to avoid abrasion of the pipe coating. Belt slings or padded hooks or tongs shall be used for lowering pipe into the trench. Chains or wire rope shall not be used. Poles used as levers for removing skids across trenches shall be of wood, with broad flat faces, to prevent damage to the pipe coating. Pipes or steel bars shall not be used for this purpose. If belt slings are used for lowering the pipe, care shall be taken when the sling is withdrawn to avoid injury to the wrapping. The installation of couplings shall be made in accordance with the recommendations of the coupling manufacturer.

28.5.2.4 Connections to cast-iron pipe or gate valves shall be made with transition fittings. Calked joints shall be made in accordance with the applicable requirements hereinbefore for joints of cast-iron pipe.

28.6 ASBESTOS-CEMENT PIPE.

28.6.1 Material.

28.6.1.1 Pipe and Couplings shall conform to ASTM C 296 or AWWA C400 of the class shown on the drawings. Couplings with threaded inserts for service connections will be acceptable.

28.6.1.2 Specials and Fittings shall be cast-iron, as specified hereinbefore under cast-iron pipe, except that fittings shall have all bell connections of standard dimensions, or special dimensions as required, or shall be equipped with adapters of the proper class for the size of pipe, as recommended by the manufacturer.

28.6.1.3 Connections to Cast-Iron Fittings. Connections between asbestos-cement pipe and cast-iron fittings or gate valves shall be made with jointing materials as specified hereinbefore for cast-iron pipe or with other materials recommended by the pipe manufacturer.

28.6.2 Installation.

Pipe, couplings, and fittings shall be handled and installed in accordance with the recommendations of the pipe manufacturer. Cutting or sawing which might produce dust shall be done in strict compliance with OSHA regulations.

28.7 COPPER TUBING AND FITTINGS.

28.7.1 Copper Tubing and Fittings.

Piping above ground shall be Type L; piping underground shall be Type K. Fittings shall be cast-brass or wrought-copper suitable for sweat or brazed connections for use with hard-drawn tubing, and flared-pattern for annealed tubing.

28.7.2 Flared or Sweated Tubing.

Flared or sweated tubing shall be cut square, and burrs shall be removed. Both inside of fittings and outside of tubing shall be well cleaned with steel wool before sweating. Care shall be taken to prevent annealing of fittings and hard-drawn tubing when making connections. Installation shall be made by competent workmen in accordance with manufacturer's recommendations. Mitering of joints for elbows and notching of straight runs of pipe for tees will not be permitted. Joints for soldered fittings shall be made with a noncorrosive paste flux and 50-50 for cold water, 95-5 for hot water solid string or wire solder. Cored solder will not be permitted. Joints for flared-type fittings shall be of a compression pattern. Joints in copper pipe and tubing 2 1/2 inches in diameter and larger shall be made with heat applied uniformly around the entire circumference of the pipe and fittings by a multiflame circular torch.

28.8 PLASTIC PIPE.

28.8.1 Material.

28.8.1.1 PVC Pipe used for water service shall be schedule 40 conforming to ASTM D1785. Where threaded joints are used PVC Pipe must be schedule 80.

28.8.1.2 PVC Specials and Fittings shall conform to ASTM D2466 for socket type fittings, ASTM D3036 for socket type couplings, and ASTM D2464 for threaded fittings.

28.8.1.3 PVC Joints shall be solvent welded or fusion welded for socket type joints. Screwed joints may be used for schedule 80 pipe.

28.8.1.4 PVC Solvent Cements shall conform to ASTM D2564 and the manufacturer instructions followed for application.

28.8.2 General Installation.

28.8.2.1 Pipe and Accessories shall be handled in such a manner as to ensure delivery to the trench in sound, undamaged condition. Particular care shall be taken to prevent contact of pipe with sharp objects which might scrape or gouge surface.

28.8.2.2 Pipe may be Cut by sawing or by use of cutter with special wheels for plastic pipe. Extreme care shall be taken to assure square

pipe cuts. Pipe may be deflected to the maximum radius recommended by the manufacturer. Where changes in direction cannot be made with deflection, elbow-type fittings shall be used. Miter joints will not be permitted.

28.8.2.3 Backfilling shall be done in accordance with Section 1.

28.8.2.4 When Long Sections of Piping that have been assembled alongside the ditch are lowered in, care shall be taken to avoid strains which would overstress or buckle pipe.

28.8.2.5 An Electrically Conductive Wire shall be installed with the piping to facilitate locating by goldaking.

28.8.2.6 Direct Burial of Pipe shall be in accordance with ASTM D2774.

28.8.2.7 Where Concrete Thrust Blocks are used, plastic pipe is to be wrapped to prevent direct contact between concrete and plastic.

28.8.2.8 Belt Slings or Padded Hooks or tongs shall be used to lower pipe in trench. Chains or wire ropes shall not be used.

28.9 THRUST BLOCKING.

28.9.1 After the pipe is laid in the trench, concrete thrust blocking shall be provided as shown on the drawings, in general at bends, valves, and tees, and shall be of the size and shape shown thereon. Watermains used to supply outside fire protection shall be thrust blocked to the requirements of NFPA 24.

- A. Thrust Blocking shall be of concrete mix not leaner than 1 cement, 2 1/2 sand, 5 aggregate, having a compressive strength not less than 2000 psi, in 24 hours when using high-early-strength cement, and 7 days when using standard cement.
- B. Thrust Blocking shall be placed between solid ground and the fitting to be anchored. The area of bearing on the ground shall be as shown on the drawings.
- C. Thrust Blocking shall be placed so that the pipe and fitting joints will be accessible for repair.
- D. A Metal Harness of tie rods and pipe clamps shall be used to prevent movement when specifically shown on the drawings. Steel rods and clamps shall be galvanized or otherwise rust proofed or painted.

28.10 SERVICE LINES.

Pipe and fittings used in the construction of service lines shall conform to the applicable requirements for water mains. Where building services are not installed, the Constructor shall terminate the service approximately 5 feet from the site of the proposed building. Such service

lines shall be closed with suitable plugs or caps. Service stops and gate valves shall be provided with extension service boxes of the lengths required by the depths of service line stops or valves. Service lines shall be constructed in accordance with the following requirements:

28.10.1 Service Lines 2 Inches and Smaller.

Service lines 2 inches and smaller shall be connected to the main with a rigid connection and shall have a service stop a minimum of 3 feet below grade.

28.10.2 Larger Than 2 Inch Service Lines.

Larger than 2-inch services lines shall be connected to the main with a rigid connection and shall have a gate valve 3 feet minimum below grade.

28.10.3 Miscellaneous Items.

28.10.3.1 Tapped Tees for future connections shall be installed where shown on the drawings.

28.10.3.2 Service Stops shall be waterworks inverted-ground-key type, oval flow way, tee handle, with drain. Pipe connections shall be suitable for the type of service pipe used. All parts shall be of cast red brass having a nominal composition of 85 percent copper, 5 percent tin, 5 percent lead, and 5 percent zinc, with female iron pipe size connections, and shall be designed for a minimum hydraulic test pressure of 200 pounds per square inch.

28.10.3.3 Service Boxes shall be of cast iron or concrete, as shown on the drawings. Extension service boxes of the required length and having slide-type adjustment shall be installed at all service box locations. The boxes shall have housings of sufficient size to completely cover the service stop and shall be complete with identifying covers. Service boxes shall be installed in accessible locations beyond the limits of streets, walks, and driveways.

28.10.3.4 Gate Valves 3 inches and smaller shall be designed for a minimum water-working pressure of not less than 150 pounds per square inch. See Section 42 "Fire Protection System - Water" for Gate valves 4 inches and larger. Domestic or process services valves shall have bell or spigot ends or screws as required for the piping in which they are installed. Gate valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counter-clockwise. The operating nut or wheel shall have an arrow, cast in the metal, indicating the direction of opening. Each valve shall have markings cast on the body in accordance with the marking requirements of the specifications under which the valve is furnished. Valves smaller than 2 inches shall be all bronze. Valves 2 inches and larger shall be iron-body, bronze-mounted. Lubricated plug valves shall be of the types and pressure ratings noted on the drawings.

28.10.3.5 Pressure-Reducing Valves shall be of the sizes shown on the drawings, and unless otherwise indicated, shall be suitable for a minimum of 150 psi operating pressure on the high side, and with outlet pressure as required. Ends shall be threaded or flanged. Unions shall be installed in the pipeline on each side of a threaded valve. A suitable pressure relief valve shall be installed downstream of the PRV unless otherwise shown on the drawings. The pressure-reducing valve shall be the standard product of a manufacturer of waterline equipment for cold water domestic service.

28.10.3.6 Indicator Post for Valves. Each valve shown on the drawings with the designation "P.I.V." shall be equipped with an indicator post. Unless otherwise shown, indicators are to be for fire protection service, see Section 42. Operation shall be by lockable wrench, unless otherwise indicated on the drawings. Guard posts shall be provided wherever damage could be inflicted by vehicular traffic.

28.10.3.7 Check Valves shall be horizontal swing check, Class 175 (WOG), with flanged or screwed ends as required for the piping system. Valves shall have an iron-body, bronze disk and an external lever with adjustable spring tension.

28.10.3.8 Vacuum and Relief Valves shall be installed at high points in the supply mains or as shown on the drawings. The valves shall be of the sizes shown on the drawings and shall be of a type that will release free air and that will prevent the formation of a vacuum. The valves shall automatically remove air from the lines when the lines are being filled with water, and shall admit air into the lines when water is being withdrawn in excess of the inflow.

28.10.3.9 Valve Boxes may be of cast iron or concrete, complete with cover, and special wrench for removal, if required. Cast-iron boxes shall be of extension type with slide-type adjustment and with flared base. The minimum thickness of metal shall be 3/16 inch. Concrete boxes shall be the standard product of a manufacturer of precast concrete equipment. The word "WATER" shall be cast in the cover. Boxes shall be installed over each outside gate valve unless otherwise shown on the drawings. The boxes shall be of such length as will be adapted, without full extension, to the depth of cover required over the pipe at the valve locations. Concrete boxes may be installed only in locations not subjected to traffic hazards.

28.10.3.10 Pressure Gages shall be 3 1/2-inch diameter with a phosphor bronze alloy bourdon tube and self-lubricating movement of corrosion-resistant metal. The pressure range shall be 50-100 percent greater than normal operating pressure.

28.10.3.11 Steel Flanges for pipe shall conform to AWWA C207, Class D.

28.10.3.12 Bolts shall be of steel with American Standard Regular unfinished square heads. Nuts shall be of steel with American Standard Regular hexagonal dimensions. Threads shall be coarse thread series, Class 2A and 2B fit.

28.10.3.13 Gaskets shall be provided at all flanged joints and shall be 1/16-inch thick full-face of cloth inserted rubber type unless otherwise shown on the drawings.

28.10.3.14 Flexible Pipe shall be installed above ground between a trailer and the underground water piping. Flexible pipe shall be of the same diameter as the trailer pipe stubouts, and shall be minimum 8 inches long. Pressure rating shall be compatible with the system.

Flexible pipe shall be copper unless specifically approved by the COR.

28.10.3.15 Fire Hydrants shall be obtained from REECO Fire Department stock. Hydrant and all details of installation shall conform to Section 42. Location will be defined by drawing.

28.11 SETTING VALVES AND VALVE BOXES.

Valves and valve boxes shall be installed where shown on the drawings, and shall be set plumb. Valve boxes shall be centered on the valves. Where feasible, valves shall be located outside the area of roads and streets. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face if less than 4 feet. Valves shall have the interior cleaned of all foreign matter before installation. Stuffing boxes shall be tightened and the valve shall be inspected in opened and closed positions to ensure that all parts are in working condition. Valve boxes located in roads or walks shall be protected by a concrete slab in accordance with the details shown on the drawings.

28.12 STANDARD VALVE MANHOLES.

Standard valve manholes shall be constructed as indicated, and in accordance with the details shown on the drawings.

28.13 TESTS

28.13.1 Tests for Water Lines 3 Inches and smaller After the pipe is laid, the joints completed, and the trench partially backfilled, leaving the joints exposed for examination, the newly laid piping shall be subjected for one hour to a hydrostatic pressure test of 50 pounds per square inch in excess of the static pressure at the point of reading when the system is put in operation.

28.13.2 Tests for Water Mains 4 Inches and larger

All tests shall conform to Section 42 "Fire Protection Systems -Water" and NFPA Standard 24.

28.13.3 Tests for Valves

All tests shall conform to Section 42 "Fire Protection Systems - Water" and NFPA Standard 24.

28.14 DISINFECTION.

The entire potable water distribution system shall be disinfected with chlorine prior to acceptance for domestic operation. Disinfection shall be accomplished as described by the American Water Works Association's Standard C601. The amount of chlorine applied shall be such as to provide and maintain a minimum dosage of not less than 50 parts per million (ppm) free residual. Lines shall be thoroughly flushed before the introduction of chlorinating materials. After a chlorine contact period in the lines for at least 24 hours, the treated water shall contain not less than 25 ppm free chlorine residual throughout the length of the main. The system shall be flushed with potable water until the free chlorine residual is not less than 0.5 ppm. All valves in the lines being disinfected shall be opened and closed several times during the contact period.

28.15 SHOP DRAWINGS.

The Constructor shall submit shop drawings, catalog cuts, design data, and wiring and control data to the COR, prior to procurement. Three copies of the submittal will be retained by the COR and the remainder of the copies will be returned to the Constructor. Equipment shall not be delivered to the jobsite prior to the approval of the drawings.

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SECTION 29

SANITARY SEWERS

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SECTION 29

SANITARY SEWERS

29.1 GENERAL.

This section covers the requirements for the furnishing of all materials and the construction of sanitary sewers and structures as shown and noted on the drawings and as specified, from a point 5 feet outside the buildings.

29.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

29.2.1 International Association of Plumbing and Mechanical Officials:

Uniform Plumbing Code (UPC)

29.2.2 American Society for Testing and Materials (ASTM).

A 48	Gray Iron Castings
A 123	Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
C 33	Concrete Aggregates
C 62	Building Brick (Solid Masonry Units made from Clay or Shale)
C 139	Concrete Masonry Units for Construction of Catch Basins and Manholes
C 150	Portland Cement
C 425	Compression Joints for Vitrified Clay Bell-and-Spigot Pipe
C 428	Asbestos - Cement Nonpressure Sewer Pipe
C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
C 700	Vitrified Clay Pipe
D 1869	Rubber Rings for Asbestos-Cement Pipe

29.2.3	<u>Federal Specifications (FS):</u>
HH-P-117	Packing; Jute, Twisted
HH-P-119	Packing Material, Sewer Joint, Asphalt-Saturated Cellulose-Fiber
QQ-C-40	Calking, Lead Wool, and Lead Pig
RR-F-621	Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
SS-P-331	Pipe, Sewer, Nonpressure, Asbestos-Cement; Couplings and Fittings
SS-P-361	Pipe and Fittings, Clay (Sewer)
SS-P-371	Pipe, Concrete (Nonreinforced, Sewer, Storm Drain, and Culvert)
SS-P-375	Pipe, Concrete, (Reinforced, Sewer, Storm Drain, and Culvert)
SS-S-168	Sealing Compound, Sewer, Bituminous, Two-Component, Mineral-Filled Cold-Applied
SS-S-00169	Sealing, Sewer Joint, Mineral-Filled, Hot-Pour
WW-P-401	Pipe and Pipe Fittings, Cast-Iron, Soil

29.3 SANITARY DRAINAGE SYSTEM

29.3.1 General Requirements.

Materials for sewer lines shall be Johns-Manville, Class 2400 asbestos-cement, installed in accordance with the Johns-Manville Corp., "Transite Sewer Pipe Installation Specifications;" VCP sewer pipe; or cast-iron pipe and pipe fittings (class as indicated on the drawings) conforming to Specifications listed in Paragraph 29.2. Sewer lines installed under buildings, under bearing walls, or through footings shall be extra-heavy bell-and-spigot cast-iron pipes unless otherwise shown on the drawings or approved by the Contracting Officer's Representative (COR). The above requirement also applies to new construction over existing lines.

29.3.2 Soil, Waste, and Drain Piping.

Unless otherwise indicated on the drawings, or approved by the COR, underground soil, waste, and drain pipe and fittings shall be Johns-Manville, Class 2400 asbestos-cement pipe. Fittings 3 inches and larger for similar installation shall be standard weight cast-iron pipe (bell-and-spigot or "No-hub").

29.3.2.1 Pipes. Horizontal soil and waste pipes shall be given a grade of 1/4-inch per foot unless otherwise indicated on the drawings or approved by the COR, but in no case less than 1/8-inch per foot (1.04%).

29.3.2.2 Fittings. Changes in pipe size on soil, waste, and drain lines shall be made with reducing fittings or recessed reducers. Changes in direction shall be made by the appropriate use of 45-degree wyes, half wyes, long-sweep 1/4 bends, 1/6, 1/8, or 1/16 bends. Short quarter bends or elbows may be used in soil and waste lines where the change in direction of flow is from the horizontal to the vertical.

29.3.2.3 Joints between cast-iron soil and waste pipes shall be firmly packed with jute packing and calked with lead at least 1-inch deep. (Reference Paragraph 29.5.4.)

29.4 INSTALLATION

29.4.1 Location

The sewer shall not be closer horizontally than 10 feet to a water-supply main or service line, except that where the bottom of the water pipe will be at least 12 inches above the top of the sewer pipe, the horizontal spacing may be a minimum of 6 feet.

29.4.2 Crossings Above Waterlines.

Where gravity-flow sewers cross above waterlines, as shown on the drawings, the sewer pipe for a distance of 10 feet each side each side of the crossing: shall be cast iron, steel, ACP, or other acceptable pressure pipe and without any joint closer horizontally than 3 feet to the crossing; or shall be fully encased in concrete. The thickness of the concrete around the sewer pipe, including that at the pipe joints, shall be not less than 4 inches.

29.4.3 Pipe Laying.

The bottom of the trench shall be shaped to give substantially uniform circumferential support to the grade with the spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow. Each pipe shall be laid true to line and grade and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. As the work progresses, the interior of the sewer shall be cleared of all dirt and superfluous materials of every description. Where cleaning after laying is difficult because of small pipe size, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after the jointing has been completed. If the maximum width of the trench at the top of the pipe, specified in Section 1, is exceeded for any reason other than by direction of the COR, the Constructor shall install such concrete cradling, pipe encasement, or other bedding as may be required to satisfactorily support the added load of the backfill. Trenches shall be kept free from water until the pipe-jointing material

has set, and pipe shall not be laid when the condition of the trench or the weather is unsuitable for such work. At times when work is not in progress, open ends of pipe and fittings shall be securely and satisfactorily closed so that no trench water, earth, or other substance will enter the pipe or fitting.

29.5 JOINTING.

At the option of the Constructor but within the limitations specified, the joints of pipe shall be tightly sealed with one of the following materials and in the manner hereinafter specified. Cement mortar shall not be used as a pipe-jointing material except as specified for installing wye branches in existing sewer lines of bell-and-spigot pipe.

29.5.1 Plastic Joint Sealer.

Plastic joint sealer shall be molded in the annular space or on the spigot of the pipe, or both, in a plant specially equipped for the purpose. Plastic will be acceptable only when used with clay pipe.

29.5.2 Rubber Gaskets.

The configuration of the gasket shall be as recommended by the pipe manufacturer for the particular type of pipe joint. The gasket shall be so installed as to provide a tight fit. Rubber gaskets may be used with asbestos-cement pipe, clay pipe, concrete pipe, and cast-iron soil pipe.

29.5.3 Bituminous Sealers.

Bituminous sealers may be used in the joints of bell-and-spigot pipe, or joints having similar annular space. Before jointing with bituminous compound, the inside of the bells and outside of the spigots shall be dry and clean and shall be primed if and as recommended by the manufacturer of the compound. The joint shall be made according to the applicable method for the type and class of material as follows:

29.5.3.1 Hot-Pour Bituminous Sealer, Poured-in-Place. The pipe shall be centered so that the annular space is uniform. The annular space shall be well calked with joint packing. The depth of the packing shall be such as to leave a space, measured from the end of the bell, of at least 1 inch for pipes 15 inches and less in diameter, 1 1/2 inches for pipes 18 to 24 inches in diameter, and 2 inches for pipes larger than 24 inches in diameter. When the joint is made with the pipe in its final location, a suitable joint runner, previously dipped into thick mud or grout to permit easy removal when the joint has cooled, shall be placed around the pipe, leaving an opening at the top of the runner. Molten bituminous compound shall be poured continuously into this opening until the joint is completely filled and shall be poured as rapidly as possible without entrapping air. Hot-poured sealer shall be heated to the proper temperature to permit rapid pouring and to obtain strong adhesion of the compound to the pipe. In cold weather, special care shall be exercised to assure that the compound is not cooled too rapidly for proper adhesion and, if

necessary, the pipe shall be preheated. The temperature of the molten compound shall be between 350° F. and 450° F. unless otherwise recommended by the manufacturer. The compound shall not be overheated or subjected to prolonged heating which might cause a change in its physical properties.

After the compound has cooled or set, the runner may be removed. Alternate joints may be poured before the pipe is lowered into the trench. In this case, the joints shall be poured with the pipe in vertical position without the use of the runner. The compound shall have thoroughly set before the pipe is placed in the trench, and the pipe shall be handled so as not to cause deformation of the joint. Poured-in-place sealer shall not be used when weather or other conditions at the site of the work are such that the pipe cannot be maintained in acceptable condition for jointing with this type of bituminous compound.

29.5.3.2 Hot-Pour Bituminous Sealer, Ring-and-Collar. Tapered rings and collars may be precast with bituminous compound into the pipe bells and onto the pipe spigots, respectively, when and at such place as conditions are suitable for pouring, and the pipe may then be used as required. The taper shall be such that when the spigot is shoved into the bell, complete surface contact between the ring and collar will be made. No joint packing shall be used, and each ring and collar shall completely fill the annular space between the bell and the spigot. The rings and collars shall be formed by pouring the molten compound into suitable molds centered about the pipe in vertical position. Before pouring, the molds shall be coated with a wash of clay, lime, or other suitable material that is not oil or grease, to permit easy removal after the compound has set. Just before the pipe is laid, the inside of the ring of the previously laid pipe shall be painted with a material recommended by the manufacturer of the bituminous compound that will cause the surfaces of the ring and collar to unite and form a homogeneous body.

29.5.3.3 Cold-Applied, Mineral-Filled Sealer, Two-Component. The annular space between the bell and the spigot of the pipe shall be packed with asphalt-saturated, cellulose-fiber packing. The packing shall be of a size suitable for the annular space and shall be cut in lengths to completely encircle the pipe. The first strands shall be calked solidly against the back of the bell. Additional strands shall be placed and calked solidly in the bell to fill one-third to one-half of the annular space. The annular space shall then be filled completely and compactly with the joint sealer, but overfilling is not required. The sealer shall be mixed on the job in accordance with the manufacturer's recommendations and in relatively small quantities so that setting will not be appreciable before use.

29.5.4 Lead.

Cast-iron soil pipe joints may be made with lead and jute or other material approved by the COR. The packing material shall be well packed into the annular space so as to prevent the entrance of lead into the pipe. The remainder of the space shall be filled with molten lead that is hot enough to show a rapid change in color when stirred. Scum shall be

removed from the molten lead before pouring. The lead shall be calked to form a tight joint without overstraining the bell and shall have a minimum depth of 1 inch after calking.

29.5.5 Test for Displacement of Sewers.

Sewer mains shall be checked to determine whether any displacement of the pipe has occurred after the trench has been backfilled to 2 feet above the pipe and tamped as specified. The test will be as follows: A light will be flashed between manholes, or, if the manholes have not as yet been constructed, between the locations of the manholes by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipeline shows poor alignment or other defects, the defects shall be corrected and reinspected prior to continuation of backfill operations.

29.6 CONCRETE CRADLE AND ENCASEMENT.

The pipe shall be supported on a concrete cradle or encased in concrete where indicated on the drawings. The concrete shall consist of 1 part Portland cement, 2 1/2 parts sand, and 5 parts gravel, with just enough water to produce a workable consistency.

29.7 WYE BRANCHES.

Commercially manufactured wye branches shall be installed where sewer connections are indicated. Cutting into pipe, other than asbestos-cement pipe, for connections shall not be done except when approved by the COR. Wye branches used with asbestos-cement pipe shall be asbestos-cement of the same quality as the pipe or special cast-iron branches furnished for the purpose by the pipe manufacturer and as approved. When conditions are such that the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete or supported on a concrete cradle as shown on the drawings or as directed by the COR. The installation of wye branches in an existing sewer of bell-and-spigot pipe shall be made by removing one pipe section, breaking off the upper halves of the next lower section and of the section to be installed, inserting the new section, and rotating the new section so that the unbroken half of its bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

29.8 MANHOLES.

29.8.1 General.

Manholes shall be constructed of brick, concrete precast concrete rings, or precast concrete segmental blocks, with cast-iron covers, and in accordance with the drawings. The invert channels shall be smooth and semicircular in shape conforming to the inside of the adjacent sewer section. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. The

invert channels shall be formed directly in the concrete of the manhole base or shall be built up with brick and mortar, or shall be half tile laid in concrete, or shall be constructed by laying full-section sewer pipe through the manhole and breaking out the top half after the surrounding concrete has hardened. The floor of the manhole outside the channels shall be smooth and shall slope toward the channels not less than 1 inch per foot nor more than 2 inches per foot. Free drop inside the manhole shall not exceed 2 feet measured from the invert of the inlet pipe to the top of the floor of the manhole outside the channels, and drop manholes shall be constructed whenever the free drop would otherwise be greater than 2 feet. When the depth from top of cover to invert of main sewer exceeds 3 feet, manholes shall have cast-iron steps of approved design or 7/8-inch diameter wrought-iron rungs not less than 10 inches in width built into and thoroughly anchored in the walls and spaced uniformly approximately 12 inches apart with alternate steps or rungs offset 6 inches. Rungs may be installed without being offset if the crossbar width is not less than 14 inches. All rungs shall be so shaped that the crossbar will be below the plane of the side bars sufficiently to prevent the foot from slipping off the side of the rung. Rungs shall be installed with at least 6 1/2 inches of the toe space from the inside face of the rung. The wall along the line of steps or rungs shall be vertical its entire height. Rungs shall be galvanized by manufacturer after fabrication. Steps or rungs shall not be installed unless the depth exceeds 3 feet.

29.8.2 Standard Manholes.

Standard manholes shall be constructed at locations shown and in accordance with the details shown on the drawings. Manholes shall be formed of precast, reinforced concrete rings and cone with cast-iron grade ring and cover. Base and invert channel shall be of concrete cast in field to suit design. Manholes shall be the product of Hydro-Conduit Corp., Henderson, Nevada; Superior Concrete Specialties, Las Vegas, Nevada, or an approved equal; rings and covers shall be supplied by Concrete Fabricator or Alhambra Foundry Co., California, or approved equal.

29.8.3 Concrete.

Concrete used in manholes shall have a compressive strength of not less than 3,000 psi at 28 days and shall be composed of the aggregates specified under Section 2 using not less than 6 bags of Portland cement per cubic yard. Coarse aggregate shall be used in the greatest amount consistent with required workability. Concrete rings shall be standard type with wall thickness not less than 4 inches for vertical wall sections and not less than 4 3/4 inches for cone sections, and shall be reinforced with not less than 0.12 square inch of steel per foot of wall height. Joints between precast rings shall be full bedded in cement mortar and shall be smoothed to a uniform surface on both the interior and exterior of the manhole. Segmental blocks shall be at least 5 inches but not more than 8 inches in thickness, not less than 8 inches in length, and of such shape that the joints can be effectively sealed and bonded with cement mortar.

29.8.4 Jointing and Plastering.

Mortar for jointing and plastering shall consist of 1 part Portland cement and 2 parts fine sand. For brickwork, lime may be added to the mortar in the amount of not more than 25 percent of the volume of cement. The joints shall be completely filled and shall be smooth and free from surplus mortar on the inside of the manhole. Brick manholes shall be plastered with 1/2 inch of mortar over the entire outside surface of the walls. Brick shall be laid radially with every sixth course laid as a stretcher course.

29.8.5 Frames and Covers.

Cast-iron frames and covers shall conform to the drawings in all essentials of design and shall have a clear opening of 24 inches minimum. Approved standard castings differing in nonessential details will be acceptable. The frames and covers shall be constructed as detailed on the drawings. The letter "S," at least 1 3/4 inch x 2 inches, shall be cast into all covers so as to be plainly visible. The frames and covers shall be so set that the top of the cover will be flush with the finished pavement and concrete surfaces, and 3/4 inch above finish earth grade.

29.9 CONNECTIONS TO EXISTING MANHOLES.

Pipe connections to existing manholes shall be made in such manner that the finished work will conform as nearly as practicable to the essential applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping.

29.10 SURFACE CLEANOUT.

The cleanout riser shall be constructed at 6-inch CI or vitrified clay pipe and fittings using two 1/8" bends. The riser shall terminate with a heavy-duty cast-iron cleanout with adjustable housing and bronze plug (Zurn Z-1329 or approved equal). The cleanout shall be encased in an 18-inch x 18-inch x 6-inch-thick, 2500 psi minimum, concrete pad and mounted flush with top of concrete.

29.11 SERVICE CONNECTIONS.

Where a building service is not installed, the Constructor shall terminate the service approximately 5 feet from the site of the proposed building at a designated point and shall be marked by means of a stake at grade. Such service line shall be closed with a suitable plug. If a building service is installed, the Constructor shall make the connection thereto.

29.12 ABANDONED SEWERS AND SEWAGE DISPOSAL FACILITIES.

Every cesspool, septic tank, and seepage pit which has been abandoned or discontinued otherwise from further use, or to which no waste or soil pipe from a plumbing fixture is connected, shall have the sewage removed therefrom and be completely filled with earth, sand, gravel, concrete, or other approved material.

The top cover or arch over the cesspool, septic tank, or seepage pit shall be removed before filling and the filling shall not extend above the top of the vertical portions of the side walls or above the level of any outlet pipe until the cesspool, septic tank, or seepage pit has been inspected. After such inspection, the cesspool, septic tank, or seepage pit shall be filled to the level of the top of the ground.

29.13 TESTING.

29.13.1 Exfiltration.

Leakage shall not exceed a rate of 20 gallons per inch of pipe diameter per 1,000 feet per hour. The maximum internal pressure in any part of the system under exfiltration test shall not be greater than 5 psi. Exfiltration tests shall be made on all lines. The tests shall be made by filling the sewer between successive manholes with water to the top of the outlet of the upper manhole. The amount of water required to maintain the pipe full for the required test period shall be measured and the rate leakage determined. When leakage exceeds the maximum amount specified, satisfactory correction shall be made. Regardless of the amount of leakage, ALL DETECTABLE leaks shall be repaired.

29.13.2 Defective Pipe.

Defective pipe shall be removed from the work and replaced with sound, undamaged pipe.

29.13.3 Final Tests.

Final tests shall be made by the Constructor and approved by the COR prior to connection to existing main by sealing the lowest end of each section to be tested and filling the pipe with water to the point of overflow at the upper end. The water shall be left for at least 12 hours to allow for absorption and, at the end of that period, makeup water shall be added and the test period shall begin. However, the rate of leakage, based on a one-hour period, shall not be exceeded. When leakage exceeds the maximum amount specified, joints in the lines shall be inspected and repaired by the Constructor to the satisfaction of the COR.

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SECTION 30
SEWAGE DISPOSAL SYSTEMS

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SECTION 30

SEWAGE DISPOSAL SYSTEMS

30.1 GENERAL.

This section covers the requirement for furnishing all materials and equipment and constructing septic tanks, leaching systems, sewage lagoons, and sewage disposal appurtenances shown and noted on the drawings and as specified. The design of a subsurface sewage disposal system shall be based upon soil information derived from a soil profile and percolation.

30.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

30.2.1 Same as 29.2.1 and the following:

The International Association of Plumbing and Mechanical Officials

Uniform Plumbing Code (UPC)

Manual of Septic Tank Practice, Publication No. 526 (USPHS)

30.3 SEPTIC TANKS.

Septic tanks shall be constructed of sound durable materials, not subject to excessive corrosion or decay and shall be watertight. Each such tank shall be structurally designed to withstand all anticipated earth or other loads and shall be installed level and on a solid bed.

The walls and floor of each poured-in-place concrete septic tank shall be monolithic and a minimum of four inches thick.

Concrete septic and tank covers shall have a minimum compressive strength of 3000 pounds per square inch at 28 days (psi). All precast tanks and covers shall be adequately reinforced.

All septic tank covers shall be capable of supporting earth load of not less than 300 pounds per square foot unless otherwise shown on the drawings.

The minimum wall thickness of any steel septic tank shall be No. 12 U.S. gauge (.109) and each such tank shall be protected from corrosion both externally and internally by an approved bituminous coating or by other acceptable means.

Septic tank design shall be such as to produce a clarified effluent consistent with accepted standards and shall provide adequate space for sludge and scum accumulations.

Septic tanks shall have a minimum of 2 compartments. The inlet compartment of any septic tank shall be not less than 2/3 of the total capacity of the tank nor less than 500 gallons liquid capacity, and shall be at least 3 feet in width and 5 feet in length. Liquid depth shall be not less than 4 feet nor more than 5 feet. The secondary compartment of any septic tank shall have a minimum capacity of 250 gallons and a maximum capacity of 1/3 of the total capacity of such tank. In septic tanks having over 1500 gallons capacity, the secondary compartment may be not less than 5 feet in length.

Access to each septic tank shall be provided by at least 2 manholes 20 inches in minimum dimension or by an equivalent removable cover slab. One access manhole shall be located over the inlet, the baffle wall, and the outlet.

The inlet and outlet pipe or baffle shall extend a distance above the liquid line equal to 20 percent of the liquid depth and extend a distance below the liquid line equal to 40 percent of the liquid depth.

The total depth shall be not less than 9 inches greater than liquid depth. The cover of the septic tank shall be at least 2 inches above the back vent openings.

Partitions or baffles between compartments shall be of sound durable material and shall extend at least 4 inches above the liquid level. An inverted fitting equivalent in size to the tank inlet, but in no case less than 4 inches in size, shall be installed in the inlet compartment side of the baffle with the bottom of the fitting placed one-half the depth of the liquid. Wooden baffles are prohibited.

All concrete septic tanks shall be protected from corrosion by coating the inside with an approved bituminous coating or by other acceptable means. The coating shall extend to at least 4 inches below the water line, and shall cover all of the internal area above that point.

30.4 LEACHING SYSTEMS

30.4.1 Leaching Trenches.

Leaching trenches shall be constructed to dimensions indicated on the drawings. Excavations shall conform to Section 1. Distribution lines shall be constructed of unglazed clay tile, four inch perforated distribution pipe, or other approved material. The distribution lines shall be laid in 12 to 18 inches of 3/4 to 1 1/2 inch wash coarse gravel with at least 6 inches of gravel below the lines. The lines and material shall be covered with untreated building paper and backfilled with a minimum of 6 inches of clean cover material. Trenches shall be a minimum of 12 inches wide and the maximum depth from the invert of the distribution line to finished grade shall not exceed 24 inches. Grade of field shall be 1/4 to 1/2 inches per 10 feet, not to exceed 6 inches per 100 feet maximum.

30.4.2 Leaching Beds.

Where leaching beds are permitted in lieu of trenches, due to the unavailability of adequate installation conditions, the area of each such bed shall be at least 50% greater than the requirements for trenches. Distribution drain lines in leaching beds shall not be more than 6 feet apart on centers and no part of the perimeter of the leaching bed shall be more than 3 feet from a distribution drain line. All other disposal field construction shall be the same as required for leaching trenches.

Lateral trenches shall be filled first with 3/4- to 2 1/2-inch coarse gravel aggregate, within which is laid unglazed clay tile or a 4-inch perforated distribution pipe. If tile is selected, a 1- x 4-inch redwood board shall be installed under the distribution system. Burial and grade shall follow the requirements for Paragraph 30.4.2 for individual pipes.

30.5 DISTRIBUTION BOXES.

Distribution boxes are required when more than one distribution line is used and shall be precast concrete or field constructed as indicated on the drawings. The size of the box and number of outlets shall be as indicated. Provide manhole, manhole ring and cover, M.C. Nottingham Co., or approved equal. Field construction distribution boxes shall conform to the details shown on the drawings and to Section 2.

30.6 GREASE AND WASTE INTERCEPTORS.

Grease and waste interceptors, where required, shall be installed where shown on the drawings. Interceptors shall be connected to the kitchen waste line, and to the septic tank or to the drain line to a sewage lagoon, as indicated. Interceptors shall be of the type and size indicated. No food waste disposal unit shall be connected to or discharge into any interceptor. The grease and waste interceptors shall be provided with a removable cover for ease of skimming off the collected grease. Unit shall be Josam Co., J.R. Smith, or approved equal, size and model as shown on the drawings.

30.7 SEWAGE LAGOONS.

Sewage lagoons shall be constructed as shown on the drawings and the size and cross sections indicated. Earthwork shall conform to Section 1.

30.8 ABANDONED SEWAGE DISPOSAL FACILITIES.

Every cesspool, septic tank and seepage pit which has been abandoned or has been discontinued otherwise from further use shall have the sewage removed therefrom and be completely filled with earth, sand, gravel, concrete or other approved material.

The top cover or arch over the cesspool, septic tank, or seepage pit shall be removed before filling, and the filling shall not extend above

the top of the vertical portions of the sidewalls or above the level of any outlet pipe until the cesspool, septic tank, or seepage pit shall be filled to the level of the top of the ground.

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SECTION 31
FUEL SUPPLY SYSTEMS

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SECTION 31

FUEL SUPPLY SYSTEMS

31.1 GENERAL.

This section covers the requirements for furnishing all materials and equipment and installing diesel fuel supply systems shown and noted on the drawings and as specified. This covers only automotive-type diesel fuel and gasoline.

31.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

31.2.1 American National Standards Institute (ANSI):

B16.5 Steel Pipe Flanges and Flanged Valves and Fittings

B36.10 Welded and Seamless Wrought Steel Pipe

31.2.2 American Petroleum Institute (API):

5L Specification for Line Pipe

650 Welded Steel Tanks for Oil Storage

31.2.3 American Society for Testing and Materials (ASTM):

A 53 Welded and Seamless Steel Pipe

A 135 Electric-Resistance-Welded Steel Pipe

A 283 Low and Intermediate Tensile Strength Carbon-Steel Plates of Structural Quality

D 1751 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

D 1752 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

31.2.4 American Water Works Association (AWWA):

C 203 Coal-Tar Enamel Protective Coatings for Steel Water Pipe

31.2.5 Federal Specifications (FS):

VV-F-800B Fuel Oil, Diesel

WW-N-351C Nipples, Pipe, Threaded

WW-P-521F Pipe Fittings, Flange Fittings, and Flanges Steel and Malleable Iron (Thread and Butt-Welding) 150 Pound

WW-U-531E Unions, Pipe Steel or Malleable Iron, Threaded Connection, 150 pounds, and 250 pounds

WW-V-51E Valve, Angle, Check, Globe and Bronze (125, 150 and 200 pound Threaded End, Flange Ends and Brazed End for Land Use)

WW-V-54D Valve, Gate, Bronze (125, 150 and 200 pound, Threaded Ends, Flange Ends Solder-End and Brazed Ends for land use)

31.2.6 Military Specifications (MIL):

MIL-A-7021 Asbestos Sheet, Compressed, for Fuel, Lubricant, Coolant, Water, and High Temperature Resistant Gaskets

MIL-G-3056 Gasoline, Military Combat

31.2.7 National Bureau of Standards (NBS) Handbook:

H28 Screw-Thread Standards for Federal Service

31.2.8 Underwriters' Laboratories, Inc. (UL):

Building Materials Directory

Gas and Oil Equipment List (with supplements)

31.2.9 National Fire Protection Association (NFPA):

Flammable and Combustible Liquids Code - NFPA 30

Installation of Oil Burning Equipment - NFPA 31

National Electrical Code - NFPA 70

Classification of Flammable Liquids - NFPA 321

31.2.10 American Society of Mechanical Engineers (ASME).

Code for Pressure Vessels Section VIII

31.2.11 Factory Mutual System (FM)

Approval Guide

31.3.1 STANDARD PRODUCTS.

The equipment to be furnished under this section shall be essentially the standard product of the manufacturer. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer. Wherever there are UL/FM listed products that serve the desired function, only UL or FM products will be acceptable. Where there are no products that are UL/FM listed for the desired function,

certification by another recognized testing laboratory may be accepted if the manufacturer attests, in writing, that the product, as currently manufactured, is identical to that which was originally tested.

31.4 APPROVAL OF MATERIALS AND EQUIPMENT

Approval of equipment under this section shall not be construed as authorizing any deviation from the specification unless the attention of the Contracting Officer's Representative (COR) has been directed to the specific deviation. Equipment differing from that specified may be proposed, provided the Constructor clearly states such differences and provided all essential requirements of the specification are met.

31.5 MATERIALS AND EQUIPMENT.

Only new materials shall be used. All materials shall be resistant to the effects of diesel fuel and motor gasoline, in conformance with VV-F-800 and MIL-G-3056, respectively.

31.5.1 Couplings.

Couplings used for pipe connections to fuel tanks shall conform to API Specification 5L and shall be seamless, extra heavy, of wrought steel, and with recessed ends.

31.5.2 Flange Gaskets.

Flange Gaskets shall be fabricated from homogeneous synthetic rubber-base and/or resin-base material conforming to MIL-A-7021, Class I. Gasket stock shall be approximately 3/32 inch thick in its free state and 1/16 inch thick after compression in a flanged joint.

31.5.3 Joint Compound.

Joint Compound shall be suitable for use with fuel containing 40 percent aromatics and shall be resistant to water.

31.5.4 Joint Filler Strips.

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

31.5.5 Mechanical Equipment.

Mechanical Equipment shall be of the best quality used for the purpose in commercial practice and shall be the products of reputable manufacturers. Each major component of equipment shall have the manufacturer's name, address, and catalog number marked in a permanent manner on a brass plate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable. Pulleys, chains, couplings, projecting set screws, keys, and other rotating parts exposed to personnel shall be fully enclosed or properly guarded.

31.5.6 Workmanship.

Equipment shall be installed in accordance with the recommendations of the manufacturer and the best standard practice for this type of work.

31.6 PIPING.

31.6.1 General.

Piping in the fuel system shall be steel. Materials shall be new and unused unless otherwise approved by the COR. Piping connections to equipment shall be in accordance with the drawings. The interior of the pipe shall be thoroughly cleaned of all foreign matter. The pipe shall not be laid when weather conditions are unsuitable for such work. When work is not in progress, open ends of pipe and fittings shall be securely closed so that earth or other substances cannot enter the pipe or fittings. Any pipe, pipe fittings, or appurtenances found defective after installation shall be replaced.

31.6.2 Steel Pipe.

Steel pipe schedules specified herein shall conform to ANSI B36.10 for wrought-steel pipe with respect to dimensions and weight. Pipe for fuel systems shall be manufactured by seamless electric-resistance-welded or lap-welded processes. All pipe shall be of a grade and quality that will withstand bending.

31.6.2.1 Pipe Sizes Smaller Than 2 Inches shall conform to ASTM A 135, Grade A electric-resistance-welded black carbon steel pipe or to ASTM A 53, Type S seamless black carbon steel pipe, Schedule 40 dimensions. Extra heavy, recessed end couplings shall be furnished with threaded pipe.

31.6.2.2 Pipe Sizes 2 Inches and Larger shall conform to ASTM A 53, Type S, Grade A, seamless or lap-welded black carbon steel pipe or ASTM A 135, Grade A electric-resistance-welded black carbon steel pipe.

31.6.3 Screwed Joints.

Screwed Joints shall be made with tapered threads conforming to the NBS Handbook H28, and shall be made perfectly tight with joint compound applied to the male threads only.

31.6.4 Cutting Pipe.

Cutting pipe, where necessary, shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise authorized, cutting shall be done by means of an approved type of mechanical cutter. Wheel cutters shall be used when practicable. Pipe shall be reamed to true internal diameter after cutting to remove burrs.

31.6.5 Installing Pipe.

In shipping, delivering, and installing, pipe and accessories shall be handled in such manner as to ensure a sound, undamaged condition. Particular care shall be taken not to injure pipe coating when handling and/or lowering pipe into trench and when backfilling. No other pipe or material of any kind shall be placed inside a pipe or fitting after the coating has been applied. Coated and wrapped steel pipe shall be coated and wrapped in conformity with the applicable requirements of the AWWA C 203.

31.6.5.1 Pipe Sleeves. Piping passing through concrete or masonry construction shall be fitted with sleeves. Each sleeve shall extend through the respective wall and shall be cut flush with each surface. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor. In all areas where pipes are exposed, extend sleeves 1/4 inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor. The sleeve shall be large enough to provide a minimum clear distance of 1/2 inch between the pipe and sleeve, except where otherwise indicated. Sleeves through concrete may be 20 gage metal, fiber, or other approved materials. Sleeves shall be accurately located to center with the piping and shall be securely fastened in place. The space between the sleeves and the pipe shall be caulked and filled with bituminous plastic cement.

31.6.6 Pneumatic Testing.

Piping specified herein shall be tested with soapy mixture under a pneumatic pressure of 90 pounds per square inch for at least 20 hours during which time there shall be no drop in pressure in the line, allowances being made for thermal expansion and contraction. To facilitate this test, the Constructor may isolate various sections of the piping system and test each one separately. Where such sections terminate at valve points, the lines shall be closed by means of caps in lieu of relying on the valve. The Constructor shall furnish tapped flanges that can be attached to the end of the section of line being tested, and that will permit a direct connection for the piping from the air compressor. No taps in the line will be permitted. The Constructor shall furnish necessary equipment for testing and gages shall be subject to testing and approval. The air used for testing shall have residual relative humidity of not over 20 percent. The Constructor shall provide dehumidifying equipment on the suction or discharge side of the air compressor used to provide air for testing. In the event leaks are detected, the line shall be repaired and the test repeated. On completion of satisfactory tests, the pressure shall be relieved and the line immediately sealed. Suitable provision shall be made to prevent displacement of the piping during testing. Equipment such as pumps and meters shall be isolated from the piping system during this test.

31.7 VALVES AND FITTINGS.

31.7.1 Screwed Fittings.

Screwed Fittings shall be wide banded 150-pound malleable iron conforming to WW-P-521, Type I, black with added requirement that all fittings shall be air tested to 90 pounds per square inch.

31.7.2 Nipples.

Steel pipe nipples shall be of the same material as the pipe and shall conform to the requirements of WW-N-351.

31.7.3 Unions.

Steel pipe unions shall conform to WW-U-531, Type A, black, brass seated with ground joints.

31.7.4 Valves.

Valves shall be designed for 150 pound ANSI B16.5 primary service pressure ratings. Gate valves shall be bronzed, conforming to WW-V-54, Type II, Class B, union bonnet, for screwed connections. Check valves shall be bronzed, synthetic rubber disk type, conforming to the applicable requirements of WW-V-51, Type IV, swing check, Class B, 150-pound. All valve bodies shall be of bronze.

31.8 STORAGE TANKS.

31.8.1 General.

Storage tanks shall be low-pressure type, horizontal, welded steel tanks suitable for aboveground installation and conform to NFPA 30. Joints shall be butt type. Tanks shall be of the size and thickness of plate as indicated, allowance being made for manufacturer's fabrication. No internal bracing shall be used. Openings shall be provided and attachments welded as indicated. Tanks shall be shop tested and proved tight against leakage under a test of 5 pounds per square inch air pressure. Shop testing shall be performed after the various openings are installed. Tanks shall be Underwriters' Laboratories, Inc., listed. Capacities shall be as shown on the drawings. See drawings for details, coating requirements, and installation of fuel storage tanks.

31.8.2 Steel Plate.

Steel Plate for storage tanks shall be open hearth, and shall conform to ASTM A 283, Grade C.

31.8.3 Tank Equipment.

31.8.3.1 Atmospheric Vent. Each storage tank shall be provided with a separate atmospheric vent equipped with screened mushroom or T-type head. The vent pipe shall be a minimum size of 2 inches and shall terminate at

least 12 feet above grade or 2 feet above roof of building and shall be so located that discharge vapor will not enter building openings or downspouts. Terminate with a UL-listed vent cap suitable for the design conditions and the type of liquid.

31.8.3.2 Fill Connection. The fill line to each storage tank shall enter at the top of the tank. The fill line shall be a minimum size of 3 inches and shall extend to within 6 inches of the tank bottom. An antisplash deflector shall be connected to the end of the fill line in the tank. Fill line cap shall be watertight with lock.

31.8.3.3 Access Manway. Tanks with capacity of more than 4,000 gallons and less than 12,000 gallons shall be provided with one 24-inch inside diameter access manway. Each manway shall be provided with a bolted and gasketed steel cover and steel ladder to the bottom of the tank. Access manways for tanks over 12,000 gallons shall be as shown on the drawings.

31.8.3.4 Suction Connection. The suction line shall be located at the opposite end of the tank from the fill line. The suction line shall be equipped with a double poppet spring-loaded foot valve that extends within 6 inches of the tank bottom.

31.8.3.5 Cleanout and Gage Connection. A combination cleanout and gage connection shall be provided with each tank. This combination shall be provided with each tank. This combination shall be a commercial standard type gage as specified on drawing and UL listed for service specified. Gage shall be calibrated to suit tank capacity and shall be removable for cleanout purposes without disturbing calibration.

31.8.3.6 Tank Supports. It shall be the Constructor's responsibility to design and construct suitable concrete or steel supports for each new storage tank.

31.8.3.7 Antisiphon Device shall be installed at the highest point of the suction line. Provide a plugged tee located just below the antisiphon device for priming. Device shall be UL listed. (Preferred Utilities Manufacturing Corporation or approved equal.)

31.8.4 Cleaning Interior Surface of Tanks.

Before the Constructor withdraws from the job, the interior surface of the storage tanks shall be cleaned and made free from all foreign matter, such as dirt, debris, grease, moisture, and oils, that might later interfere with the operation of the system or that might be a source of contamination of the product to be stored in the tank. The cleaning shall be done to the satisfaction of the COR.

31.8.5 Flushing and Testing

The dispensing system shall be flushed with the same type fuel intended for final use in the system, until the fuel being delivered is "clean" and "bright." Clean means the absence of any sediment or emulsion. Bright refers to the fluorescent appearance of fuel that has no cloud or haze.

After various components of the system have been properly adjusted by the Constructor, the Constructor shall demonstrate to the satisfaction of the COR that the system meets the performance requirements for which it was designed. In the event any portion of the system or any piece of equipment fails to meet the various tests, the Constructor shall make the necessary repairs or adjustments and the test shall be repeated until satisfactory performance is obtained. All tests shall be witnessed by the COR, and the Constructor shall notify the COR sufficiently in advance of the test to permit arrangements for a representative. All instruments and equipment required to properly conduct the tests shall be furnished by the Constructor.

31.8.6 Grounding.

See Section 23 for grounding requirements.

31.9 PUMPS.

Transfer pumps and dispensing devices shall be selected for the particular application, rated for diesel or gasoline service (as applicable) and U. L. listed. The motor shall be "Dust Ignition Proof" as defined by the National Electrical Code. All electrical work for diesel systems shall comply with NFPA 70 (NEC) for Class II, Division I - Hazardous Locations. All electrical work for gasoline systems shall comply with NFPA 70 (NEC) for Class I - Hazardous Locations.

31.10 OTHER FUEL SYSTEMS.

For fuel systems other than diesel and gasoline fuel supply systems, see drawings for detailed requirements.

31.11 SHOP DRAWINGS.

The Constructor shall submit shop drawings, catalog cuts, design data and wiring and control data to the COR, prior to procurement. Three copies of the submittal will be retained by the COR and the remainder of the copies will be returned to the Constructor. Equipment shall not be delivered to the jobsite prior to the approval of the shop drawings.

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SECTION 32

FENCING

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SECTION 32

FENCING

32.1 GENERAL.

This section covers the requirements for furnishing all materials and constructing wire-mesh fencing, barbed wire fencing, and gates as shown and noted on the drawings and specified.

32.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

32.2.1 Federal Specifications (FS):

RR-F-183	Fence Posts, Gates, and Accessories
RR-F-00191	Fencing, Wire and Post, Metal (and Gates, Chain-Link Fabric, and Accessories)
RR-F-00191/1	Fencing, Wire and Post, Metal (Chain-Link Fence Fabric)
RR-F-00191/2	Fencing, Wire and Post, Metal (Chain-Link Fence Gates)
RR-F-00191/3	Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails, and Braces)
RR-F-00191/4	Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)
RR-F-221	Fencing, Wire (Barbed Wire, Woven Wire, and Netting) Fence Posts and Accessories.

32.2.2 U.S. Army Material Command (AMC):

Safety Manual, AMCR 385-100

32.2.3 U.S. Energy Research and Development Administration (ERDA):

ERDA Manual Appendix 6301

ERDA Manual Appendix 2401

32.3 MATERIALS.

32.3.1 Accessories.

Accessories shall consist of the parts indicated on the drawings and shall be of design standard with the manufacturer. Accessories shall conform to FS RR-F-00191 and RR-F-221 as applicable.

32.3.2 Wire Mesh Fabric.

Wire mesh fabric gage, mesh, size, fabric height, and edge finish shall be as indicated on the drawings, and shall conform to FS RR-F-00191, RR-F-00191/1, and RR-F-221, as applicable.

32.3.3 Concrete.

Concrete shall be 3,000 psi at 28 days and shall be as specified in Section 2.

32.3.4 Posts, Rails, Braces, and Gate Frames.

Posts, rails, braces, and gate frames for wire-mesh fencing shall be of the sizes and shapes indicated on the drawings, and shall conform to FS RR-F-183.

32.3.5 Wire.

32.3.5.1 Barbed Wire shall be two twisted strands of 12 1/2-gauge wire, with 2-point barbs spaced at not more than 4 inches apart and shall conform to FS RR-F-221.

32.3.5.2 Top and Bottom Reinforcing Wire for wire-mesh fencing shall conform to FS RR-F-00191 and be of gauge not lighter than that indicated on the drawings.

32.3.5.3 Tie Wire for attaching wire-mesh fabric to posts, rails, top-and-bottom reinforcing wires, and gates shall conform to FS RR-F-00191 or RR-F-221 as applicable.

32.3.6 Posts for Barbed Wire Fencing.

Posts for barbed wire fencing shall be of the drive type and of the length shown on the drawings.

32.4 INSTALLATION.

32.4.1 General.

The ground along the fence line shall be graded and compacted so that the vertical clearance between bottom of fence fabric and ground will not exceed 2 inches, unless otherwise shown on the drawings or approved by the Contracting Officer's Representative (COR).

32.4.2 Excavation.

Excavation for posts and other concrete-embedded items in other than bedrock shall be of the dimensions indicated on the drawings. If bedrock is encountered before reaching the required depth, the excavation shall be continued to the depth indicated or 18 inches into the bedrock, whichever is less, and shall be a minimum of 6 inches in diameter larger than the post. Waste material from excavation shall be spread where directed. Post holes shall be thoroughly cleared of loose material.

32.4.3 Post Setting.

Posts, where indicated on the drawings shall be set in concrete. Concrete shall be thoroughly compacted by the hand-tamp method with a rod of sufficient length to reach the bottom of the post hole and the top shall be finished in a dome shape. Line posts in material other than rock shall have concrete bases of dimensions indicated on the drawings, and in rock, shall have a minimum of 3 inches of concrete all around. Concrete shall be allowed to cure a minimum of 72 hours before any further work is done on the posts. Care shall be taken to ensure proper alinement and plumb installation.

32.4.4 Post Tops.

Post tops shall be installed as recommended by the manufacturer. Post tops shall be of the design required to accommodate the top rail or top wire and barbed wire extension arms as indicated on the drawings. In addition to manufacturer's standard connections, barbed-wire extension arms shall be securely anchored to posts by use of through-bolts or other approved method.

32.4.5 Top Rail.

Top rail, where indicated, shall be installed prior to installation of wire-mesh fabric. The top rail shall have expansion couplings spaced as indicated. An expansion-contraction coupler standard with the manufacturer shall be provided every 100 feet or fraction thereof. Straight runs between braced posts shall not exceed 500 feet. End clamps shall be used for attaching top rail to end posts, gate posts, and pull posts, and for attaching braces to line posts and gate posts. Corner clamps shall be used for attaching top rail and braces at corner posts.

32.4.6 Top and Bottom Wires.

Top and bottom wires, where indicated, shall be installed prior to installation of wire-mesh fabric and shall be pulled taut. Straight runs between braced post shall not exceed 500 feet and each end, gate, corner, or pull post shall be equipped with a wire-stretching band.

32.4.7 Fabric.

Fabric shall be pulled taut and secured to the top rail, or top wire and bottom wire close to both sides of each post and at intervals of not more than 24 inches apart and to the posts at intervals of not more than 14 inches apart with tie wires. Fabric shall be attached to end, corner, pull, and gate posts with stretcher bars and stretcher-bar bands. Bands shall be equally spaced on the stretcher bar and not over 14 inches apart.

32.4.8 Barbed Wire.

Barbed wire shall be installed on extension arms above the chain-link fence posts where indicated on the drawings. The method of securing wire shall be positive and completed at each extension arm. When the method requires several wires to be connected to each extension arm, the assembly shall be positive in all respects. Each strand shall be pulled taut and securely fastened to the extension arms in the manner recommended by the manufacturer of the extension arms. Wire shall be attached to end, corner, pull, or gate posts with wire-stretching bands.

32.4.9 Gates.

Gates shall be of the sliding type or swing type, as indicated. Swing gates shall be hinged to swing through 90 degrees or 180 degrees, as indicated, from closed to open, and shall be complete with latches, stops, keepers, hinges, fabric, braces, and locks. Extension arms for three strands of barbed wire above the fabric shall be provided where required to match adjoining fence. Keepers shall be manufacturer's standard, located on gate or ground. Sliding gates shall be as detailed on the drawings.

32.4.9.1 Gate Frames shall be constructed of round or square tubular members. Gate sections more than 8 feet wide shall have intermediate members and diagonal truss rods or tubular members as necessary to provide rigid construction, free from sag or twist. Gates less than 8 feet wide shall have truss rods or intermediate braces. The end members of gate frames shall be extended sufficiently above the top member to carry strands of barbed wire in perfect horizontal alignment with the strands of barbed wire on the fence; clips or other approved attachments shall be utilized for securely fastening the barbed wire to the extended members. Joints between tubular members shall be made by welding or by means of heavy fittings. Connections shall be rigid and weathertight. Truss rods shall be 3/8-inch minimum diameter. Plunger bars shall be provided on double gates. Plunger bars shall have top, bottom, and middle locking points with the middle point arranged for padlocking. The padlock shall be accessible from both sides of the gate.

32.4.9.2 Gate Fabric shall be of the same wire-mesh fabric used in the fence. Fabric shall be attached to gate-frame ends by use of bolt hooks, stretcher-bar bands and stretcher bars, or by other methods standard with the manufacturer, except that welding the fabric to the gate frame will not be permitted. The top and bottom of fabric shall be attached with specified wire ties at intervals not exceeding 14 inches apart.

32.4.10 Barbed-Wire Fencing.

32.4.10.1 Drive Posts shall be spaced as indicated on the drawings, driven to the depth required to provide the fence height indicated.

32.4.10.2 Barbed Wire shall be spaced as indicated to provide the number of strands shown on the drawings. Barbed wire shall be fastened as required by the type of post to be used in the work.

32.4.10.3 Gates shall be of the design indicated on the drawings. Security gate hinges shall have tight, nonremovable pins; latches shall be provided with means of padlocking.

32.4.11 Security Fence Ditch Closure.

Where a ditch or other unavoidable depression requires a security closure, it shall be accomplished, unless otherwise shown on the drawings, by setting a welded grid of #6 rebar 6 inches center-to-center each way 3 inches deep in a 6-inch thick by 2-foot 6-inch wide concrete apron, centered on the fence line, placed between line posts, and fastening the upper end to the bottom tie wire and fence fabric.

32.5 GROUNDING.

Security fences, fences enclosing explosive storage areas, and fences enclosing electrical substations shall be grounded in accordance with AMCR-385-100, ERDA Manual Appendix 6301, and ERDA Manual Appendix 2401, as applicable.

32.6 SECURITY FENCES.

All security fences shall be constructed in accordance with ERDA Manual Appendix 6301 and ERDA Appendix 2401.

32.7 SIGNS.

All signs to be installed on a fence shall be of the size and type shown on the drawings. Size, type, and color of letters shall be as indicated.

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SECTION 34

CULVERTS

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SECTION 34

CULVERTS

34.1 GENERAL.

This section covers the requirements for furnishing all materials and constructing pipe culverts, headwalls, and appurtenances as shown and noted on the drawings and specified.

34.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

34.2.1 American Association of State Highway Officials (AASHO):

M 36 Corrugated zinc-coated (Galvanized) Iron or Steel Culverts and Under Drains

M 170 Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

M 196 Corrugated Aluminum Alloy Culvert Pipe

34.2.2 State of Nevada Dept. of Highways (SNDH):

Standard Specifications for Road and Bridge Construction

34.3 PIPE FOR CULVERTS

34.3.1 Metal Pipe.

Metal pipe shall be galvanized corrugated metal, unpaved, pipe and pipe arch as manufactured by Armco Drainage and Metal Products, Inc., or an approved equal and shall conform to the drawings and AASHO M 36. Corrugated metal pipe and pipe arch shall be of the gauge indicated on the drawings. Culverts shall be shipped and handled in such a manner as to prevent bruising, scaling, or breaking of spelter coating. Damaged spelter coating shall be repaired in accordance with the requirements of AASHO designation M 36. Corrugated metal pipe arches shall consist of corrugated metal pipe that has been reformed to multicentered pipe having an arch-shaped top with a slightly outward-curved integral bottom. Dimensions of pipe arch shall be in accordance with the drawings.

34.3.2 Aluminum Pipe

Corrugated aluminum pipe shall conform to the requirements of AASHO M 196.

34.3.3 Reinforced Concrete Pipe.

Reinforced concrete pipe, where shown on the drawings, shall be of the type, class, and size indicated. The pipe shall conform to AASHTO M 170. Elliptical pipe with circular reinforcing and circular pipe with elliptical reinforcing shall have a continuous axial line painted on the outside of the pipe so that when the pipe is laid in its proper position, the line will be on the top of the pipe, thereby facilitating proper setting of the pipe sections and easy inspection upon completion of the pipeline.

34.4 TRENCHING AND BEDDING FOR PIPE CULVERTS.

Excavation and backfilling for culverts shall be in accordance with Section No. 1, and the following requirements:

34.4.1 Trenching.

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 20 inches to permit satisfactory joining and thorough tamping of the bedding material under and around the pipe. Care shall be taken not to overexcavate.

34.4.2 Bedding.

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. The pipe shall be carefully bedded in a tamped soil foundation that has been accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or the lower curved portion of pipe arch.

34.5 INSTALLATION OF PIPE.

34.5.1 General.

Each pipe will be carefully examined at the direction of the Contracting Officer's Representative (COR) before being laid. Defective or damaged pipe shall not be used unless repairs satisfactory to COR can be made to the pipe. Culverts shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe be laid in water or on frozen trench bottom, and no pipe shall be laid when, in the opinion of the COR, trench conditions or weather are unsuitable for such work. All pipe in place shall have been inspected and approved before backfilling. Care shall be taken to prevent damage to or misalignment of the pipe.

34.5.2 Corrugated Metal Pipe Laying.

Pipe shall be laid with separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. Any unprotected metal in the joints of the culvert pipe shall be coated with approved bituminous paint. During

installation, the culvert pipe shall be handled with care to prevent damage to the spelter coating. Prior to placing the backfill, damaged areas of the coupling bands and culvert pipe shall be repaired as specified in Paragraph 34.3.1. Pipes of a diameter of 48 inches or more shall be elongated vertically 5 percent before placement of fill. Elongation of the vertical diameter may be accomplished by jacking in the field or by prefabrication. The method of jacking shall be subject to the approval of the COR. A tolerance of 25 percent above or below the specified amount will be allowed. Where preformed elliptical pipe is used and strutting is specified, further distortion is not required but the struts shall be wedged tightly in place.

34.5.2.1 Jointing. In making corrugated metal pipe joints or pipe arch joints, the space between the pipe and connecting bands shall be kept free from dirt and grit so that the corrugations fit snugly. The connecting band while being tightened shall be tapped with a softhead mallet of wood, rubber, or plastic to take up slack and ensure a tight joint.

34.5.2.2 Standard Field Joints. Field joints shall be made with outside bands, each band consisting of one or two pieces. The type, size, and size of angles and bolts shall be the standard of the manufacturer of the pipe.

34.5.3 Reinforced Concrete Pipe Laying.

Bed first pipe section to the established grade line with groove end upstream. Prepare a shallow excavation underneath the joint and fill with mortar to provide a firm bed for the second pipe section. The grooved end of the first pipe shall be carefully cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned carefully with a wet brush, and while in a horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall then be inserted in the groove end of the first pipe, until mortar is squeezed out on the interior and exterior surfaces. Sufficient mortar shall be used to completely fill the joint and to form a bead on the outside. The interior surface of the pipe at the joint shall then be brushed smooth. The mortar on the outside shall immediately be protected from the air and sun with a cover of wetted burlap and shall be kept protected until the mortar is satisfactorily cured. (Reference Paragraph 34.4.6.)

34.5.4 Multiple-Pipe Culverts.

Where multiple lines of pipe are installed, the adjacent sides of the pipe shall be separated as indicated on the drawings.

34.6 BACKFILLING FOR PIPE

34.6.1 Backfilling.

Backfilling is specified in Section No. 1.

34.6.2 Construction Machinery.

In compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert at any stage of the construction shall be avoided to the fullest extent possible.

34.6.3 Compaction.

Backfill over and around the pipe shall be compacted as specified in Section No. 1.

34.7 FLARED-END SECTIONS.

Flared-end sections for metal pipe shall be placed on the culverts as indicated, shall be of a design standard with the pipe manufacturer, and shall conform to the requirements of this section for corrugated metal pipe.

34.8 HEADWALLS.

Headwalls where shown on the drawings, shall be constructed in accordance with the details indicated thereon. All work shall conform to Section No. 2.

34.9 BEVELED ENDS.

Pipe culverts shall be cut with the embankment (2:1) and the skew. Spelter coating that is damaged during beveling operations shall be repaired as specified above.

34.10 EARTH COVER.

All culverts, after bedded and backfilled as specified in this section, shall be protected by a 4-foot cover of fill material before heavy equipment will be permitted to cross during construction.

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SECTION 35

AGGREGATE BASE COURSE

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SECTION 35

AGGREGATE BASE COURSE

35.1 GENERAL.

This section covers the requirements for furnishing all materials and equipment and constructing the aggregate base course as shown and noted on the drawings and specified.

35.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

35.2.1 State of Nevada Department of Highways (SNDH):

Standard Specifications for Road and Bridge Construction

Materials Manual of Testing Procedures

35.2.2 Occupational Safety and Health Administration (OSHA):

Part 1926, Safety and Health Regulations for Construction

35.3 SAMPLING AND TESTING.

Sampling and testing will be the responsibility of the Government. Samples will be obtained at the source, stockpile, and other locations, as required, for determination of gradation, liquid limit, plastic limit and plasticity index, density, and all other testing, as necessary, during progress of the work.

35.4 MATERIALS.

The aggregate for the gravel base course and the mineral aggregate shall be selected from designated gravel pits, or may be imported, with the approval of the Contracting Officer's Representative (COR). Aggregates shall be free from organic matter, objectionable coatings, and other foreign material and shall be durable and sound. The portion retained on No. 4 sieve shall be known as coarse aggregate, and the material passing the No. 4 sieve shall be known as binder material.

35.4.1 Coarse Aggregate.

Coarse aggregate shall consist of angular fragments reasonably uniform in density and quality. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3, and an elongated particle is one having a ratio of length to width greater than 3.

35.4.2 Pit-Run Aggregate.

Pit-run aggregate may be used in the construction of base courses where shown or noted on the drawings or specified. The pit-run material shall be hard, durable, and free from excessive disintegrated pieces, alkali and vegetable matter. Gradation will be determined by laboratory tests.

35.4.3 Binder Material.

Binder material shall consist of screenings, angular sand, soil, or other finely divided mineral matter processed or naturally combined with the coarse aggregate. It shall be of such character that the composite material will conform to Paragraph 35.4.5, Gradation.

35.4.4 Deficiencies.

If the product of a deposit is deficient in material passing the No. 16 sieve, binder material from other approved deposits, meeting the requirements specified herein, may be added at the crushing and screening plants.

35.4.5 Gradation.

The aggregate shall conform to one of the following sieve analyses, the size to be selected after adequate material is produced by the gravel plant to secure representative samples. The size selected, 1 1/2-inch or 1-inch, shall then be used for all gravel base produced from the deposit.

<u>Laboratory Sieve Sizes (Square Openings)</u>	<u>Percentage by Weight 1 1/2-inch size</u>	<u>Passing Sieve 1-inch size</u>
1 1/2-inch	100	-
1-inch	80-100	100
3/4-inch		90-100
No. 4	30-65	35-65
No. 16	15-40	15-40
No. 200	2-12	2-10

Base course shall meet the following tests of Nevada Standard Test Procedures.

<u>Test</u>	<u>Test Method</u>	<u>Requirements</u>
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	
Crushed Particles	Nev. T230	35 percent minimum
Plasticity Index	Nev. T212	Table I*
Liquid Limit	Nev. T210	35 maximum
Resistance Value	Nev. T115	70 minimum
(R Value)		
Percentage of Wear	Nev. T233	45 percent maximum
(500 Rev.)		

- * See Paragraph 704.02.03 SNDH Standard Specifications for Road and Bridge Construction.

35.5 WORKMANSHIP.

All work in conjunction with the construction of the aggregate base course shall conform to Section 302 of the SNDH "Standard Specification for Road and Bridge Construction," as applicable, and to this specification.

35.6 EQUIPMENT.

All plant, equipment, tools, and machines used in the performance of the work covered by this section shall be approved by the COR prior to commencement of work. This equipment shall be maintained in satisfactory working condition at all times. Plant and equipment shall meet OSHA 1926.

35.6.1 Power Rollers.

Power rollers shall be the self-propelled three-wheel or tandem type weighing not less than 10 tons, and shall have a maximum weight of 300 pounds per inch width of rear wheel. The wheels shall be equipped with adjustable scrapers.

35.6.2 Blade Graders.

Blade graders shall have a wheel base of not less than 15 feet, a blade of not less than 10 feet in length, and shall be self-propelled.

35.6.3 Small Rubber-Tired Rollers.

Small rubber-tired rollers shall consist of two axles on which are mounted not less than nine rubber-tired wheels, five wheels on one axle and four on the other, mounted in such a manner that the rear group of tires will not follow in the tracks of the forward group. The axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading so that the total weight of the roller can be varied to produce an operating weight per tire of between 1,000 and 2,000 pounds. The tires shall be self-propelled and shall weigh not less than 8 tons.

35.6.4 Sprinkling Equipment.

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

35.6.5 Hauling Equipment.

Hauling equipment shall consist of pneumatic-tired vehicles having dump bodies suitable for dumping materials in windrows or into spreading machines.

35.6.6 Spreader.

Spreader shall be of the hopper type and shall be equipped with an adjustable screed capable of laying material to uniform thicknesses with a minimum range of 1-to-8 inches over a minimum lane width of 8 feet. The hopper shall be a shape that minimizes segregation, and shall be carried on pneumatic-tired trucks on drum-type steel rollers or crawler tracks that will not dig into or scuff the subgrade. The spreader may be either the towed type for attaching directly to the dump truck or the self-propelled type with sufficient power to propel the dump truck. An asphaltic-concrete paver may be used where approved. The base shall be of uniform thickness, free of ridges and depressions.

35.6.7 Tampers.

Tampers shall be of an approved mechanical type operated by either pneumatic pressure or internal combustion. They shall have sufficient weight and striking power to produce the compaction required in Paragraph 35.12, "Compaction."

35.6.8 Miscellaneous Equipment.

Tractors, windrow equalizers, plows, and other equipment used on the job shall be of approved types suitable for constructing aggregate base course.

35.7 WEATHER LIMITATIONS.

Aggregate base courses shall not be constructed when the atmospheric temperature is below 35° F. Any areas of completed base courses that are damaged by freezing, rainfall, or other weather conditions shall be brought to a satisfactory condition by the Constructor in conformance with this specification.

35.8 PREPARATION OF SUBGRADE.

Prior to constructing the base course, the previously constructed subgrade shall be cleaned of all foreign substances. The surface of the subgrade will be inspected for adequate compaction and surface tolerances. The subgrade shall conform to Section 1. Ruts or soft yielding spots that may appear in the subgrade, areas having inadequate compaction, and deviations of the surface from the requirements set forth therein shall be corrected to line and grade and to all specification requirements. For cohesionless subgrades containing sands, sand-gravels, or any other cohesionless material in harmful quantities, the surface shall be stabilized with aggregate prior to placement of the base course. Stabilization may be accomplished by mixing base-course material into the existing subgrade and compacting by approved methods. The stabilized material will be considered as part of the underlying course and shall meet all requirements for the underlying course.

35.9 GRADE CONTROL.

During construction, the lines and grades indicated for the base course shall be maintained by means of line and grade stakes placed by the Constructor, or an approved survey team.

35.10 MIXING AND PLACING MATERIALS.

The placing procedures apply to each layer of the base course. The Constructor shall make such adjustments in mixing or placing procedures or in equipment as are necessary to obtain grades within the allowable tolerance, to minimize segregation and degradation, to reduce or accelerate loss or gain of water, and to ensure a satisfactory base course.

35.10.1 Stationary-Plant Method.

The coarse aggregates and binder materials shall be proportioned by weight or by volume in quantities so that the required gradation, liquid-limit, and plasticity-index requirements will be met. Adjustments of percentages of coarse aggregates and binder material shall be made by the Constructor when directed by the COR. Water in approved quantities, measured by weight or volume, shall be added during mixing. Mixing operations shall produce an approved uniform blend. The finished mixture shall be hauled to the area to be paved in pneumatic-tired vehicles. The material shall be placed in a uniform layer to the required contour and grades, and to a loose depth that, when compacted, will produce a layer of the designated thickness. The material shall be placed uniformly on the subgrade from spreader boxes or mechanical spreaders to the required contour and grades. Unsatisfactory areas shall be removed and replaced with satisfactory mixture, or the material shall be mixed in the area, as directed by the COR. Blading will not be permitted when a spreader is used.

35.10.2 Traveling-Plant Method.

The coarse aggregates and binder materials shall be hauled to the area to be paved in approved pneumatic-tired vehicles and deposited in windrows of such proportions that the required gradation, liquid-limit, and plasticity-index requirement will be met. The size of the windrow of combined material shall not exceed the rated capacity of the traveling plant. Adjustments in percentages of coarse aggregates and binder materials shall be made by the Constructor when directed. The materials shall be mixed by the traveling plant and deposited on the subgrade in windrows of uniform cross section. Water in approved quantities shall be added during mixing. Mixing operations shall produce an approved uniform blend. The windrowed mixed material shall be spread by blade graders and in a layer of uniform thickness to the required contour and grades and to a loose depth that, when compacted, will produce a layer of the designated thickness. Unsatisfactory areas shall be removed and replaced with satisfactory material, or the material shall be mixed in the area, as directed by the COR.

35.10.3 Road-Mix Method.

35.10.3.1 The Coarse Aggregates and Binder Materials shall be hauled to the area to be paved in approved pneumatic-tired vehicles. The materials shall be spread in layers of uniform thickness from spreader boxes or moving vehicles. Aggregate shall be placed, using an approved blade grader, in a layer of uniform thickness on the subgrade without segregation of sizes, followed by placing thereon uniform layers of the other materials to such loose depths and proportions that, when mixed together, using an approved blade grader, and compacted, the finished layer will conform to the required gradation, liquid-limit, plasticity-index, and designated thickness.

35.10.3.2 The Fine Aggregates and Binder Materials as an alternate may be placed on the subgrade in windrows of such cross-section proportions that, when mixed, spread, and compacted, the layer will conform to the required gradation, the liquid-limit, the plasticity-index, and to the thickness indicated. The material shall be mixed with mechanical mixers, blade graders, harrows, discs, or other approved equipment, in such manner as not to disturb or mix material from the underlying subgrade into the overlying layer. The windrowed material shall then be spread in a layer of uniform thickness.

35.10.3.3 Mixing shall continue until the mixture is uniform throughout, adding water to the extent necessary to prevent segregation during mixing. Water shall be added as required during mixing, in accordance with Paragraph 1.15, Watering. Mixing shall continue until the water is uniformly distributed throughout. Following this mixing procedure, the approved mixture shall be leveled to the required contour and grades with blade graders. Unsatisfactory areas shall be removed and replaced with suitable material, or, where approved by the COR, the material shall be remixed in the area.

35.11 LAYER THICKNESS.

The compacted thickness of the base course shall be as indicated on the drawings. When a compacted layer of 6 inches is specified, the material may be placed in a single layer. When a total compacted thickness of more than 6 inches is required, no single layer of the placed material shall be in excess of 6 inches nor less than 3 inches when compacted.

35.12 COMPACTION.

Each layer of the base course shall be compacted with vibratory rollers, rubber-tired rollers, or smooth-wheeled power rollers. Water content shall be maintained at optimum or at the percentage required for compaction. In all places not accessible to the rollers, the mixture shall be compacted with mechanical tampers. Compaction shall continue until each layer through the full depth is compacted to a relative compaction of not less than 95 percent, in accordance with Paragraph 1.10, Compaction Control. The Constructor shall make such adjustments in rolling or finishing procedures as may be required to obtain true grades,

to minimize segregation and degradation, to reduce or accelerate loss or gain of water, and to ensure a satisfactory base course. Unsuitable materials shall be reworked to produce a suitable material.

35.13 EDGES OF BASE COURSE.

Approved material shall be placed along the edges of the base course in such quantities as will compact to the thickness of the course being constructed or, when the course is being constructed in two or more layers, to the thickness of each layer of the course, allowing in each operation at least a 1-foot width of the shoulder to be rolled and compacted simultaneously with the rolling and compacting of each layer of the base course.

35.14 SMOOTHNESS TEST.

The surface of each layer shall not show any deviations in excess of .04 foot when tested with a 12-foot straightedge applied both parallel with and at right angles to the centerline of the completed area. Deviations in excess of .04 foot when tested with a 12-foot straightedge applied both parallel with and at right angles to the centerline of the completed area. In addition, the finished surface of the base course shall not vary more than 0.05 foot from the established grade or approved cross section with no more than 0.05 foot accumulated deviation between stations. Any deviation in excess of these tolerances shall be corrected by the Constructor by removing material by adding new material, or by reworking existing material and compacting.

35.15 THICKNESS CONTROL.

The completed thicknesses of the base course shall be within 1/2 inch minus of the thickness indicated on the drawings or approved by the COR. Excess thickness is acceptable provided surface grades and tolerances are met. The thickness of the base course shall be measured at intervals in such manner that there will be a thickness measurement for at least each 500 square yards of base course. Thickness measurement shall be made by test holes at least 3 inches in diameter through the base course. Where the measured thickness of the base course is more than 1/2-inch deficient in thickness the Constructor shall correct such areas by scarifying, adding mixture of proper gradation, reblading, and recompacting. Where the measured thickness of the base course is more than 1/2-inch thicker than indicated, it shall be considered as conforming with the required thickness requirements.

35.16 PROTECTION.

The Constructor shall protect and maintain the base course in a satisfactory condition until the surface course is placed thereon. If a loss of density occurs in the base course material for any reason, recompaction to the specified density will be required prior to placement of any subsequent course.

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SECTION 36

BITUMINOUS PRIME COAT

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SECTION 36

BITUMINOUS PRIME COAT

36.1 GENERAL.

This section covers the requirements for the application of a bituminous prime coat, including any necessary surface preparation of underlying subgrade or base course, to an untreated base to prepare it for an asphalt surface.

36.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

36.2.1 State of Nevada Department of Highways (SNDH)

Standard Specifications for Road and Bridge Construction

Materials Manual of Testing Procedures

36.2.2 American Society for Testing and Materials (ASTM).

D 140 Sampling Bituminous Material

D 1250 Standard Petroleum Measurement Tables

36.2.3 Occupational Safety and Health Administration (OSHA):

Part 1926 Safety and Health Regulations for Construction

36.3 SAMPLING AND TESTING.

Samples of bituminous material, may be required during construction and unless otherwise specified, shall be in accordance with ASTM Standard D 140. All test samples shall be supplied by the Constructor. The source(s) from which the bituminous material is to be obtained shall be selected before the material is required for use in the work. The Constructor shall furnish to the Contracting Officer's Representative (COR) with the manufacturer's certified test report for each shipment of bituminous material used in the work.

36.4 MATERIALS.

The bituminous material shall conform to the requirements of SNDH Standard Specifications for Road and Bridge Construction. The prime coat, unless otherwise shown on the drawings of approved by the COR, shall be MC 70 liquid asphalt, applied at a rate of 0.2 to 0.5 gallons per square yard and at a temperature of 120° F. minimum, and 180° F. maximum.

36.5 WEATHER LIMITATIONS.

The prime coat shall be applied only when the subgrade or base course is dry or contains moisture not in excess of the amount that will permit uniform distribution and the desired penetration. Bituminous materials shall not be applied when the atmospheric temperature is below 50° F. or when weather conditions, in the opinion of the COR, would prevent the proper penetration of the prime coat.

36.6 EQUIPMENT.

Equipment, tools, and machines used in the performance of the work required by this section shall be subject to approval of the COR and shall be maintained in satisfactory working condition at all times. All equipment shall meet OSHA 1926.

36.6.1 Bituminous Distributor.

Bituminous distributor shall have pneumatic tires of such width and number that the load produced on the base surface shall not exceed 650 pounds per inch of tire width. The distributor shall be designed and equipped to distribute the bituminous material uniformly at an even heat on variable widths of surface at readily determined and controlled rates from 0.2 to 0.5 gallons per square yard, with a pressure range of 25 to 75 pounds per square inch and with an allowable variation not to exceed 5 percent from any specified rate. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gages, volume-measuring devices, adequate heaters for heating materials to the proper application temperature, a thermometer to show the temperature of tank contents, and a hose attachment suitable for applying bituminous material to spots unavoidably missed by the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process. The tank shall be insulated. Certification of the calibration of the spreader shall be presented to the COR.

36.6.2 Heating Equipment for Storage Tanks.

The equipment for heating bituminous material shall include steam coils and equipment for producing steam, so designed that steam cannot get into the material. An armored thermometer with a range from 40° F. to 200° F. shall be fixed to the tank so that the temperature of the bituminous material may be read at all times.

36.7 PREPARATION OF SURFACE.

The surface upon which the bituminous prime coat is to be placed shall conform to the established lines and grades; shall be smooth and uniform; and shall be compacted to the required density. If the required density deteriorates for any reason whatsoever from the time the last course was compacted originally and the time the prime coat is placed, then the surface shall be recompacted to the required density. The bituminous

material shall be uniformly applied at the rate specified above. To assure a uniform spread of the bituminous material, the portion of the subgrade or base course prepared for treatment, if excessively dry, shall be lightly sprinkled with water immediately before the application, with the approval of the COR.

36.8 APPLICATION OF BITUMINOUS MATERIAL.

Following the preparation of the subgrade or base course, the bituminous material shall be applied, at a temperature within the range specified, by means of a bituminous spreader. The bituminous material shall be applied at a pressure within the range of 25 to 75 pounds per square inch and in the amounts required. The bituminous material shall be applied with uniform distribution at all points of the surface to be treated. Unless the distributor is equipped to obtain satisfactory results at the junction of previous and subsequent applications, building paper shall be spread on the surface of the applied material for a sufficient distance back from the ends of each application so that flow from the sprays may be started and stopped on the paper, and so that all sprayers will operate at full force on the surface to be treated. Immediately after the application, the building paper shall be removed. All lightly coated areas and spots missed by the distributor shall be properly treated with bituminous material applied with a hand spray. Following the application of prime material, the surface shall be allowed to dry without being disturbed for a period of not less than 48 hours or longer, as may be necessary to attain penetration into the subgrade or base course and evaporation of the volatiles from the prime coat material. The Constructor shall furnish and spread enough approved sand to effectively blot up and cure any excess bituminous material. The Constructor shall maintain the primed surface until the surface course is placed, by protecting the surface against damage and by repairing broken spots. No smoking, fires, or flames other than the heaters that are a part of the equipment shall be permitted within 25 feet of the heating, distributing, or transferring operations of bituminous materials. This does not apply to bituminous emulsions.

SECTION 37

BITUMINOUS TACK COAT

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SECTION 37

BITUMINOUS TACK COAT

37.1 GENERAL.

This section covers the requirements for the application of a bituminous tack coat between the courses of plant-mix surface or over an existing bituminous or rigid pavement prior to placement of and overlaying asphalt surface.

37.2 APPLICABLE PUBLICATIONS.

Same as Paragraph 36.2.

37.3 SAMPLING AND TESTING.

Same as Paragraph 36.3.

37.4 MATERIALS.

The bituminous materials shall conform to the requirements of SNDH Standard Specifications for Road and Bridge Construction. The tack coat, unless otherwise shown on the drawings or approved by the Contracting Officer's Representative (COR), shall be SS1 or SS1h, diluted 40 percent of the emulsified asphalt by weight with water, applied at a rate of 0.05 to 0.15 gallons per square yard at a temperature of 75° F. minimum, and 130° F. maximum.

37.5 WEATHER LIMITATIONS.

The tack coat shall not be applied when the atmospheric temperature is below 40° F. or when weather conditions in the opinion of the COR would prevent the proper construction of the tack coat.

37.6 EQUIPMENT.

Same as Paragraph 36.6.

37.6.1 Bituminous Distributor

Same as Paragraph 36.6.1.

37.6.2 Heating Equipment for Storage Tanks.

Same as Paragraph 36.6.2.

37.6.3 Power Brooms and Power Blowers.

Power brooms and power blowers shall be suitable for cleaning the surfaces to which the tack coat is to be applied.

37.7 PREPARATION OF SURFACE.

Immediately before applying the tack coat, all loose material, dirt, or other objectionable material shall be removed from the surface to be treated, with a power broom or blower, supplemented with hand brooms. After the cleaning operation, and prior to the application of the tack coat, an inspection of the area to be treated will be made to determine the fitness of the area to receive the bituminous coating. That portion of the surface prepared for immediate treatment shall be dry and in a satisfactory condition, except, if the existing pavement temperature is 140° F. or above, the surface of the pavement and all crack faces shall be wetted thoroughly with water, all surfaces shall be in a uniformly damp condition, and no free water will be allowed on the surface or in the cracks when the bituminous coating is applied.

37.8 APPLICATION OF BITUMINOUS MATERIAL.

Same as Paragraph 36.8 except following the application of the bituminous material, the surface shall be allowed to dry until it is in a proper condition of tackiness to receive the surface course. The bituminous coating shall be applied only so far in advance of surface-course placement that it will be covered during the following 36 hours. The Constructor shall furnish and spread a sufficient quantity of clean, dry sand on all areas that show an excess of bituminous coating, to effectively blot up and cure the excess. The treated surface shall be maintained by the Constructor until the succeeding layer of pavement, has been placed. During this interval, the Constructor shall protect the treated surface against damage.

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SECTION 38

BITUMINOUS SURFACE COURSE

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SECTION 38

BITUMINOUS SURFACE COURSE

38.1 GENERAL.

This section covers the requirements for the construction of a hot-mix surface course on a previously prepared base.

38.2 APPLICABLE PUBLICATIONS.

Same as Paragraph 36.2

38.3 SAMPLING AND TESTING.

Same as Paragraph 36.3

38.4 MATERIALS.

The bituminous surface course shall consist of fine and coarse aggregates and mineral filler uniformly mixed with hot bituminous material, and placed and compacted on a prepared base course. Materials shall conform to the applicable publications listed under Paragraph 38.2.

38.5 AGGREGATES

Aggregates shall consist of crushed stone, crushed or uncrushed gravel, screenings, sand, and mineral filler conforming to the requirements specified below. The portion of these materials retained on the No. 10 sieve shall be known as coarse aggregate; the portion passing the No. 10 sieve and retained on the No. 200 sieve shall be known as fine aggregate; and the portion passing the No. 200 sieve shall be known as mineral filler. The coarse and fine aggregates and mineral filler shall be so graded and of such character that when combined, a blend will be produced that will meet the requirements specified in subsequent Paragraphs 38.6, 38.7, and 38.8.

38.5.1 Coarse Aggregates.

Coarse aggregates shall consist of particle shapes which are generally spherical or cubical. The flat particles to elongated particles in any size group shall not exceed 20 percent. A flat particle is one having a ratio of width to thickness greater than three, and an elongated particle is one having a ratio of length to width greater than three. Coarse aggregates shall consist of the following:

38.5.1.1 Crushed Gravel or Uncrushed Gravel shall be sound, durable, free from adherent coatings of clay, dust, and other objectionable matter.

38.5.1.2 Crushed Stone shall consist of clean, sound, durable fragments free from access of soft or disintegrated pieces, dust, dirt, and other objectionable matter.

38.5.2 Fine Aggregates.

Fine aggregates shall consist of natural sands; manufactured sands prepared by crushing stone or gravel; or any combination of natural and manufactured sands. Natural sands shall consist of grains of quartz sand or other hard, durable rock moderately sharp and free from injurious coatings, organic matter, and other foreign matter.

38.5.3 Mineral Filler.

Mineral filler shall consist of limestone dust, Portland cement, or other suitable mineral matter. It shall be thoroughly dry and free of lumps consisting of aggregations of fine particles.

38.6 ASPHALT MATERIAL.

Asphalt material used in the work shall be in accordance with the paving grade, AR4000 or AR8000, unless otherwise shown on the drawings or approved by the COR.

38.7 AGGREGATE GRADATION.

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified below unless otherwise approved by the COR. The gradations represent the extreme limits which shall determine suitability of aggregate for use from all sources of supply. The aggregate as finally selected for use in the work shall have a gradation within the limits designated and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa, but shall be uniformly graded from coarse to fine.

<u>Sieve Sizes</u>		<u>Percentage by Weight Passing Sieve</u>		
		<u>Type 1</u>	<u>Type 2</u>	<u>Type 3</u>
1	Inch	100	100	
3/4	Inch	90-100	90-100	
1/2	Inch			100
3/8	Inch		55-85	80-100
No. 4		40-65	40-65	40-70
No. 16		15-40	15-40	20-45
No. 200		3-9	3-9	3-10
<u>Project Control Tests</u>		<u>Test Method</u>	<u>Requirements</u>	
Sieve Analysis		Nev. T206	Above	
Sampling Aggregate		Nev. T200	---	
Fractured Faces		Nev. T230	50% Min. for Type 2, 35% Min. for Types 1 & 3	
Plasticity Index		Nev. T212	6% Max.	
Liquid Limit		Nev. T210	35% Max.	

<u>Source Requirement Tests</u>	<u>Test Method</u>	<u>Requirements</u>
Stripping Test	Nev. T209	Satisfactory
Stabilometer Value (Types 1 & 3)	Nev. T303	30 Min.
Stabilometer Value (Type 2)	Nev. T303	35 Min.
Moisture Vapor Susceptibility (Stabilometer Value)	Nev. T312	25 Min.
Swell Test	Nev. T304	0.030" Max.
Percentage of Wear (500 Rev.)	Nev. T233	45% Max.

38.8 JOB-MIX FORMULA.

The job-mix formula to be used in the manufacture of bituminous pavement will be laboratory-designed under the the supervision of the Contracting Officer's Representative (COR). The formula will indicate the percentage of each sieve fraction of aggregate, percentage of asphalt, temperature of the complete mixture when discharged from the mixer, and the temperature of the mixture in the hopper of the paving machine. The bitumen content and aggregate gradation may be adjusted within the limits of the gradation tables specified as follows:

Aggregate passing the No. 4, and larger sieves.	<u>+7%</u>
Aggregate passing the No. 8 to 100 sieves	<u>+4%</u>
Aggregate passing the No. 200 sieve	<u>+2%</u>
Bitumen content	<u>+0.4% of volume or batch weight of aggregate</u>
Temperature leaving the mixer	<u>+20° F.</u>
Temperature in hopper of paving machine	<u>+20° F.</u>

Should there be a change in sources of material, a new job-mix formula will be established before the new material is used. When unsatisfactory results make it necessary, the COR may establish a new job-mix formula and so notify the Constructor in writing.

The temperature of the bituminous material and the aggregate just prior to mixing; and the completed mixtures shall be within the following ranges unless otherwise approved by the COR.

<u>Grade of Paving Asphalt</u>	<u>Distributor Spraying Temp., °F.</u>		<u>Pugmill Mixing Temperature of Aggregates, °F.</u>	
	<u>Min.</u>	<u>Max.</u>	<u>Min.</u>	<u>Max.</u>
AR4000	295	350	275	325
AR8000	290	350	275	325

The temperature of the completed mixture at the hopper of the paver shall be not less than 240° F.

39.9 PLANT, EQUIPMENT, MACHINES, AND TOOLS.

Plant, equipment, machines, and tools used in the work shall be in conformance with the referenced sections of the Standard Specifications for Road and Bridge Construction, State of Nevada Department of Highways (SNDH).

38.10 MIXING PLANTS.

Mixing plants shall be designed as in Paragraph 38.9.

38.11 OTHER EQUIPMENT

38.11.1 Bituminous-Material Spreaders.

Bituminous-Material spreaders shall be the self-propelled type equipped with hoppers, tamping or vibrating devices, distributing screws, adjustable screeds, equipment for heating the screeds, and equalizing devices. The spreader shall be capable of spreading hot bituminous mixtures without tearing, shoving, or gouging, and capable of producing a finished surface conforming to the smoothness requirements specified hereinafter. The spreader shall be capable of confining the edges of the strips to true lines without the use of stationary side forms and capable of placing the course to the required thickness. Spreaders shall be designed to operate forward at variable speeds and in reverse at traveling speeds of not less than 100 feet per minute. The use of a spreader that leaves indented areas or other objectionable irregularities in the fresh-laid mix during operation will not be permitted.

38.11.2 Blowers and Brooms

Blowers and brooms shall be of the power type and shall be suitable for cleaning the surface to be paved.

38.11.3 Saw.

Saw shall be of the power type. The saw shall be capable of rapidly cutting pavement and trimming joints and edges of pavement.

38.11.4 Scales.

Scales shall be standard, beam-type truck scales equipped with an accurate weight-recording device and shall be of sufficient size and capacity to accommodate all trucks to be used in handling bituminous mixtures.

38.11.5 Small Tools.

Small tools shall consist of rakes, lutes, shovels, tampers, smoothing irons, pavement cutters, portable heater for heating small tools, wood

sandals and stilt sandals of standard type, and other small tools as may be required. A sufficient number of small tools shall be available at all times for use in constructing the bituminous pavements. The lutes shall be constructed of metal and shall consist of a plate or sheet 36 x 4 inches attached to a handle properly braced and with sufficient strength to adequately compact the free edge of a binder or surface course. Hand tampers shall weigh not less than 25 pounds and shall have a tamping face not larger than 50 square inches.

38.11.6 Rolling Equipment.

Rolling equipment used in the work shall conform to the requirements of these specifications.

All rollers shall be in first-class mechanical condition, self-propelled, and reversible, adequately equipped and powered, and shall be subject to the approval of the COR as to type, size, and mechanical condition. No roller shall be permitted on any project that does not have displayed thereon in permanent legible characters, the manufacturer's guaranteed weight without ballast. The rollers shall be continuously maintained in first-class operating condition throughout their use on the project. When rollers are found unsatisfactory by the COR, they will be changed, replaced, or removed from the work as directed.

The rolling equipment used in the work shall conform to the following requirements:

38.11.6.1 Steel Wheel Rollers. Three-wheel steel-tired rollers shall weigh not less than 10 tons, with a compression on the rear wheels of not less than 325 pounds per linear inch of tire width.

Three-axle steel-tired tandem rollers shall weigh not less than 10 tons. Two-axle steel-tired tandem rollers shall weigh not less than 8 tons. Rollers used for initial or breakdown rolling shall be equipped with rolling wheels having a diameter of 40 inches or more. The finish roller shall be a two-axle tandem weighing not less than 8 tons.

38.11.6.2 Pneumatic-Tired Roller. Pneumatic-tired rollers shall consist of not less than nine wheels equipped with pneumatic tires of equal size and diameter mounted on two axles attached to a rigid frame equipped with a loading platform or body suitable for ballast loading, so that the total weight of the roller can be varied to produce an operating weight per tire of between 1000 and 2000 pounds. The tires on the rear axle shall be so spaced that the entire gap between adjacent tires on the front axle will be covered by one tread of the following tires. The tires shall be uniformly inflated so that the air pressure in the several tires will not vary more than 5 pounds per square inch. Inflation pressure in pounds-per-square-inch shall be the tire manufacturer's recommendation. Minimum tire size shall be 7.50 x 15 inches, four (4) ply.

The use of pneumatic-tired rollers with a lesser number of wheels and a greater maximum operating weight per tire than that specified in this subsection of the Standard Specifications will be permitted subject to the following requirements:

- a. The minimum width between the outer edge of the outside tires on a given axle shall be sixty (60) inches.
- b. The weight of the roller and the tire pressure can be varied to produce a ground contact pressure between 50-70 psi.

38.12 MIXING.

The bituminous mixtures shall be produced in a plant as specified in Paragraph 38.9.

38.13 TRANSPORTATION OF BITUMINOUS MIXTURES.

The bituminous mixture shall be transported from the mixing plant to the site in trucks having tight, clean, smooth metal bodies that have been thinly coated with a minimum amount of paraffin oil, lime solution or other approved material to prevent adhesion of the mixture to the truck bodies. Deliveries shall be such that spreading and rolling of all the mixture prepared for a day's work can be completed during daylight unless satisfactory artificial light is provided. At the direction of the COR, each load of mixture shall be covered with canvas, or other suitable material, of ample size to protect mixture from weather and prevent loss of heat. Deliveries shall be scheduled so that spreading and rolling of all mixture prepared for one day's run can be completed during daylight hours unless adequate artificial lighting is provided and so that the mixture in the hopper of the spreading and finishing machine will not cool below specified temperature between loads. Mixture shall be delivered in such manner that temperature at time of dumping into spreader will be not less than specified in Paragraph 38.14.6. Loads that have crusts of cold, unworkable material or have become wet by rain will be rejected. Hauling over freshly placed material will not be permitted.

38.14 PLACING.

38.14.1 Weather Limitations.

Bituminous courses shall be constructed only when the base course or existing pavement is dry and when the weather is not rainy. Unless otherwise approved, asphalt courses shall not be constructed when the atmospheric temperature is below 40° F.

38.14.2 Surface Preparation of Underlying Course.

Prior to the laying of the surface course, the base course shall be cleared of all foreign or objectionable matter with power blowers, power brooms and hand brooms.

38.14.2.1 Reconditioning of Base Course. The previously constructed base course shall be conditioned as specified herein. In all cases, prior to laying the bituminous course, the surface shall be cleaned of loose and foreign matter by sweeping with power blowers, power broom, and hand brooms. The surface of the base course will be inspected for adequate compaction and surface tolerances specified in Section 35, "Stabilized Aggregate Base Course." Ruts or soft, yielding spots that may appear in the base course, areas having inadequate compaction, and deviations of the surface from the requirements specified for the base course shall be corrected by loosening the affected areas, removing unsatisfactory material and adding approved material where required, and reshaping and compacting to line and grade and to the specified density requirements.

38.14.3 Prime Coat.

When shown on the drawings, a prime coat shall be applied to the compacted roadbed. The liquid asphalt shall be of the grade indicated. Application shall be as specified under Section 36, "Bituminous Prime Coat."

38.14.4 Tack Coat.

Contact surfaces of previously constructed pavement, curbs, manholes, and similar structures shall be sprayed with a thin coat of bituminous material conforming to the requirements of Section 37, "Bituminous Prime Coat."

38.14.5 Grade Control.

The lines and grades shown on the drawings will be established and maintained by means of line and grade stakes placed at the site of the work. Elevations of bench marks for controlling pavement operations will be determined, established, and maintained at the direction of the COR.

38.14.6 General Requirements for Use of Mechanical Spreader.

Asphalt mixtures shall have a temperature of not less than 240° F. when dumped into the mechanical spreader. The mechanical spreader shall be so adjusted and its speed so regulated that the course being placed will be smooth and continuous without tears and pulling and will be of such depth that, when compacted, the cross section, grade, and contour will be as shown on the drawings. The mixture shall be placed in consecutive adjacent strips of convenient widths to cover the complete area. Unless otherwise directed, the placing shall begin on the high side of areas with a one-way slope or along the centerline of areas to be paved on a crowned section and shall be in the direction of the main traffic flow. Each strip laid before a succeeding strip shall be of such length that sufficient heat will be retained to make the strip readily compactible to obtain a joint that will conform to the requirements for texture, density, and smoothness specified in Paragraph 38.17, "Joints." Longitudinal joints and edges shall be constructed to true line markings. Lines shall be established parallel to the centerline of the area to be paved and string lines shall be placed that coincide with the established lines for

the spreading machine to follow. Placing of the mixture shall be as nearly continuous as possible, and the speed of placing shall be adjusted, as necessary, to permit proper rolling.

38.14.7 Special Requirements for Laying Strips Succeeding Initial Strips.

In laying each succeeding strip after the initial strip has been spread and compacted as specified hereinafter, the screed of the mechanical spreader shall overlap the previously placed strip 3 to 4 inches and shall be sufficiently raised that compaction effected by rolling will produce a smooth, dense joint. A mixture placed on the edge of the previously laid strip by the mechanical spreader shall be pushed back to the edge of the strip being laid by use of a metal lute. When the amount of mixture on the previously laid strip, plus the uncompacted material in the strip being laid, is in excess of that required to produce a smooth, dense joint, the excess mixture shall be removed and wasted.

38.14.8 Shoveling, Raking, and Tamping After Spreading.

A sufficient number of experience shovelers and rakers shall follow the spreading machine, adding hot mixture and raking the mixtures as required to produce a course that, when completed, will conform to all requirements specified herein; when not acceptable, the operation shall be suspended until enough shovelers and rakers are available to produce a course that is acceptable. Broadcasting or forming of mixture over areas being compacted will not be permitted. When segregation occurs in the mixture during placing, the spreading operation shall be suspended until the cause is determined and corrected. Irregularities in alinement of the course left by the mechanical spreader shall be corrected by trimming directly behind the machine. Immediately after trimming, the edges of the course shall be thoroughly compacted by tamping laterally with a metal lute.

38.14.9 Hand Spreading.

In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. The mixture shall be dumped on approved dump boards or on an adjacent approved area outside the area to be paved and shall be distributed into place from the dump boards or from the approved area by means of hot shovels. The mixture shall be spread uniformly with hot rakes in a loose layer of a thickness that will conform to the required grade and thickness when compacted. During hand spreading, each shovelful of mixture shall be carefully placed by turning the shovel over in a manner that will prevent segregation. In no case shall the mixture be placed by throwing or broadcasting from a shovel. In no case shall the mixture be placed by throwing or broadcasting from a shovel. The loads shall not be dumped faster than can be properly handled by the shovelers and rakers. Rakers standing in the hot mixture while raking the course shall wear stilt sandals.

38.14.10 Safety Precautions.

No smoking, fires, or flames other than the heaters that form a part of the equipment shall be permitted within 25 feet of heating, distributing, or transferring operations of bituminous materials other than bituminous emulsions.

38.15 COMPACTION.

Initial or breakdown rolling shall consist of one complete coverage of asphalt mixtures and shall be performed with a two-axle or three-axle tandem or a three-wheel roller.

Rolling shall be performed with the drive wheel of the tandem roller forward with respect to the direction of spreading operations, unless otherwise permitted by the COR.

The initial or breakdown rolling shall be followed by additional rolling consisting of four complete coverages and a pneumatic-tired roller while the temperature of the mixture is at or above 150° F.

Final rolling shall be performed with an 8-ton two-axle tandem roller and shall continue until the layer is smooth, free of ruts, humps, and irregularities. The completed bituminous surface, when ready for acceptance, shall be thoroughly compacted, smooth and true to grade and cross section. In accordance with Paragraph 38.20 the sequence of rolling may be modified to provide breakdown rolling with a two-axle tandem or pneumatic-tired roller and final rolling with a three-axle tandem with the approval of the COR. All rolling shall start longitudinally at the edge of the course and proceed toward the center of the pavement, overlapping on successive trips, approximately 12 inches. On superelevated curves, it shall progress from the lower side to the high side overlapping as above specified. The speed of the rollers shall be slow enough to avoid displacement of the hot material and rolling shall be continuous process, so far as practicable. All parts of the mixture shall receive equal compaction. To prevent adhesion of the mixture to the roller, the wheels shall be kept moistened but an excess of water will not be permitted. Any material which is marred or displaced by the rolling operations shall be corrected with rakes and the addition of fresh material. When rolling adjacent lanes, the roller shall compress the joint by operating on the cold lane, lapping from 6 to 12 inches over the hot material and following immediately after spreading. Construction of one course or lift upon another shall not proceed until the first of the two courses or lifts has been completely cooled and set. Before a second lift or course is laid on the course previously completed, the previously laid course shall be clean and free of all mud, earth, dust, and other foreign materials. The Constructor shall furnish all equipment required for thoroughly cleaning the surface to be "tacked" or paved. The equipment shall consist of one or more mechanical sweepers of an approved type and also any scrapers, shovels, and hand brooms deemed necessary. A tack coat shall be applied to the first course in advance of spreading the next course. Each course shall be spread, compacted, and finished as specified above. The Constructor

shall use the utmost care to avoid overrolling, and rolling shall be limited to one breakdown pass and the finish pass with the roller specified for breakdown and finish. If a section of pavement shows signs of dragging immediately behind the paver, the faulty section shall be bladed off and immediately replaced with a new right-knit mat. Longitudinal and transverse joints in each course or lift shall be well bonded and made in a careful manner. Joints, including those adjacent to existing construction, shall be spaced in such a manner that joints in succeeding course will be at least 3 inches horizontally from joints in any preceding course.

38.16 PATCHING DEFICIENT AREAS.

Mixtures that become contaminated with foreign material or that are defective shall be removed. Skin patching of an area that has been rolled will not be permitted. Holes the full thickness of the course shall be so cut that the sides are perpendicular and parallel to the direction of traffic and the edges are vertical. Edges shall be sprayed with bituminous tack coat. Sufficient fresh paving mixture shall be placed in the holes to obtain the grade and smoothness required for the finished surface. The paving mixture shall be compacted to the minimum density specified herein.

38.17 JOINTS.

38.17.1 General.

The joints between old and new pavements or between successive days' work, or joints that have become cold because of delay, shall be carefully made in such manner as to ensure a continuous bond between old and new sections of the course. Joints shall have the same texture, density, and smoothness as other sections of the course. Contact surfaces of previously constructed pavements that have become coated with dust, sand, or other objectionable material shall be cleaned by brushing or shall be cut back with an approved power saw. The surface against which the material is to be placed shall be sprayed with a thin, uniform coat of bituminous tack coat. The tack coat shall be applied far enough in advance of placement of the fresh mixture to ensure adequate curing. Care shall be taken to prevent damage or contamination of the sprayed surface.

38.17.2 Transverse.

The roller shall pass over the unprotected end of the freshly laid mixture only when the laying of the course is to be discontinued or when delivery of mixture is interrupted to the extent that the unrolled material may become cold. In all cases, the edge of the previously laid course shall be cut back to expose an even, vertical surface the full thickness of the course. When required, the fresh mixture shall be raked against the joints, thoroughly tamped with hot tampers, smoothed with hot smoothers, and rolled.

38.17.3 Longitudinal.

When the edges of the previously placed strip have become cool or cold or are irregular, honeycombed, poorly compacted, damaged, or otherwise defective, unsatisfactory sections of the joint shall be cut back to expose a clean, sound surface for the full thickness of the course.

38.18 EDGES OF PAVEMENT.

Edges of pavement adjacent to the shoulders shall be trimmed neatly to line. An earth berm of selected material not less than 1-foot wide shall be placed against and to the full height of the pavement surface as soon as practicable after the final rolling has been completed and the pavement has sufficiently hardened.

38.19 PROTECTION OF PAVEMENT.

After final rolling of the pavement, vehicular traffic of any kind shall not be permitted until the pavement has cooled and hardened for at least six hours.

38.20 SURFACE REQUIREMENTS.

The surface course, upon completion of final rolling, shall be smooth and true to grade and cross section. When a 10-foot straightedge is laid on the surface parallel with the centerline, the surface shall not vary more than 1/8 inch from the straightedge. When the 10-foot straightedge is laid on the surface transverse to the centerline between the crown and edge of pavement, the surface shall not vary more than 1/4 inch from the straightedge. Low or defective areas shall be immediately corrected by cutting out the faulty areas and replacing with fresh, hot mixture, and compacting the area to conform to the remainder of the pavement.

The Constructor shall furnish one straightedge for each bituminous paver for the use of testing the finished surface. The straightedge shall be aluminum or other approved lightweight metal and shall have blades of box or box-girder cross section with flat bottom, adequately reinforced to ensure rigidity and accuracy. Straightedges shall have handles to facilitate movement on the pavement.

38.21 ASPHALT FOG SEAL.

When specified on the drawings, the surface of the entire completed surface treatment shall be sealed with asphalt emulsion SS 1h or CSS 1h diluted with equal amounts of water applied at a coverage rate of 0.1 to 0.2 gallon of diluted material per square yard. New pavement surfaces shall be allowed to cure for a period of not less than 7 days before application of the fog seal unless otherwise approved by the COR.

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SECTION 39

MINIMAL-TYPE ROADS

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SECTION 39

MINIMAL-TYPE ROADS

39.1 GENERAL.

This section covers the requirements for the construction of minimal-type roads including roadmix surfaced roads; bituminous surface-treated roads; gravel-surfaced roads; bladed, graded, and sealed native soil roads; and slurry coating of existing paved roads. The methods and materials may also be applied to the construction of storage, parking, or other open areas, as shown and noted on the drawings and specified.

39.2 APPLICABLE PUBLICATIONS.

Same as Paragraph 36.2.

39.3 SAMPLING AND TESTING.

Same as Paragraph 36.3.

39.4 MATERIALS.

Materials required in the work shall conform to the applicable publications listed under Paragraph 39.2.

39.5 ROADMIX SURFACE.

Roadmix surface shall consist of the construction of a surface course of mineral aggregate and bituminous material mixed in place on a prepared base or road surface. The prepared mixture shall be spread and compacted upon the prepared roadbed to lines, grades, and dimensions shown on the drawings.

39.5.1 Equipment.

Equipment shall be of types approved by the Contracting Officer's Representative (COR). All plant and equipment shall meet OSHA 1926 requirements.

39.5.1.1 Asphalt Material. The asphalt shall be MC-250 or MC-800 unless otherwise shown on the drawings, or approved by the COR. For patching mixes to be stockpiled for long periods before use, SC-250 may be used.

39.5.1.2 Aggregate. The aggregate shall meet requirements of Paragraph 38.7, Aggregate Gradation.

When the mineral aggregate consists of material in place in the roadbed, all rocks or lumps of material larger than 2 1/2 inches in greatest dimension shall be removed and discarded.

39.5.2 Excavation and Embankment, and Preparation of Roadbed.

Excavation and embankment, and preparation of roadbed as required in the work, shall conform to the applicable paragraphs of Section 1.

39.5.3 Prime Coat.

When shown on the drawings, a prime coat shall be applied to the compacted roadbed, as specified in Section 36.4.

39.5.4 Placing Aggregate.

After the prime coat, if required, has had sufficient time to penetrate and dry, the required amount of mineral aggregate shall be placed on the roadbed and spread smoothly and uniformly over one-half of the roadbed except that when a traveling mixing plant is used, the loose aggregate shall be formed into a windrow or windrows, or into a blanket of uniform cross section.

39.5.5 Application of Bituminous Material.

The type and grade of bituminous material shall be as indicated on the drawings. The material shall be uniformly distributed. The temperature of the bituminous material when applied shall be within the temperature range specified on the drawings. After each application of bituminous material, the mixing equipment shall partially mix the aggregate and the bituminous material so as to leave as little free bituminous material as possible. The intervals between applications of bituminous material shall be as directed by the COR.

Bituminous materials shall not be spread when weather conditions in the opinion of the COR would prevent proper application nor when the atmospheric temperature of the mineral aggregate is below 50° F.

No more bituminous material shall be applied per day than can be mixed with the aggregate on the same day it is applied.

39.5.6 Mixing.

The materials may be mixed upon the roadbed or upon some other approved area off the roadbed by roadmixing methods, or the material may be mixed by plantmix methods as specified below, at the option of the Constructor.

39.5.6.1 Roadmix Method. Prior to applying the bituminous material, the prepared aggregate shall be spread smoothly and uniformly over one-half the mixing area or some other convenient width. The first application of bituminous material shall then be applied, and partially mixed with the aggregate. The remaining applications of bituminous material, with a partial mixing after each application, shall follow in like manner. After the last application of bituminous material and partial mixing, the entire mass of bituminous material and aggregate shall be windrowed on the mixing surface and then thoroughly mixed and combined to the

minimum units specified by blading the mix from side-to-side of the mixing surface, or by a manipulation producing equivalent results, until all particles are coated with bituminous binder and the whole mass has uniform color and the mixture is free from spots containing an excess or deficiency of binder, balls, or uncoated particles. During the mixing operations, care shall be taken to avoid cutting into the underlying course or contaminating the mixture with earth or other extraneous matter. When so directed by the COR, the mixing process shall be confined to part of the width or area of the roadbed so as to allow a convenient passage for traffic. Prior to spreading and compacting, should the mixture show an excess or deficiency of bituminous material, or an uneven distribution thereof, the condition shall be corrected by adding mineral aggregate or bituminous material and then remixing to produce a satisfactory mixture. If necessary, all compressed masses of mixed materials shall be broken up. Spreading of the mixture shall not be done when the base to be covered is wet. The amount of material mixed in any one day shall not be more than can be spread and compacted on the following day provided, however, that when approved by the COR, mixed material may remain in the windrow for a longer period.

39.5.6.2 Machine Mixed Roadmix Method. In lieu of mixing the material as above specified, a roadmixing machine or any equipment other than that required above may be employed which will produce the completed mixture equal to that which would be produced by the means above specified. The roadmixing machine shall be of the pugmill or auger type which picks up the loose material from the mixing area or it may be of the type which cuts a true plane in material at a specified depth, leaving no loose material in either case. Either type shall introduce the bituminous material through a metering device at the time of mixing. The machine shall be equipped to provide for a positive control of the amount of bituminous binder introduced into the mix, which can be readily adjusted to the changes required. The rate of movement of the roadmixing machine, the amount of the material mixed, and the amount of mixing shall be so regulated that a satisfactory mix will result. The materials shall be mixed until a uniform mixture of unchanging appearance is obtained and all particles of aggregate are thoroughly coated with bituminous material. Before mixing, the loose materials shall be placed in windrows or in a blanket of uniform cross section and of such size that all the material in the windrow or blanket can be passed through the mixing machine at each mixing operation. Materials mixed off of the roadbed shall be uniform in character and equal in all respects to that which would be produced by mixing on the roadbed as above specified.

39.5.6.3 Plantmixing Method. Should the Constructor elect to mix the materials at a central mixing plant by the plantmix methods, the mineral aggregate shall be dried, proportioned, and mixed with the bituminous material in accordance with the applicable requirements of Section 38 with the following modifications:

When the moisture content of the mineral aggregate does not exceed (2) percent by weight of the dry aggregate and laboratory tests indicate that such increased moisture content will not produce an unstable mixture,

mixing of the materials without passing the aggregate through a dryer will be permitted at the discretion of the COR.

Unless otherwise directed by the COR, separation of the mineral aggregate into required sizes and storing in separate bins will not be required.

39.5.6.4 Spreading, Compacting, and Finishing. Spreading and compacting equipment shall conform to the requirements of Section 38, except that the use of a self-propelled mechanical spreading and finishing machine will not be required. Before the finished mixture is spread for compaction, a triangular cut shall be made with a motor grader at each edge of the base course to provide for a thickened edge of bituminous mixture. The cut shall be approximately 2 inches deep at the outer edge and slope to zero, 2 feet in toward the center. In making a cut, the excavated material shall be thrown to the edge of the roadbed in a small windrow against which the mixture shall then be spread. After roadmixing operations have been completed and the mixture has been approved by the COR, the mixture shall be uniformly spread over the area to be surfaced to the proper width and to such depth as will compact to the required thickness. Should the Constructor elect to mix the materials prior to the delivery on the roadbed, as provided above, spreading the mixture on the roadbed shall begin at the point or points farthest from the point of mixing and shall progress continuously toward the point of mixing, unless otherwise directed by the COR. The mixture shall be spread by means of an approved spreader box.

Segregation of coarse or fine particles shall be avoided and the mixture shall be free from lumps or pockets of coarse and fine material after spreading. After the mixture has been spread, approximately the top half of the material shall be removed by motor graders and placed into a windrow on one side. The windrow shall be so placed that earth or other extraneous materials will not become intermixed with the windrowed material. The exposed area not occupied by the windrow shall then be thoroughly rolled, after which the windrow shall be moved and the area occupied by the windrow shall be rolled. Rolling shall be continuous throughout the spreading operations. The windrowed material shall then be respread over the entire surface by alternating the windrow from one side of the roadbed to the other and to the center and gradually decreasing the amount of material moved, until the entire surface has uniform texture and is smooth and true to cross section and grade and is uniformly compacted. During blading and rolling, all lumps and loose stones shall be moved to the outside of the surface area and disposed of. All rolling, except for the final finish rolling, shall be done as specified under Section 38, commencing at the lower edge, progressing toward the highest portion. Under no circumstances shall the highest portion be rolled first.

39.5.7 Asphalt Fog Seal.

See Paragraph 39.10.

39.6 BITUMINOUS SURFACE TREATMENT AND AGGREGATE SEAL COAT.

This type of surfacing shall consist of sprayed asphalt with cover aggregate placed over a compacted native soil base. When shown on the drawings, the compacted base shall be primed.

39.6.1 Weather Limitations.

Bituminous materials shall not be applied when weather conditions are unsuitable, or when atmospheric temperature is below 65° F. or the surface temperature is below 80° F.

39.6.2 Equipment.

Heating equipment, bituminous distributors, aggregate spreaders, rollers, and other equipment used in the work shall conform to the applicable paragraphs in Sections 35, 36, and 38. Rollers shall be of such weight that crushing of the aggregate will not occur. All equipment shall be maintained in proper operating condition during progress of the work. All plant and equipment shall meet OSHA 1926 requirements.

39.6.3 Materials.

The size and quantities of aggregate and the types and quantities of bituminous materials to be used in the surface treatment shall be as noted on the drawings.

The gradation of aggregates shall conform to the following requirements:
(Screenings)

<u>Sieve Sizes</u>		<u>Percentage by Weight Passing Sieve</u>	
		<u>1/2" Size</u>	<u>3/8" Size</u>
1/2	Inch	100	
3/8	Inch	90-100	100
No.	4	15-35	20-45
No.	16	0-4	0-6
No.	200	0-2	0-2

<u>Project Control Tests</u>	<u>Test Method</u>	<u>Requirements</u>
Sieve Analysis	Nev. T206	Above
Sampling Aggregate	Nev. T200	----
Fractured Faces	Nev. T230	90% Min.

<u>Source Requirement Test</u>	<u>Test Method</u>	<u>Requirements</u>
Stripping Test	Nev. T209	Satisfactory
Percentage of Wear (500 Rev.)	Nev. T233	37% Max.
Degradation:		
Passing No. 20 Sieve	Nev. T232	25% Max.
Height, Inches	Nev. T232	2.5 Max.

The bituminous material used shall conform to the applicable standards listed in Paragraph 39.2 of these specifications and shall be emulsified asphalt CRS 2 applied at a temperature of 110° F. Minimum and 160° F. Maximum unless otherwise noted on the drawings or approved by the COR.

39.6.4 Preparation of Base.

The native soil base shall be stripped of all vegetation, scarified to a minimum depth of 12 inches, disced or otherwise broken up, moistened or aerated as necessary, thoroughly mixed, graded, and compacted to 95 percent of maximum density at optimum moisture content. Where additional native material is required to raise the base to required elevation, suitable material shall be borrowed locally from areas approved by the COR.

39.6.5 Application of Surfacing.

Surfacing shall not be applied prior to inspection and approval of the base by the COR.

39.6.5.1 Prime Coat or Tack Coat, where required by the drawings, shall be applied in the quantity and within the temperature range indicated and in accordance with Section 36 or 37, as applicable.

39.6.5.2 Surfacing. Before applying the asphalt to the primed and unprimed base, the asphalt distributor and the aggregate spreader shall be checked and properly adjusted for the quantities of materials to be applied. The aggregate spreader shall be filled, in place, and ready for operation before the asphalt is sprayed, and, after the spraying operation commences, the aggregate spreader shall be operated in close proximity to the asphalt distributor and the road speed of the equipment shall be uniform. The asphalt shall be sprayed uniformly in the quantity specified, or where field conditions require changes in quantity, asphalt coverage shall be as directed by the COR. The aggregate shall be uniformly spread at the rate specified on the drawings.

39.6.5.3 Rolling. Pneumatic-tire rollers shall be used to embed the aggregate in the asphalt. Care shall be taken to avoid crushing the aggregate.

39.6.5.4 Multiple Surfacing. When double or triple surface treatments are specified on the drawings, each course shall be rolled before subsequent applications of asphalt and aggregate.

39.7 GRAVEL-SURFACED ROADS.

This type of surfacing shall consist of the application and compaction of gravel surfacing over a compacted native material base as shown on the drawings.

39.7.1 Aggregate.

The size of aggregate and thickness of the gravel surface course shall be in accordance with the drawings. Aggregate gradation shall conform to the requirements specified under Paragraph 38.7 unless otherwise noted on the drawings or approved by the COR. Testing of the aggregate will be the responsibility of the Government.

39.7.2 Equipment.

Equipment to be used in the work shall conform to Sections 1 and 35, as applicable, and shall be maintained in proper operating condition during progress of the work. All plant and equipment shall meet OSHA 1926 requirements.

39.7.3 Preparation of Base.

The base upon which the gravel surfacing is to be placed shall conform to Section 1.

39.7.4 Placing and Compaction.

Placing and compaction of the aggregate shall conform to Section 35.

39.8 BLADED AND GRADED ROADS.

Bladed and graded roads shall consist of scarified graded, bladed, and compacted native soil roads. When specified on the drawings, the surface shall be oiled for control of dust.

39.8.1 Equipment.

Equipment to be used in the work shall conform to Section 1, as applicable, and shall be maintained in proper operating condition during progress of the work.

39.8.2 Construction.

Construction of the road shall conform to Section 1, ~~except the degree of compaction shall be a relative compaction of 90 percent.~~ In general, ~~bladed and graded roads shall follow, approximately, the natural contours of the roadway.~~ Where excessively steep contours are encountered, embankments shall be constructed as shown on the drawings or as directed by the COR. ~~Embankment compaction shall be 90 percent of maximum density at optimum moisture content for the full depth of the placed material.~~

39.8.3 Dust Control.

See Paragraph 39.11.

39.9 SLURRY SEAL COAT.

Slurry seal coat shall consist of a mixture of fine aggregate, preferably minus No. 8 size, mixing type asphaltic emulsion and water, applied to existing pavement containing hairline and alligatored cracks, ravelling, ruts, and depressions.

39.9.1 Materials.

39.9.1.1 Aggregate shall consist of fine sand or a combination of sand and crusher dust, 100 percent passing a No. 8 sieve, 60 to 90 percent passing a no. 30 sieve, and 3 to 10 percent passing a No. 200 sieve. The actual gradation used in the mix may vary according to the condition of the pavement and will be determined by tests.

39.9.1.2 Emulsified Asphalt.

Emulsified asphalt shall conform to Section 37.

39.9.2 Batching.

Typical batch quantities, subject to slight adjustments to suit field conditions shall be as follows:

Using portable mixer:	Aggregate--Fine	700 lb.
	Emulsified Asphalt	20 gal.
	Water--(Variable)	15 gal.*
Using Transit-mix Truck (3 cu. yd.):	Aggregate--Fine	3,000 lb.
	Aggregate--Plaster Sand	3,000 lb.
	Total	6,000 lb.
	Emulsified Asphalt	120 gal.
	Water--(Variable)	80 gal.*

* Includes water in the emulsified asphalt and the water that may be present in the aggregates.

39.9.3 Mixing.

Mixing may be accomplished by portable mixing equipment similar to the paddle-type plaster mixer or by transitmix truck at the option of the Constructor. When transitmix equipment is used, care must be taken to preclude the formation of balls in the mix. Balls present in the mix shall be broken up manually in the spreader box. The dry aggregates shall be thoroughly blended before they are added to the liquid in the mixer to reduce the possibility of balling. Proper control of consistency must be maintained to ensure a creamy, free-flowing slurry which shall be accomplished by adjustment of the water content. The amount of water used in the mix will vary dependent upon the aggregates, condition of the existing pavement, and weather conditions. Mixing time shall be as determined in the field.

39.9.4 Spreading.

Spreading shall be accomplished by use of a spreader box equipped with an adjustable strike-off or squeegee. The pavement shall be cleaned with a power broom, and dirt and dust in cracks shall be blown out. A tack coat of diluted emulsified asphalt shall be applied to the existing pavement in accordance with Section 37. When the tack coat has dried to the proper condition of tackiness and prior to application of the slurry, the pavement ahead of the spreader box shall be dampened. Slurry seal coating shall be applied at a thickness of 1/16 inch to 1/8 inch except in depressed areas where the thickness shall be varied accordingly.

39.9.5 Protection.

The coated pavement shall be protected from damage by traffic until properly cured, but in no case shall traffic be permitted over the surface for a period of one hour after application of the slurry coat.

39.10 ASHPALT FOG SEAL.

When specified on the drawings, the surface of the completed surface treatment shall be sealed with asphalt emulsion SS 1h or CSS 1h diluted with an equal amount of water, applied at the coverage of 0.1 to 0.2 gallon of diluted material per square yard.

39.11 DUST CONTROL.

A dust palliative consisting of emulsified asphalt shall be applied to ~~the road in areas requiring the control of dust as shown or specified on the drawings, or as directed by the COR.~~ Bituminous material used for the dust palliative shall conform to the applicable standards listed in Paragraph 39.2 and shall be emulsified asphalt SS 1 or CSS 1 as noted on the drawings or as directed by the COR. The asphalt emulsion, unless otherwise specified by the manufacturer or approved by the COR, shall be diluted one part water to one part emulsified asphalt and shall be thoroughly mixed prior to distribution. The water shall be of such character that when mixed with asphalt emulsion, the resultant mixture will not break or separate. The bituminous distributor shall be of a type approved by the COR. In general, application of the bituminous material shall conform to Section 37.

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SECTION 40

ROADWAY APPURTENANCES

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SECTION 40

ROADWAY APPURTENANCES

40.1 GENERAL.

This section covers the requirements for the furnishing and erecting of roadway appurtenances including guardrail, guide posts, culvert markers, roadway signs, and roadway paint striping as shown and noted on the drawings and as specified.

40.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification:

40.2.1 Bureau of Public Roads Publication:

ANSI D6.1 Manual on Uniform Traffic Control Devices for Streets and Highways

40.2.2 State of California, Department of Transportation (Caltrans)

Specifications for Traffic Line Paints

8010-81D-59	Traffic Line Paint, Black
8010-71F-59	Traffic Zone and Curb Marker Paint, Red
8010-81D-04	Traffic Line Paint, Fast Dry, White
8010-81D-02	Traffic Line Paint, Rapid Dry, White
8010-81D-05	Traffic Line Paint, Fast Dry, Yellow
8010-81D-03	Traffic Line Paint, Rapid Dry, Yellow

40.2.3 West Coast Lumber Inspection Bureau Standard:

16 Standard Grading Rules for West Coast Lumber

40.2.4 Federal Specification (F.S.):

TT-P-115E	Paint, Traffic, Highway, White, and Yellow.
TT-B1325A	Beads (Glass Spheres, Retroreflective)
TT-P-85E	Paint, Traffic: (Reflectized for Airfield Runway Marking (Drop on type)

40.2.5 State of Nevada Department of Highways (SNDH):

Standard Specification off Road and Bridge Construction

40.3 TESTING.

Testing, where necessary, will be the responsibility of the Government. Samples of materials and appurtenances to be tested shall be made available by the Constructor when requested by the Contracting Officer's Representative (COR).

40.4 GUARDRAIL.

Guardrail shall include treated wood posts, steel plate beams, supports, fittings, and fastenings specified herein, shall be in accordance with the State of Nevada standard specification for road and bridge construction and shall be erected at locations and to details indicated on the drawings.

40.4.1 Steel Plate Beams.

Steel plate beams shall be manufactured of steel sheet not lighter than No. 12 gage. Supports, fittings, and fastenings shall be the standard of the steel plate beam manufacturer, as approved.

40.4.2 Wood Posts.

Wood posts shall be either Douglas Fir, West Coast Hemlock, or Western Larch treated posts, and shall be the dimensions indicated on the drawings. Post spacing and installation depth below grade shall be in accordance with the drawings. All posts shall be given a preservative treatment by pressure process after cutting. The preservative medium shall be creosote, 50-50 creosote-petroleum, or 5 percent pentachlorophenol unless otherwise noted on the drawings. The minimum retention of preservative in pounds per cubic foot of wood shall be 8 pounds.

40.4.3 Erection.

40.4.3.1 Posts shall be set plumb, except on superelevated curves where they shall be set perpendicular to the roadbed. Front faces of posts shall form a straight line, except on curves where they shall be a uniform distance from the centerline of the roadway. Post holes shall be backfilled in layers with approved material thoroughly rammed with an iron tamping tool in such manner as not to displace the bottom of posts from correct alinement.

40.4.3.2 Metal Beam Guardrail shall be erected so that the bolts at expansion joints will be located at the centers of the slotted holes. Fittings shall be attached in such manner that the rail, after erection, will be true to line and grade and will have the proper tension in the rail plates. Care shall be taken to prevent the disturbance of posts during the erection of the rail, and when necessary, temporary braces shall be installed to ensure against post displacement. Rail elements shall be lapped so that the exposed ends will not face approaching traffic.

40.4.3.3 Painting and Finishing. After erection, all metal parts and fittings shall be cleaned of all dirt, rust, oil, and grease, and shall be given two coats of approved zinc chromate paint. Priming coats shall be omitted from all metal parts and fittings which have been either galvanized or shop prime coated by the manufacturer. Galvanized parts, prior to applying paint, shall be solvent-cleaned and treated with a vinyl-type wash coat consisting of one part acid to four parts resin applied at a rate of 250 to 300 square feet per gallon. Prime

coat applied by the manufacturer shall be carefully handled to prevent scratching and marring and all such scratches or mars shall be spot-painted prior to application of finish painting.

Prime coat shall be applied under dry and dust-free conditions and in a manner to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to ensure that they receive an adequate thickness of paint.

Finish painting, applied in the field, shall consist of two coats of approved aluminum paint. The paint shall be applied to clean, dry surfaces and under satisfactory weather conditions. Paint shall be applied by brush or spray. The first coat shall completely cover the prime coat or the treated galvanized surfaces. The finished surfaces shall be free from runs, drops, laps, and brush marks. After the rail has been painted, nuts fastening rail plate to wood posts shall be backed off slightly so that the connection is firm but not tight and will permit the slight movement necessary to absorb expansion and contraction of the rail.

40.5 GUIDE POSTS AND CULVERT MARKERS.

Guide posts and culvert markers shall conform to the details shown on the drawings and shall be erected at locations indicated. Guide posts and culvert markers shall be metal.

40.5.1 Materials.

40.5.1.1 Metals Posts shall be manufactured of 10- or 11- gage steel with permissible thickness variation of 0.010 inch. The posts shall be straight, shall be manufactured as one continuous piece of metal with no welded joints, and shall be free of sharp corners or rough burred surfaces or edges. The posts shall be galvanized.

40.5.1.2 Target Plates shall be fabricated of steel or aluminum sheet at the option of the Constructor. Sheet steel shall be 18 gage; aluminum shall be 0.050-inch thick minimum alloy 3105-H25. Target plates fabricated from steel sheet shall be galvanized. Any flaking of spelter around punched holes shall be cause for rejection. Fabrication of metal parts shall be accomplished in a uniform and workmanlike manner. Plates shall be cut to size and shape and the holes punched for mounting bolts in accordance with the details shown on the drawings. Surfaces and edges of the plates shall be free from defects resulting from fabrication. All fabrication of steel plates, including shearing, cutting, and punching of holes, shall be done prior to enameling.

40.5.2 Finishing.

40.5.2.1 Surface Preparation. Steel target plates shall be prepared by bonderizing or other approved process.

The aluminum target plates shall be prepared for painting with chemical conversion coating. The coating shall be applied in accordance with the manufacturer's specifications and recommended sequence of operation.

40.5.2.2 Painting. The white enamel finish coat on target plates as well as black enamel tops, where indicated, shall be an approved alkyd-melamine type baking enamel. A portion of the alkyd or amino resins may be replaced with a suitable vinyl resin providing the baking enamel meets all the specified performance requirements. Application of the baking enamel may be by spray, roller, or dip. The dry film thickness of the baked enamel coating on the galvanized steel plates shall be not less than 2.0 mils on both front and back surfaces. The dry film thickness on both front and back surfaces of the aluminum plates shall be not less than 1.5 mils on each side if enamel is applied by spray or dip method and not less than 1.0 mil if enamel is applied by continuous roller coat method. The coating shall be uniform throughout and shall be smooth and free from flow lines, streaks, blisters, or other surface imperfections. The method of baking shall be the standard of manufacturer of the target plates used in the work. The finished plates shall be free from dents and defects. The maximum surface deviation from a horizontal plane on which the finished plate lies shall not exceed 0.25 inch. Galvanized posts shall not be painted.

40.5.3 Hardware.

Hardware for attaching the target plates shall consist of round-head galvanized 1/4-inch machine screws with "Parkerized" treatment, or equal, with aluminum finished speed nuts. Washers shall be 5/16-inch I.D. asbestos, not less than 1/32-inch thick.

40.5.4 Reflectors.

Reflectors shall be a reflectorized material of silver color such as 3M "Scotchlite", or an approved equal. The reflectorized materials shall be of the design shown on the drawings and shall be applied after erection. The reflectorized material shall be firmly attached to the target plates by means of an adhesive designed specifically for this purpose.

40.5.5 Erection.

The guide posts and culvert markers shall be spaced and erected in a manner indicated on the drawings, and shall be set plumb. When soil conditions permit, metal posts may be driven in place, provided the method of driving does not damage the posts. Metal targets shall be installed after the posts have been set in place. All areas where paint has been damaged shall be given a spot coat of paint and all exposed areas that have become soiled shall be cleaned or repainted.

40.5.6 Plastic Delineator Post.

Plastic delineator post shall be a plastic post, diamond shaped, (6" wide x 3/8", 6'-0" long. The delineator post shall be complete with a

black plastic cap and 3" diameter reflection crystal attached 8" from the top. Erection and location shall be as indicated on the drawings.

40.6 ROADWAY SIGNS.

Roadway signs shall be of the types and quantities indicated on the drawings and shall be installed where indicated or directed. Signs may be of steel or aluminum, at the Constructors option, and shall be Hawkins-Hawkins Co., Inc., products, Berkely, California, or approved equal.

40.6.1 Steel Signs.

Steel signs shall be manufactured from galvanized, bonderized steel sheet, not less than No. 18 gage prior to zinc-coating. Enamel shall be a synthetic color-fast baking enamel, alkyd-melamine type. Application and mil thickness shall be as specified for guide posts and culvert markers, hereinbefore.

40.6.2 Aluminum Signs.

Aluminum signs 12 X 18 inches and smaller shall be manufactured from 0.050-inch, alloy 3105-H25 aluminum sheet. Signs larger than 12 X 18 inches shall be manufactured from 0.063-inch, alloy 6061-T6 aluminum sheet. The aluminum shall be prepared for painting with a chemical conversion coating. Finish shall be baked enamel as specified for steel signs.

40.6.3 Sign Posts.

Sign posts shall be formed of hot-dipped galvanized cold-rolled low-carbon steel and unless otherwise shown on the drawings shall be round pipe with one end bevel-cut. Thickness of metal, cross section dimensions, and length of posts shall conform to the details indicated on the drawings for the various sizes of signs. Sign posts shall not be painted.

40.6.4 Hardware.

Hardware for attaching signs to sign posts shall consist of round-head, galvanized, 1/4-inch hex-head bolts and fiber, or asbestos washers and galvanized steel stiffener plates. The number of bolts to be used shall be as recommended by the sign manufacturer.

40.6.5 Erection.

Permanent signs shall be set in 3000 psi concrete to the depth indicated on the drawings. Temporary signs, required during road construction operations, may be driven in place provided the driving method does not damage the posts. Signs shall be installed after sign posts are in place.

40.7 PAVEMENT STRIPING AND MARKING.

40.7.1 General.

This specification covers the striping and marking of highways, and special accent markings at intersections, and parking areas as shown on the drawing. The Constructor shall furnish all material, labor, supplies, tools, and equipment required.

40.7.2 Preparation.

The Constructor shall thoroughly clean the surface to be painted by sweeping and/or blowing to remove all dirt and loose material which would reduce the bond between the coat of paint and the pavement.

40.7.3 Weather Limitations.

Painting and marking shall be performed only when the surface is dry and clean, when the ambient temperature is above 40° F, and the weather is acceptable to the conditions.

40.7.4 Equipment.

The paint striping machine shall be approved by the COR before the Constructor commences work.

40.7.5 Materials.

Materials shall be delivered in unopened original containers bearing the manufacturer's name and data required by the applicable specifications.

40.7.5.1 Paints used in work shall show the designated name, formula or specifications number, batch number, color, date of manufacture, manufacturer's direction, and conform to the State of California Department of Transportation specifications for paint formulas, and Federal Specification TT-P-115E, TT-B-1325A and TT-P-85E. Reflectorized pre-mixed and or job-mixed paint will not be acceptable. or job-mixed paint will not be acceptable.

40.7.6 Application.

The center line shall be 15 foot segments with 25-foot gaps (or what is known as the 40 cycle) yellow in color and 4" wide. The no passing lines shall be yellow in color, 4" wide, and continuous. Where double no-passing lines are required, the dashed center-line shall be omitted and the two no passing lines shall be spaced 3" from each other.

Pavement edge lines shall be white in color, 4" wide, continuous, and placed as near the edge of the asphalt road surfaces as practical. Follow existing lines where they are still visible.

All lines shall be clean and sharp as to dimensions. Ragged ends of segments, foggiess along the sides, or objectionable drizzling along the unpainted portions of the strip shall not be permitted. The finished products shall have an opaque, well-painted appearance, with no black or other discolorations showing through.

Any smears shall be omitted with black traffic grade paint or removed and repainted, to the satisfaction of the COR. The Constructor shall take all reasonable precautions to protect the paint during drying time, and may be required to paint out all objectionable tracking or remove and repaint.

Paint shall be applied at its original consistency without the addition of thinners. Air shields shall be provided on the spray nozzle to eliminate paint splatter outside the limit lines. The stripes shall be applied as to not be visible.

Paint shall be applied at the rate of 6.6 to 8 gallons/mil for broken zones and 17.6 to 22 gallons/mile for solid zones or as directed by the COR.

40.7.7 Maintaining Traffic.

Traffic shall be permitted to pass through the work zones under the specific control of the Constructor who shall be responsible for all traffic control.

The Constructor shall provide, install, and maintain all necessary signs, lights, flares, barricades, flagmen, and other facilities for directing the movement of traffic through the work.

40.7.9 Defective Workmanship or Material.

When any material not conforming to the requirements of the specifications or plans has been delivered to the project or incorporated in the work, or any work performed is of inferior quality, such material or work shall be considered defective and shall be corrected as directed by the COR at the expense of the Constructor.

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SECTION 41

PARKING AREA APPURTENANCES

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SECTION 41

PARKING AREA APPURTENANCES

41.1 GENERAL.

This section covers the requirements for wheel bumpers, parking area striping, and traffic control marking as shown and noted on the drawings and specified.

41.2 APPLICABLE PUBLICATIONS.

Same as Paragraph 40.2.

41.3 WHEEL BUMPERS.

Wheel bumpers shall be of the type or types shown on the drawings and as follows:

41.3.1 Precast Concrete Wheel Bumpers.

Precast concrete wheel bumpers shall be cast of concrete having a minimum compressive strength of 3000 psi at 28 days. The bumpers shall be reinforced with two No. 3 reinforcing bars. The bumpers shall conform to the details shown on the drawings. The finished surface of the concrete shall be smooth and without blemishes. Bumpers shall be installed where indicated and shall be secured in position with two driftpins, No. 4 x 2-foot long reinforcing bars, driven flush with the top of the bumper. Care shall be taken to avoid damage to the bumpers when driving the driftpins. Bumpers may vary in minor details from the design shown on the drawings subject to approval by the Contracting Officer's Representative (COR).

41.3.2 Timber Wheel Bumpers.

Timber wheel bumpers, where required, shall be constructed of construction heart redwood of the dimensions shown on the drawings. Redwood spacers 2- x 6 inches by width of the wheel bumper shall be provided under the bumpers at each driftpin. Each spacer shall be secured to the bumper with not less than two 12d galvanized or aluminum nails. Bumpers shall be set to the line shown on the drawings. Driftpins, No. 4 x 2-foot long reinforcing bars, shall be driven flush with the top of the bumper. Spacing of driftpins shall conform to the drawings.

41.4 PARKING AREA STRIPING AND MARKING.

Parking area and striping and marking shall be provided in accordance with the configuration shown on the drawings. Striping shall be not less than 4 inches in width. The color of the paint shall be white and shall be an approved type specially formulated for application on asphalt paving, such as those specified under Paragraph 40.2 and applied in

accordance with Paragraph 40.7. Prior to painting, all areas to receive paint shall be cleaned by means of compressed air, vacuum cleaning equipment, or other approved method. The pavement shall be dry when paint is applied. Traffic control painting including arrows, lettering, and other required markings shall be accomplished by the use of stencils. Equipment and tools used in the work shall be approved by the COR prior to start of work.

41.5 PARKING AREA SIGNS.

Same as Paragraph 40.6.

* * * * *

SECTION 42

FIRE PROTECTION SYSTEMS - WATER

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SECTION 42

FIRE PROTECTION SYSTEMS - WATER

42.1 SCOPE

The work includes the furnishing of all materials, equipment, and labor for the installation or modification of fire protection systems of the type indicated.

42.1.1 New Installations or Major Modifications.

New installations or major modifications of fire protection systems shall be accomplished by a qualified fire sprinkler system installation firm, unless assigned to the Constructor by the Contracting Officer's Representative (COR).

42.1.2 Minor Modifications.

Minor modifications of fire protection systems, when specifically approved by the COR shall be accomplished by the installer in accordance with approved design drawings and these specifications.

42.1.3 Water Supply Connections.

Water supply connections from tapping supply valve to base flange of fire protection assemblies inside new or existing buildings shall be accomplished by the installer unless assigned to a subcontractor by the COR or accomplished by others under-lump sum contract. (Reference Section 28, "Waterlines.")

42.1.4 Tapping.

Tapping of all existing water supply lines shall be performed by the Constructor and shall be coordinated with the Fire Department to minimize downtime. (Reference Section 28 "Waterlines.")

42.2 APPLICABLE PUBLICATIONS

The latest issues of the following publications, including revisions and amendments, form a part of this specification. Any conflict between the following documents will be resolved by the COR.

42.2.1 American National Standards Institute (ANSI):

A13.1 Identification of Piping Systems, Scheme for

42.2.2 Federal Specifications (FS):

O-C-114 Calcium Hypochlorite, Technical, and Chlorinated Lime, Technical

O-S-602	Sodium Hypochlorite Solution
BB-C-120	Chlorine, Technical; Liquid
HH-P-151	Packing, Rubber-Sheet, Cloth-Insert
WW-P-421	Pipe, Cast Gray and Ductile Iron, Pressure (for Water and Other liquids)
WW-P-501	Pipe Fittings, Cast-Iron, Screwed 125 and 250 Pound
WW-V-0051	Valve, Bronze, Angle, Check, and Globe 125, 150, and 200 Pound Screwed, Flanged, or Solder (for Land Use)
WW-V-0054	Valve, Bronze, Gate 125, 150, and 200-Pound, Screwed, Flanged, Solder End, (for Land Use)
WW-F-406	Flanges, Cast-Iron (Classes 125 and 250) and Bronze (Classes 150 and 300)
WW-V-58	Valves, Gate, Cast-Iron, Threaded and Flanged (for Land Use)

42.2.3 American Water Works Association (AWWA):

C 100	Cast-Iron Pressure Fittings
C 400	Asbestos-Cement Water Pipe
C 500	Gate Valves--3-inch through 48-inch--or Water and Other Liquids
C 601	Disinfecting Water Mains

42.2.4 Factory Mutual Engineering Corporation (FM)

Approval Guide

42.2.5 International Conference of Building Officials

Uniform Building Code (UBC)

42.2.6 National Fire Protection Association Standards (NFPA):

No. 13	Sprinkler Systems, Installation
No. 14	Standpipe and Hose Systems, Installation
No. 24	Outside Protection

42.2.7 Underwriters' Laboratories, Inc., Publications (UL)

Equipment Lists (with Supplements)

No. 262 Gate Valves for Fire Protection Service

42.3 STANDARDS

The installation shall include all appurtenances and features specified herein and required by NFPA Standards, so as to obtain a system complete and approved in all respects for specified hazard occupancy and specified design. The provisions of these standards, unless otherwise specified herein, shall be followed in total whether the stipulations listed therein are directed or recommended. The term "should" and advisory material used in these standards are to be considered mandatory unless existing conditions, as determined by the COR, prohibit the accomplishment of the stipulation. The system shall be so installed that no part thereof will interfere with doors, windows, heating, plumbing, or electrical equipment.

42.4 AUTHORITY HAVING JURISDICTION

For interpretation of NFPA Standards, the "Authority Having Jurisdiction" referred to in the standards shall be the COR. The COR must review and approve all fire sprinkler submittals before any installation work is started.

42.5 MATERIALS AND EQUIPMENT

Materials and equipment shall be new and current products of the respective manufacturers. Where two or more pieces of equipment performing the same function are required, they shall be exact duplicates produced by one manufacturer. All materials and equipment shall be "APPROVED" FOR THE INTENDED PURPOSE in conformity with current requirements of the applicable referenced NFPA Standards. If UL-listed or FM-approved equipment is commercially available, none other will be APPROVED. The installer shall submit proof that the items furnished under this specification conform to such requirements. The Underwriters' Laboratories, Inc., label or seal, or listing in the Equipment List will not necessarily be acceptable as sufficient evidence that the items conform to the requirements of such standards.

42.6 APPROVAL OF MATERIALS AND EQUIPMENT

Before starting installation of any materials or equipment, complete lists of materials and equipment to be incorporated in the work, and any shop drawings, shall be submitted to the COR. All items which are identical in model and manufacture as items shown on the approved drawings are to be listed for identification only, all items proposed as 'equal,' or other required components not specified on the approved drawings shall be supported by sufficient descriptive material, such as catalogs, cuts, diagrams, and other data published by the manufacturer, as well as

evidence of compliance with safety and performance standards to demonstrate conformance to the specification requirements; catalog numbers alone will not be acceptable. Listing of all items that function as parts of an integrated system shall be furnished at one time. The COR will retain 3 copies of each submittal and return the remaining copies to the installer.

42.7 REQUIREMENTS - FIRE PROTECTION SYSTEM MINOR MODIFICATIONS

42.7.1 Sprinklers.

Sprinklers shall be ordinary finish, approved upright, or pendant, or approved dry pendant as required, 1/2-inch orifice type, ordinary rating, except that intermediate rated sprinklers or higher rated sprinklers shall be installed as shown on approved drawings, where required by local heat-producing appliances, or where required by NFPA 13. Sprinklers nipped down or through suspended ceilings shall be installed with escutcheons, canopies, or adjustable ceiling plates. Sprinklers installed within seven feet of the floor or otherwise subjected to mechanical injury, as determined by the COR, shall be equipped with head guards.

42.7.2 Pipe and Fittings.

All pipe and fittings shall conform to NFPA Standard No. 13 unless specific requirements are outlined on the approved drawings.

Except where specifically required types are shown all joints may be made with flexible couplings, cast-iron flanges, screwed fittings, or any approved method rated for 175-pounds cold water working pressure.

Screwed joints shall be made up with approved joint compound.

Piping shall be reamed to remove all chips and foreign materials prior to making joints.

Shop-welded pipe sections are allowable; however, no welding shall be allowed inside any building unless shown on the approved drawings, without prior approval of the COR.

Pipe finish shall be as specified in Section 42.13, "Cleaning and Painting."

42.7.2.1 Reducers, Bushings. A one-piece reducing fitting shall be used wherever a change is made in the size of the pipe. Bushings shall not be used unless such reducing fittings are not manufactured. Bushings shall not be used as an expedient or simply because the installer may be temporarily out of stock of the proper fitting.

42.7.3 Pipe Unions and Couplings.

Except where shown on approved drawings or to join full lengths of pipe, use of couplings or unions shall require specific approval. (Reference, NFPA 13, Paragraph 3-12-2.)

42.7.4 Pipe Supports.

Metal pipe supports, sway braces, hangers, clamps, and all other accessories shall be of UL-listed or FM-approved pattern and so placed as to conform with the design furnished which is based on the UBC for Zone 3 seismic loading as well as the requirements of NFPA Standard No. 13. Protection of the piping against earthquake damage shall conform to referenced standards. All supports, hangers, braces, etc., shall be attached to the building structural members only. Drilling holes in open-web joist chords shall not be allowed.

42.7.5 Valves.

Gate valves, 2 inches and smaller, shall be screwed, bronze body, solid wedge, rated for 150 psi minimum nonshock cold-water-working pressure. Gate valves, 2 1/2 inches or larger, shall be flanged, iron body, bronze mounted, double disc, parallel seat, OS&Y, rated for 175 psi nonshock cold-water-working pressure. Globe, angle, ball or butterfly valves shall be of similar construction and pressure rating.

42.7.5.1 Testing prior to installation all valves 4 inches in diameter and larger shall pass a pressure test by the Holmes and Narver Material Testing Laboratory (H&N/MTL). The pressure test shall be based on UL Standard 262.

42.7.6 Floor, Wall, and Ceiling Plates.

Pipe passing through floors, walls, or ceilings shall be fitted with pressed-steel, floor, wall, or ceiling plates. Plates shall be chromium-plated or primed for finish paint as determined by the COR. Plates shall be sized to completely cover penetration and sleeve.

42.7.7 Sleeves.

Sleeves shall be provided around all piping extending through floors and walls.

42.7.7.1 Minimum Clearance between the pipe and sleeve shall be 1-inch nominal for pipes sizes 1 inch through 3 1/2 inches and 2-inch nominal for pipe sizes 4 inches and larger. (i.e., a 2-inch pipe requires a 4-inch sleeve, 8-inch pipe requires a 12-inch sleeve.)

42.7.7.2 Clearance between the pipe and sleeves shall be filled with noncombustible flexible material such as mineral wool, fiberglass, or equivalent, unless specific requirements are shown on the approved drawings.

42.7.7.3 Sleeves penetrating exterior walls shall be made weather- and watertight using Oakum packing and nonhardening mastic, or equal.

42.7.7.4 Sleeves shall be fabricated of metal, minimum 18-gauge, or standard weight black steel pipe with square-cut ends.

42.7.7.5 Floor Sleeves shall project three to six inches above floors, and shall be continuous through floors. Sleeves should be grouted in-place through concrete floors, and/or securely bolted through other construction. Passage of water, smoke, or fire shall be prevented by packing with flexible material in accordance with Paragraph 42.7.7.2 or 42.7.7.3, held in-place with pipe collars on each side.

42.7.8 Drains.

All drains shall terminate with a 45-degree ell on the exterior of the building except where otherwise shown on the approved drawings. Ell shall discharge at a point one foot above grade. Discharge of all drains shall be visible and, where directed to unpaved ground, shall discharge to concrete splash blocks on grade. No drains shall be connected to sewer lines. Splash blocks are to be furnished by the Constructor.

42.7.9 Pipe Installation.

Piping in occupied areas is to be held as high as possible and attached to the building structural framing members only; no pipe is to be supported from ceiling-finish materials or other piping or equipment. No welding, cutting, drilling, or tapping of structural members (other than that shown on drawings) shall be done without prior approval of the COR. No piping is to be run through ductwork unless absolutely unavoidable, and only with prior approval. Cutting through walls may be necessary. Holes shall be close-cut to piping. (Reference Paragraph 42.7.7.) Work shall be performed in a neat manner.

All piping shall be accurately cut to design measurements and shall be worked into place without springing or forcing. In any situation where bending of pipe is required, such bending shall be accomplished through the use of a standard pipe-bending template.

42.8 WATER SUPPLY LINES FOR FIRE PROTECTION SYSTEMS (Reference Section 28.)

Piping for water supply lines within 5 feet of the building shall be cast iron. Sprinkler supply line shall terminate with standard flange for connection to steel piping ten inches ± two inches above the floor in the building to be sprinklered.

42.8.1 Excavation, Installation, and Backfilling of Water Supply Line.

The entire water supply line from tapping point to the base flange of the fire protection riser inside buildings shall be installed in accordance with Sections 1 & 28, except as noted.

42.8.2 Water Piping Below Concrete.

Water piping below concrete slabs and/or foundations or through walls shall be cast iron, Class 150, coated, cement-lined, bell-and-spigot or mechanical joint as described in Section 28, or as shown on the approved drawings.

42.8.3 Water Piping Below Ground.

Water piping below ground shall be cast iron as described above, or Class 150 asbestos-cement pipe, as shown on the approved drawings. Cast-iron fittings shall conform to AWWA C 100, and shall be cement lined corresponding to the water piping.

42.8.4 Piping and Fittings Below Concrete.

Pipes penetrating slabs and/or foundations or through concrete foundation walls shall be fitted with approved mechanical joints with listed mechanical joint retainer glands to prevent joint separation; or with tie rods, clamps, and anchors, to conform to requirements of NFPA 13 and NFPA 24. Rodding and clamps shall extend a minimum of 12 feet outside the building, unless otherwise shown on the approved drawings.

42.8.5 Flange at Base of Riser Location.

Flange at base of riser location shall be cast iron, Class 125, conforming to Federal Specification WW-F-406. Unless otherwise specified, the rods shall extend to, and through, the flange, with threaded ends and nuts installed above and below the flange.

42.8.6 Blind Flange.

A Class 125 cast-iron blind flange shall be installed on riser-base flange to maintain sanitation until subcontractor may proceed. This blind flange should be fitted with 1/2-inch NPT tapping and 1/2-inch globe valve for hydrostatic testing use.

42.8.7 Valves.

All valves for fire protection systems shall be UL listed or FM approved for fire protection service and shall be tested in accordance with 42.7.5.1.

42.8.7.1 Gate Valves shall be designed for a water-working pressure of not less than 175 pounds per square inch. Valves shall have a clear waterway equal to the full nominal diameter of the valve, and shall be opened by turning counterclockwise. Buried gate valves shall be nonrising-stem designed for use with an approved indicator post of the same manufacture as the valve. (Reference 42.8.8) Gate valves not buried shall be OS&Y. Each valve shall have the maker's initials and pressure rating cast on the body. All valves shall be UL listed and/or FM approved.

42.8.7.2 Butterfly Valves shall be designed for a water-working pressure of not less than 175 psi. Valves shall be 4-inch minimum, 12-inch maximum, with gear operator assembly, with permanently-lubricated gears in heavy-duty sealed case. All valves, unless otherwise indicated on the approved drawings, shall be fitted with an electric valve position supervisory and tamper switch. Post indicator valve assemblies shall have a visual target indicating open and closed positions, in addition to electric valve position supervisory and tamper switch. (Reference 42.8.10.) Valve shall be flanged, or body shall be of wafer or lug form, to fit between ANSI 150-lb. flanges. Body may have self-gasketing seals or require gaskets per Section 20.

Valve seats shall be elastomeric specifically approved for cold water. Entire assembly shall be UL listed.

42.8.7.3 Check Valves. Check valves, unless otherwise shown on drawings, shall be iron body, bronze mounted. All valves shall be UL listed and/or FM approved. Working pressure rating shall be 175 pound, nonshock cold water.

42.8.8 Indicator Post.

Indicator post shall be provided on valve at the location shown on the drawings. Indicator post shall conform to NFPA requirement. Indicator posts shall be of same manufacture as the valve. Post shall be painted two coats of Federal Safety Red.

42.8.9 Setting Valves and Indicator Posts.

Valves shall have the interior cleaned of all foreign matter before installation. Valves and indicator posts shall be set plumb. Earth backfill shall be carefully tamped around each valve and indicator post to a distance of four (4) feet on all sides, or to undisturbed trench face if less than four (4) feet. The valves shall be inspected in opened and closed positions to ensure that all parts are in working condition.

42.8.10 Indicator Post Supervisory Switch.

All indicator post (PIV) valves, unless otherwise shown, shall be fitted with a UL-listed and/or FM-approved valve position supervisory switch. PIV switch shall have SPDT or SPST-N.O. contacts with tamper switch feature. Switch shall be mounted in accordance with manufacturer's data to cause supervisory alarm (switch closure) before the valve operating wrench is moved more than one and a half turns from the normally open-valve condition. PIV switch shall be connected to the nearest Fire Department Station, see Section 44 for alarm connection, conduit, and conductors.

42.8.11 Tapping Valves.

Tapping valves, if required, shall comply with the requirements specified for valves 2 1/2 inches and larger. Tapping valves shall have full open bore to clear tools and be fitted with ends or adapters as required to suit tapping tools when necessary. All tapping valves shall be UL listed and/or FM approved.

42.8.12 Tapping Sleeves.

Tapping sleeves and cut-in sleeves shall be of AWWA types, rated 200 psi minimum. Outlet(s) shall have standard 125-pound flanges. Sealing gaskets may be a direct "O" ring form, or duck-tipped rubber end seals with mechanical joint type sleeve ends. Split sleeves shall be fitted with multiple draw-up bolts, which shall be taken up evenly, using a torque wrench to establish values.

42.9 FIRE HYDRANTS AND HOSE HOUSES.

All fire hydrants and hose houses, unless otherwise indicated on approved drawings, shall meet the following requirements.

42.9.1 Fire Hydrants.

Fire hydrants shall be UL approved and shall comply with specifications of the AWWA and the NFPA. The hydrant shall be designed for 150 psi working pressure and 300 psi hydrostatic test pressure. With the exception of the main valve face and seat, the moving parts of the hydrant shall be equipped with a self-lubricating device, including an oil storage reservoir. The main valve shall be of the compression type; i.e., the main valve shall open against the water flow and close with the water flow. The hydrant shall be equipped with drain valves which automatically drain the hydrant barrel when the hydrant is closed and which are automatically closed when the hydrant is open. The hydrant shall be provided with breakable sections, bolts, or joints designed to prevent damage to the hydrant barrel and operating parts, in the event of vehicle or other mechanical damage. This feature shall permit rapid repairs to the hydrant by replacement of a minimum number of breakable parts available in a repair kit. The hydrant shall be constructed so that all working parts may be removed for repairs or replacement without disassembly of the hydrant barrel and without excavating and detaching the hydrant from the water main. All working parts shall be constructed of bronze. The hydrant shall have two each 2 1/2-inch hose connections and one each 4 1/2-inch pumper connection, National Standard Fire Hose Threads. The hydrant shall have a 4 1/2-inch valve opening, 6-inch flanged shoe connection, and 36-inch depth of cover (or 42-inch depth of bury). The operating nut and nozzle cap nuts shall be pentagon shaped and shall measure 1 1/2 inches from point to flat. The hydrant shall be painted with one coat of primer paint and two finishing coats of safety yellow, Rust'Oleum 944, weather-resistive paint.

42.9.1.1 Hydrant. Hydrant shall be Mueller Improved AWWA Fire Hydrant, Catalog No. A-24012 as manufactured by Mueller Company.

42.9.2 Installation.

Installation of standard fire hydrants shall conform to the following criteria, and as shown on the attached sketch.

42.9.2.1 Valves. A valve conforming to 42.8.7.1 or 42.8.7.2 (with valve box and cover) shall be located between the hydrant and the water supply main. A spool piece shall be installed between hydrant and valve to provide 18-inch minimum spacing.

42.9.2.2 Thrust Blocks and Valve Pedestals. Thrust blocks and valve pedestals shall be provided in accordance with Section 28, or as shown on approved drawings. Hydrant thrust block must not cover hydrant drain holes.

42.9.2.3 Hydrant Drain Holes. Hydrant drain holes shall be examined and must be free of dirt, concrete, or any obstruction prior to backfill.

42.9.3 Hose Houses.

Hose houses shall be installed over hydrants where shown on the drawings. Hose houses shall be of the low-silhouette type, with removable pivoting or hinged roof, metal construction; W. D. Allen Co., Allenco Model 400. or approved equal.

42.9.3.1 Hose House. Hose house shall be fitted with the following equipment at a minimum. Additional equipment shall be procured and installed if specified on the approved drawings, or as determined by the COR.

- a. Two 200-foot lengths of 1 1/2-inch UL- and/or FM-listed single jacket, cotton, rubber-lined fire hose, connected to a gated 2 1/2- by 1 1/2-inch wye connected to 2 1/2-inch hydrant butt. Each hose terminated with a spray/shut-off nozzle, "Elkhart" No. L-205-B-95, or approved equal.
- b. Two 200-foot lengths of 2 1/2-inch UL- and/or FM-listed single jacket, cotton, rubber-lined fire hose.
- c. Adapter fittings, 2 1/2-inch to 1 1/2-inch.
- d. Two hydrant wrenches, two 1 1/2-inch spanners, two 2 1/2-inch spanners.
- e. All hose and nozzles shall have National Standard fire hose threads.

42.10 REPAIR OF EXISTING WORK

Where required, and approved by the COR any significant damage to building, piping, or equipment caused by the work shall be repaired and refinished by skilled mechanics of the trade involved.

42.11 INSPECTION, TESTS, AND ACCEPTANCE

After each system has been fully installed, all components shall be examined by installer for compliance with design and related codes and standards. Inspection shall be made in conjunction with COR and shall be performed prior to calling for hydrostatic tests or final inspection. To reduce retesting the installer shall pretest the system to examine for leakage.

When the installer has satisfied himself that the systems are in complete operating condition in every respect, he shall notify the COR that he is ready for final inspection and acceptance.

Final inspection of all phases of the work shall be made by the COR. The installing foreman, or other competent representative shall be present at this time to conduct any operating tests of alarms, drains, or other system functions requested by the COR. Any faults or malfunctions in system, segment, or component operation discovered shall be corrected by the installer as directed by the COR. Successful completion of final inspection and acceptance tests, disinfection, cleaning and painting, and hydrostatic testing as determined by the COR, shall constitute evidence of satisfactory completion of the respective system and the system shall be considered as accepted.

42.12 HYDROSTATIC TESTS AND FLUSHING.

Hydrostatic tests and flushing shall conform to NFPA Standards 13 and 24 and shall be performed on all water lines for final acceptance.

Test may be scheduled before, during, or after final acceptance testing. All new pipe, including underground, shall be tested hydrostatically to 200 psi minimum for not less than 2 hours. All joints observed to leak shall be tightened, remade, or replaced as necessary. The COR shall be given three working days' advance notice of all hydrostatic tests.

All necessary apparatus and connections for testing shall be provided by the installer and he shall perform all testing operations under the direct supervision of the COR. In addition to the foregoing test requirements, each water control valve shall be fully opened and closed under water pressure to ensure proper operation. Blind flanges, if used during testing of water distribution and sprinkler supply lines, shall be left in place until the riser is to be installed and connections made to existing systems. Flushing of systems shall include the entire waterline from the tapping point to the riser.

42.13 DISINFECTION OF SPRINKLER SYSTEM PIPING

Disinfection of aboveground sprinkler-system piping shall be performed in accordance with AWWA Standard C 601, unless specifically excluded by the COR. All underground pipe shall be sterilized, as described in Section 28.

42.14 CLEANING AND PAINTING

42.14.1 All Underground Iron and Steel

All underground iron and steel parts shall be coated and/or wrapped, as described in Section 28. All iron and steel parts shall be thoroughly cleaned.

42.14.2 All Aboveground Piping. Unless otherwise shown on the drawings, or determined by the COR, all aboveground piping and other metal, except sprinkler heads, bronze or brass fittings, and moving parts, shall be thoroughly cleaned and given a prime coat of Alkyd-type paint. After the installation has passed a satisfactory hydrostatic test all piping, in exposed locations, such as offices, or locations subject to corrosion, shall be finish painted. The finish coat shall be of a matching color to the existing pipe or surface, or Federal Safety Red, as shown on the drawings, or as determined by the COR.

All pipe shall be marked and identified in accordance with ANSI Standard A 13.1 as described and referenced in Section 18, "Painting."

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SECTION 44

FIRE ALARM AND REMOTE SIGNAL TRANSMISSION FACILITIES

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SECTION 44

FIRE ALARM AND REMOTE SIGNAL TRANSMISSION FACILITIES

44.1 GENERAL.

The work covered by these specifications includes labor, materials, equipment, supplies, and services required for the installation of fire alarm systems, with remote signal transmission facilities. This work may be accomplished by the Constructor in accordance with these specifications, or by a qualified fire alarm systems installation firm, under specifications and drawings prepared for the individual project, as determined by the Contracting Officer's Representative (COR).

44.2 APPLICABLE PUBLICATIONS.

The latest issues of the following publications, including revisions and amendments, form a part of this specification. Any conflict between the following documents will be resolved by the Contracting Officer.

44.2.1 Factory Mutual Engineering Corporation (FM):

Approval Guide

44.2.2 National Fire Protection Association Standards (NFPA):

No. 70 National Electrical Code (NEC)

No. 72C Remote Station Protective Signaling Systems

No. 72E Automatic Fire Detectors

44.2.3 Underwriters' Laboratories, Inc., Publications (UL):

Equipment Lists (with supplements)

44.3 STANDARDS.

The installation shall include all appurtenances and features specified herein and required by NFPA Standards, so as to obtain a system complete and approved in all respects for specified hazard occupancy and specified design. The provisions of these standards, unless otherwise specified herein, shall be followed in total whether the stipulations listed therein are directed or recommended. The term "should" and "advisory material" used in these standards are to be considered mandatory unless existing conditions, as determined by the COR, prohibit the accomplishment of the stipulation. The system shall be so installed that no part thereof will interfere with doors, windows, heating, plumbing, or electrical equipment.

44.4 AUTHORITY HAVING JURISDICTION.

For interpretation of NFPA Standards, the "Authority Having Jurisdiction" referred to in the standards shall be the Contracting Officer Representative (COR). The COR must review and approve all fire alarm system submittals before any installation work is started.

44.5 MATERIALS AND EQUIPMENT.

Materials and equipment shall be new and current products of the respective manufacturers. Where two or more pieces of equipment performing the same function are required, they shall be exact duplicates produced by one manufacturer. All materials and equipment shall be "APPROVED" FOR THE INTENDED PURPOSE in conformity with current requirements of the applicable referenced NFPA Standards. If UL-listed or FM-approved equipment is commercially available, none other will be APPROVED. Constructor shall submit proof that the items furnished under this specification conform to such requirements. The Underwriters' Laboratories, Inc., label or seal, or listing in the Equipment List will not necessarily be acceptable as sufficient evidence that the items conform to the requirements of such standards.

44.6 APPROVAL OF MATERIALS AND EQUIPMENT.

Before starting installation of any materials or equipment, complete lists of materials and equipment to be incorporated in the work and any shop drawings shall be submitted to the COR. All items which are identical in model and manufacturer as on the approved drawings are to be listed for identification only, all items proposed as "equal" or other required components not specified on the approved drawings shall be supported by sufficient descriptive material, such as catalogs, cuts, diagrams, and other data published by the manufacturer, as well as evidence of compliance with safety and performance standards, to demonstrate conformance to the specification requirements; catalog numbers alone will not be acceptable. Listing of all items that function as part of an integrated system shall be furnished at one time. The COR will retain 3 copies of each submittal and return the remainder to the Constructor.

44.7 REQUIREMENTS.

Furnish equipment, labor, and materials as required for the installation of necessary relays and other devices, terminal strips, cabinets and associated wiring to bring all specified remote signals and circuits to a common point in a locked cabinet, such as a listed fire alarm control panel or a remote signal terminal cabinet, when specified for connection through the telephone system to the Site-wide Alarm System.

Alarm and trouble signals to be transmitted to the Site-wide alarm System shall include, but not be limited to, the criteria for remote signal transmission as shown on the drawings.

44.7.1 Fire Alarm, Smoke Alarm, Supervisory Alarm, and Trouble Signals.

Except where specifically shown on the approved drawings, each fire, smoke, or supervisory alarm shall be wired to produce three conditions.

44.7.1.1 Normal Condition. All devices normally open, with a resistor across the end-of-line for remote reading of circuit condition.

44.7.1.2 Alarm Condition. Closure of any device shall cause a closed circuit, shorting out the resistor and resulting in an alarm signal in the case of a fire alarm closed circuit, smoke alarm in the case of a smoke alarm closed circuit, or a supervisory alarm in the case of a supervisory alarm closed circuit.

44.7.1.3 Trouble Condition. Breaking of a wire shall cause an open circuit resulting in a trouble signal in the appropriate circuit, either fire alarm, or smoke alarm, or supervisory alarm.

44.7.2 Electrically Supervised Circuits.

All alarm circuits shall be electrically supervised by the existing Site-wide Fire Alarm System, through the remote signal terminals; therefore, each circuit shall be wired as a single circuit; parallel branch connections or circuits are not permitted.

44.7.3 Signal Initiating Devices and Equipment.

One or more of the following devices and equipment items shall be required for each project, as shown on the approved drawings.

44.7.3.1 Fire Alarm Signal Initiating Devices.

44.7.3.1.1 Electric Water Flow Switch. An approved pressure-operated switch, or an equivalent vane-type water flow switch, with pneumatic retard, capable of detecting flow equivalent to that of one sprinkler head, shall be installed in each sprinkler riser/alarm valve assembly by the sprinkler system installation firm. This switch shall be connected into the fire alarm circuit, in parallel with the manual pull boxes, (if any), unless otherwise shown on the drawings.

44.7.3.1.2 Manual Alarm Station Boxes shall be Notifier Model BNG-1. Station boxes utilizing "break-glass" or similar features designed to require replacement are not acceptable. Manual station boxes shall be installed in each building where shown and located adjacent to major exit doors in such a position as to be readily seen by persons traversing the exit path, approximately 4 feet 6 inch above the floor.

44.7.3.1.3 Key Locks for manual stations and other locked fire equipment shall match the existing Nevada Test Site system. The key is No. 415, Blank No. N54G, Fort Lock of Chicago, Illinois.

44.7.3.1.4 Heat Detectors. Spot-type heat detectors shall be of the bimetallic, self-restoring, fixed temperature, rate compensation (anticipation), open circuit, with temperature rating as shown on the drawings. Detectors shall be of vertical or horizontal form, with external or built-in head guards where the detectors are below seven feet, above floors, or otherwise subject to damage, as determined by the COR.

Horizontal detectors shall be Notifier Model 302H, Fenwal Model 27021-XX or approved equal, applied within listed spacings.

Vertical detectors shall be Notifier Model 302, Fenwal Model 27121-XX or approved equal, applied within listed spacings.

44.7.3.2 Smoke Alarm Signal Initiating Devices.

44.7.3.2.1 Ionization Type Smoke Detectors shall be of the low-voltage, two-chamber, field-adjustable sensitivity type, with built-in condition indicator.

44.7.3.2.1.1 Four-Wire Circuit Detectors shall contain integral relays for normally open and normally closed alarm contacts, supervisory alarm contact(s) remote annunciation and releasing device contacts.

Detector shall be Fenwal Division, W. Kidde Co., Model CPD 1212, or approved equal.

44.7.3.2.1.2 Two-Wire Circuit Detectors shall contain integral switching for alarm condition, and connections for external remote indicator. Unit shall be connected to listed control unit which shall provide alarm condition and supervisory current.

Detector shall be Pyr-a-larm DL-2S (surface-mount) or DL-2F (flush-mount) or approved equal.

44.7.3.2.1.3 Self-Contained Smoke Detector Control unit shall be self-contained detector/control unit operating from 120 VAC, with integral battery charger and rechargeable NI-CAD battery for minimum 24-hour standby capacity.

Unit shall provide the following functions:

Integral detector, with alarm and supervisory interconnection capacity for one or more remote mounted detectors.

Audible integral alarm, with capacity for one remote mounted audible alarm.

Visual indicator lamp for alarm condition.

Visual indicator lamp for power loss or interior trouble condition.

SPST-N.O. Alarm Contacts, auxiliary contacts (SPDT) for releasing device service.

Unit shall be designed for surface or flush mounting in ceiling, and shall be U.L.-listed.

Unit shall be Pyrotronics Model CS-3(F) or CS-3(S) or approved equal.

44.7.3.2.2 Photoelectric Type Spot Smoke Detectors shall operate on the light scatter principle. Detectors shall be factory-set to operate at a nominal two percent or less light obscuration per foot. Units shall utilize light emitting diode (LED) light source, and shall have integral condition indicating light.

44.7.3.2.2.1 Four-Wire Circuit Detectors shall be provided with SPST-N.O. alarm contact and auxiliary contact(s) for releasing device service, and built-in indicator lamp(s) for "Power On" and "Alarm" conditions.

Detector shall be Fenwall #71-110000-000, or Notifier SA24L without thermostat, or approved equal.

44.7.3.2.2.2 Two-Wire Circuit Detectors shall contain integral switching for alarm condition, and connections for external remote indicator. Unit shall be connected to listed control unit which shall provide alarm condition and supervisory current.

Detector shall be Pyrotronics Model DS-2 (surface-mount) or approved equal.

44.7.3.2.3 Detector Sensitivity. Field adjustable detectors shall be set at mid-range level for initial installation. Sensitivity settings shall be verified during final inspection, using standard detector test equipment.

44.7.3.2.4 Detector Test Equipment. Manufacturer's standard equipment or instrumentation to facilitate testing, metering, or to assure adequate initial sensitivity, shall be made available, at cost. If such test equipment would be a duplication of equipment previously obtained, and in good order, such equipment, at the option of the COR, need not be acquired.

44.7.3.2.5 Location. Detecting equipment shall be installed throughout all areas shown on the approved drawings.

44.7.3.2.6 Spacing. Detector spacing shall be in accordance with NFPA 72E, where not otherwise determined.

44.7.3.3 Supervisory Signal Initiating Devices.

44.7.3.3.1 Post Indicator Valve. An approved PIV valve position supervisory switch shall be installed as specified in Section 42. PIV switch shall have SPDT or SPST-N.O. contacts and tamper indication features,

and be connected so as to cause supervisory alarm before the valve stem is moved more than one and one-half turns from the normally open condition. PIV switch shall have a 2-foot minimum length of liquid-tight flexible conduit, from switch down to a length of conduit, which shall carry conductors into ground. The conduit shall extend not less than 5 feet from PIV, with the stub-up strapped to base of PIV. Conductors shall be No. 14, UF direct burial or equal. Switch shall be Notifier Type NIP or equal.

44.7.3.3.2 OS&Y Supervisory Switch. An approved OS&Y supervisory switch shall be installed when specified. Switch shall have SPDT contacts and be connected so as to cause supervisory alarm before the valve stem is moved more than one and one-half turns from the normally open condition.

Switch shall be Notifier Type NGV or approved equal.

44.7.3.3.3 Air Pressure Switch. An approved air pressure switch shall be installed when specified. Switch shall be set to function according to manufacturer's recommendations. The pressure settings shall be as shown on the approved drawings, or as directed by the Contractor Officer's Representative (COR).

Switch shall be Notifier ACW-5-(LA) or (HA) or approved equal.

44.7.3.3.4 Low Temperature Switch. An approved low temperature supervisory switch shall be installed when specified. Switch shall have normally open contacts set to alarm if sensing point temperature drops below the set point.

The temperature set point shall be as shown on the approved drawings or as determined by the COR.

Switch shall be Honeywell T238A (Range 15° to 45° F.) or approved equal for air temperature supervision.

Switch shall be Potter TTS or approved equal for tank temperature supervision.

44.7.3.4 Other Devices, when specified on drawings, shall be installed in strict accordance with manufacturer's data, and as directed on design drawings.

44.7.4 Fire Alarm Control Panels.

Fire alarm control panels shall be equipped with a remote station signal transmitter compatible with existing receiver equipment in the nearest Fire Department Station.

44.7.4.1 Existing Receivers in Fire Stations consist of a nonpolarized 12 VDC system set up to electrically display alarm, and trouble signals. These signals are to be connected as described in Paragraph 44.7.1, with each circuit terminated by end-of-line resistor (resistance varies) to suit the local area Fire Department receiving/supervising panel.

44.7.4.2 Control Unit shall be specifically approved for use with the devices used in the systems. Control unit shall include a suitable means for testing the systems. Unit shall be so arranged as to operate all alarm bells throughout the building in the event of activation, and continue operation until silenced by means of a reset switch with "ring-back" feature provided for that purpose. Unit shall have contact terminals for both alarm and trouble signals for connection to Site-Wide Alarm System.

Control unit shall have a compatible system of storage batteries to maintain protection during power failures. Batteries may be mounted within the control panel if a standard of the manufacturer, or in a separate lockable cabinet.

Unless otherwise specified on the drawings, the control panel/battery system shall include an integral battery charger and trickle or float-charged battery(s).

The battery shall be capable of operating the system under normal load for not less than 24 consecutive hours, with primary power supply disconnected, unless otherwise specified on the approved drawings.

Control panel shall contain all equipment necessary for the testing, supervision, and control of the alarm system circuits. All wiring to the units shall be installed in a neat and workmanlike manner and shall be trained parallel with or at right angles to the cabinet sides and back. All circuit conductors to the units shall be connected through terminal blocks with each terminal marked for identification. All terminal connections shall be readily accessible without removing any component parts. Control unit equipment shall be housed in steel, surface-mounted cabinet with full front-hinged door having key lock (see Paragraph 44.7.3.1.3 for keys) and factory painted. The cabinet front shall have prominent nameplates of etched metal or plastic identifying each system. All unit switches shall be mounted within the locked cabinet. Indicating lamps shall be mounted on the cabinet door, or mounted within the cabinet and readily visible through a glass or plastic viewing panel. All lamps, switches, controls, meters, and fuses shall have identifying nameplates of etched metal or rigid hard plastic. Nameplates for fuses shall also include ampere rating. A copy of the system circuit diagram and control panel schematic shall be provided within the control panel.

44.7.4.3 Transmitters. Fire alarm transmitters shall be of the unit type with or without manual feature. When practicable, the transmitters may be combined with the control unit in a single assembly if the combination meets all the requirements for both control unit and transmitters. The transmitters shall be fully compatible with other fire alarm equipment to which the transmitters are to be connected, and shall be approved for the use employed. Where available, equipment shall be of the same manufacturer. The transmitters shall be of the supervisory type, designed to transmit noncoded fire alarm signals and distinctive noncoded trouble signals over circuits to a "Remote Station" alarm location.

Transmission of a noncoded trouble signal shall automatically result from a break in any supervisory circuit or interior manual fire alarm box circuit or from failure of main power supply for transmitters. A fire alarm signal shall consist of audible and visual signals that require manual logging by the operator on duty at the Fire Station. The transmitter shall be housed in a cabinet as specified in Paragraph 44.6.4.2, for the control unit.

44.7.5 Remote Signal Terminal Cabinet.

When specified, remote signal terminal cabinet shall be NEMA Type 1, or approved equal, and of sufficient size and capacity to accommodate all necessary terminal strips, relays and end-of-line resistors. Cabinet shall have solid, hinged door with key lock, or be furnished with padlock eyes and padlock. Key shall be compatible with Nevada Test Site system, see Paragraph 44.7.3.1.3. Cabinet shall be factory or field painted signal red, and permanently labeled with embossed or etched metal, or engraved plastic labels identifying the cabinet as "Remote Fire Signal Terminal Cabinet--Building."

44.7.6 Terminal Strips.

Terminal strips shall be of the sectionalized type, Buchanan MD, Pressure Plate type, or approved equal. All terminals shall be identified by permanent labels as to system and function.

44.7.7 Fire Alarm Bells.

Vibrating alarm bells shall be used for all fire alarm signals. Bells shall be approved for the purpose intended and shall be 6 inches in diameter, minimum; Notifier N-CO or approved equal. The base of all bells shall be mounted not less than 7 feet above the floor and below the bottom surface of the ceiling construction.

44.7.7.1 Local Bell Relay Unit. When shown on approved drawings REECO Stock Single Point Bell Relay/Transmitter shall be installed. Unit is capable of driving a maximum of one (1) bell, utilize approved 110 VAC relay(s) for additional bells, or additional functions.

44.8 ELECTRICAL POWER

44.8.1 Power Supply.

Power supply for all systems shall be 120 volt, single-phase, 60 Hz AC derived from building service. The service connection shall be ahead of all cutouts and breakers in the designated electrical panel. System circuit protection shall be as provided on electrical drawings and shall be mounted in a separate lockable cabinet identified as to the system served. The ampere rating of circuit protection shall be as required by NEC.

44.9 SYSTEM WIRING

44.9.1 Wiring.

Wiring unless specifically shown on the approved drawings or specifically approved by the COR wire shall have solid copper conductors having a thermoplastic insulation and shall be UL-listed for the intended purpose. Conductors on alarm initiating circuits and remote signal circuits shall be not less than No. 18 AWG; on alarm bell circuits, not less than No. 14 AWG; on power connection circuits, not less than No. 12 AWG. Wiring shall conform to NFPA Standard, NEC 70, Article 760. Each conductor used for the same specified circuit function shall be distinctly color-coded with solid colors, one for each loop. A separate color and conduit shall be used for all alarm bell circuits. Exposed ends of conduits shall be bushed to prevent damage to wire insulation. If polarized bells are used, then two separate colors shall be used to designate positive and negative.

44.9.2 All Wiring.

All wiring below 7 feet shall be in conduit. Wiring above 7 feet, of power limited circuits as shown in NFPA Standard NEC 70, Paragraph 760, may be run exposed unless conduit is specified on drawings. A separate conduit shall be used for all alarm bell circuits. Exposed ends of conduits shall be bushed to prevent damage to wire insulation.

44.9.3 Exposed Low Voltage Wiring.

Exposed low voltage wiring on alarm initiating and remote signal circuits shall be UL-listed under subject of "Power Limited Fire-Protective Signaling Cable". Exposed wiring on alarm bell circuits shall be jacketed type NM cable (with ground wire), No. 14 AWG. Direct burial cable shall be Type UF.

44.9.4 Workmanship.

The installation shall not damage the building or wall or ceiling finishes, and shall be in accordance with good electrical practices.

The work shall be carefully laid out in advance. Where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surface is necessary for the proper installation, support, or anchorage of the conduit or other work, such cutting, channeling, chasing, or drilling shall be done in a neat and workmanlike manner.

44.9.4.1 Wiring shall be inconspicuous, concealed where practicable in finished areas and exposed otherwise, and shall be in accordance with the applicable provisions of NFPA Standard, NEC 70, Article 760. Exposed cables or single conductors shall follow closely the surface wired over and shall be fastened at intervals of not more than 10 feet maximum, with closer spacing as required to avoid sagging in areas where damage would be possible, or finished areas, and within 6 inches of a bend or a corner.

Cable or wire runs shall be parallel to, or at right angles to, the walls or ceilings. In exposed wood frame construction, cables or wires shall be installed on the sides of studs, rafters, or joists where practicable, and where crossing these members at right angles in occupied spaces shall be installed on running boards not smaller than 1 1/2 inches by 3/4 inch or standard messenger cable.

44.10 REPAIR OF EXISTING WORK.

Where approved by the COR any significant damage to building, piping or equipment caused by this work shall be repaired and refinished by skilled mechanics of the trade involved.

44.11 PAINTING.

Except where required on the approved drawings, or by the COR, exposed conduit, hangers, and supports shall not be painted. Where painting is specified, exposed conduits, hangers, and supports shall be given one coat of primer and finished coat to match existing surfaces.

44.11.1 Factory-Painted Equipment.

Factory-painted equipment shall not be modified.

44.11.2 Cover Plates.

All cover plates for all junction boxes, whether conduit is painted or not, shall be painted red, and stenciled with the letters "FA" not less than one inch high, white block lettering.

44.12 INSPECTION, TESTING, AND ACCEPTANCE.

After each segment of the work has been fully installed, the Contractor shall perform the following inspection and test work on each segment according to a schedule mutually agreed upon, as a condition precedent to final acceptance of the work.

44.12.1 Contractor's Inspection and Test.

Contractor's inspection and test shall be performed by the Contractor at his convenience to satisfy himself that the system or segment is in complete operating order and meets all requirements of the government-furnished drawings and these specifications and to assure that the system or segment is fully ready for final inspection and acceptance test. Contractor's inspection and test shall consist of:

44.12.1.1 Necessary Inspection to assure that all systems or segment components have been mounted and installed in accordance with manufacturer's instructions and shop drawings and that all electrical materials and equipment have been installed in accordance with these specifications, manufacturers' instructions and specifications, and shop drawings.

44.12.1.2 Testing as required to assure there are no shorts or grounds in all system or segment wiring.

44.12.1.3 Connection to Power Supply and preliminary operational tests to verify proper line voltage and to verify proper operation of all functions of all system or segment components and circuits, all in accordance with manufacturers' standard procedures and instructions and applicable portions of these specifications.

When the Contractor has satisfied himself that each system is in complete operating condition in every respect as required above, he shall notify the COR in writing that the system or segment has been inspected and tested and is ready for final inspection acceptance tests, giving at least three working days' notice of the desired date and time of such tests.

44.12.2 Final Inspection.

Final inspection of all phases of work shall be made by and at the discretion of the COR prior to final acceptance tests and may be made on the same day as acceptance tests. Inspection shall include physical removal of selected devices and/or wiring box covers to observe wiring methods or effects on systems.

44.12.3 Final Acceptance Tests.

Final acceptance tests shall be performed by the Constructor and witnessed by the COR.

Final testing shall consist of operational test to verify proper operation of each system or segment in every respect, including all circuits and components, and electrical verification of auxiliary contact operation at remote signal terminal cabinet.

Any faults or malfunctions in system, segment, or component operation discovered shall be corrected and final inspection and testing shall be repeated as directed by the COR. Successful completion of final inspection and acceptance tests, as determined by the COR, shall constitute evidence of satisfactory completion of the respective system or segment.

44.13 OPERATING INSTRUCTIONS.

Two sets of operating instructions shall be provided for the fire alarm and remote transmission facilities. One set shall be posted adjacent to the main riser. One set for the system shall be provided to the COR.

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