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SECTION 09260

GYPSUM BOARD SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 36	(1997) Gypsum Wallboard
ASTM C 475	(1994) Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 630/C 630M	(1996a) Water-Resistant Gypsum Backing Board
ASTM C 840	(1998) Application and Finishing of Gypsum Board
ASTM C 1002	(1998) Steel Drill Screws for the Application of Gypsum Board or Metal Plaster Bases
ASTM C 1047	(1998) Accessories for Gypsum Wallboard and Gypsum Veneer Base

1.2 DELIVERY, STORAGE, AND HANDLING

Schedule delivery to minimize storage periods at project site. Deliver materials in accordance with manufacturer's instructions; ship unopened containers or packages, fully identified with manufacturer's name, brand, type and grade. Store boards flat with uniform support. Protect from weather and damage as recommended by manufacturer.

PART 2 PRODUCTS

2.1 GYPSUM BOARD - INTERIOR

2.1.1 Exposed Board Surface

Exposed board surface shall be 5/8" thick gypsum wallboard unless otherwise indicated, complying with ASTM C 36, with paper face surface suitable to receive decorated finish and long edges tapered to receive standard joint treatment, in lengths as required for minimum number of joints.

2.1.2 Gypsum Backing Board for Carsiding

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Water-resistant gypsum backing board, ASTM C 630/C 630M, with core and paper facings treated to resist moisture.

2.2 GYPSUM BOARD FASTENERS

Provide type and size recommended by manufacturer for applications shown. Review fire-rated assembly requirements for fastener spacing. In general, fasten gypsum board with self-drilling screws designed for gypsum board, ASTM C 1002. Screws shall be self-tapping when used with metal framing up to 12 gauge. Heads shall be designed for covering with finishing compound if exposed in face layers.

2.3 GYPSUM BOARD METAL TRIM ACCESSORIES

Provide trim accessories of sizes required for applications shown, fabricated of galvanized steel, complying with ASTM C 1047 as follows:

- a. External Corners: Metal corner bead with smooth rigid nose and perforated and knurled metal flanges.
- b. Control Joints: Where shown and as required in Part 3 Execution, one-piece joint assembly of non-corrosive metal or extruded vinyl with continuous unperforated V-slot for insertion into joint and perforated flanges for attachment to face of gypsum board with slot opening covered with removable strip.
- c. Where face panels abut dissimilar materials, at reveals, and where designated: Shaped metal trim designed to be concealed by taping operations.
- d. Exposed panel edges and where designated: J-shape casing beads designed to be concealed by taping.

2.4 JOINT TREATMENT MATERIALS

2.4.1 Joint Tape

Plain or perforated paper, ASTM C 475.

2.4.2 Joint Compound

Factory-prepackaged vinyl based products, ASTM C 475. Provide in dry powder form for mixing with water at jobsite or factory pre-mixed, for single or two-compound treatment. Taping compound shall be formulated for embedding tape and first coat over fasteners and flanges of corner beads and edge trim. Topping compounds shall be formulated for fill (second) and finish (third) coats. All purpose compounds shall be formulated for use as both taping and topping compounds.

PART 3 EXECUTION

3.1 INSTALLATION OF GYPSUM BOARD

Comply with ASTM C 840, unless otherwise recommended by gypsum board manufacturer. Examine substrates and conditions; notify of detrimental conditions. Do not proceed until unsatisfactory conditions are corrected. Do not exceed 1/8 inch in 8 feet variation from plumb or level in line or surface; except at joints between units, do not exceed 1/16 inch variation between planes of abutting edges or ends. Shim as required to comply with

specified tolerances. Provide additional framing and blocking as required to support gypsum board at openings and cutouts, and to support built-in anchorage and attachment devices for other work. Form control joints in gypsum board construction where indicated below. Allow 1/2 inch continuous opening between edges of adjacent drywall boards to allow for insertion of control joint trim accessory.

3.2 SINGLE LAYER GYPSUM BOARD APPLICATIONS

3.2.1 Partition/Walls

For heights of 8 feet-1 inch or less, apply gypsum board vertically or horizontally at contractor's option. For heights greater than 8 feet-1 inch or for areas less than 4 feet wide, apply vertically. Use floor-to-ceiling length boards for vertical applications and locate edge joints over supports, but offset at least one stud on opposite faces of partition/walls. Use maximum practical length boards for horizontal applications and locate end joints over supports and stagger in alternate courses of board.

3.2.2 Ceilings

Apply gypsum board with long dimension at right angles to supports with end butt joints located over supports. Use maximum practical length boards to minimize end butt joints. Stagger end joints in alternate courses of boards and locate as far away from center of ceiling as possible.

3.2.3 Supports

Fasten gypsum board with screws. Comply with manufacturer's instructions for fastening, but do not exceed 12 inch o.c. spacing.

3.3 CONTROL JOINTS

Gypsum panel surfaces shall be isolated with control joints where:

- a. Partition, furring, or column fireproofing abuts a structural element (excepts floor) or dissimilar wall or ceiling.
- b. Ceiling abuts a structural element, dissimilar wall or partition, or other vertical penetration.
- c. Construction changes within plane of partition or ceiling.
- d. Partition or furring run exceeds 30 feet.
- e. Wings of "L", "U" and "T"-shaped ceiling areas are joined.

3.4 GYPSUM BOARD FINISHING

Do not install joint treatment compounds unless conditions comply with minimum temperature and ventilation requirements recommended by manufacturer. Finish exposed gypsum board surfaces with joints, corners, and exposed edges reinforced or trimmed as specified, and with joints, fasteners, accessory flanges, and surface defects filled with joint compound in accordance with manufacturer's recommendations for a smooth, flush surface. Gypsum board finishing work will not be considered acceptable if corners or edges do not form true, level, or plumb lines, or if joints, fastener heads, flanges of accessories, or defects are visible

after application.

3.5 PROTECTION

Comply with proper procedures for protection of completed gypsum board work from damage or deterioration until acceptance of work.

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SECTION 09310

CERAMIC TILE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A118.1 (1992) Dry-Set Portland Cement Mortar

ANSI A137.1 (1988) Ceramic Tile

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Tile; GA

Submit product data and installation instructions. Include certifications and other data to show compliance with these specifications.

SD-14 Samples

Tile; GA

Submit samples of each type, class, and color of tile and trim. Samples will be reviewed for color, pattern and texture only; compliance with all other requirements is Contractor's responsibility.

1.3 QUALITY ASSURANCE

Provide tile certified by Tile Council of America (TCA) to equal or exceed ANSI A137.1, "Standard Grade". Comply with TCA specifications for installation of ceramic tile. Provide materials obtained from one source for each type and color of tile.

1.4 DELIVERY AND STORAGE

Deliver materials and store on site in original containers with seals and labels intact until used.

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1.5 EXTRA MATERIALS

Supply an extra 2 percent of total quantity of each tile and trim. Place in clean marked cartons for Government's use.

PART 2 PRODUCTS

2.1 GLAZED WALL TILE

Where ceramic base is indicated in rooms with concrete floor, provide 4-1/2 inches high x 4-1/2 inches long glazed tile specifically designed for this application, with cove base and rounded top.

2.2 SETTING MATERIALS

Dry set mortar shall comply with ANSI A118.1, gray or white as required.

2.3 GROUTING MATERIALS

Glazed tile shall be commercial, white portland cement grout, wet or dry formation as appropriate.

2.4 SEALANTS

See Section 07900 JOINT SEALING.

2.5 PROTECTIVE MATERIALS

Neutral cleaner; heavy duty nonstaining construction paper with compatible masking tape.

PART 3 EXECUTION

3.1 EXAMINATION OF SURFACES

Inspect substrates for condition and maximum variations shown below:

	<u>Wall</u>
Dry-Set Mortar	1/8 inch in 8 feet

Report unacceptable surfaces. Surfaces to be tiled shall be free from coatings, curing membranes, oil, grease, wax, and dust. Do not proceed until unsatisfactory conditions are corrected.

3.2 LAYOUT

Determine location of movement joints. Lay out tile work to minimize cuts less than one-half tile in size. Locate cuts to be least conspicuous. Align wall joints to give straight uniform grout lines, plumb and level. Make joints between tile sheets same width as joints within sheets so extent of each sheet is not apparent in finished work.

3.3 TILE INSTALLATION, GENERAL

Use products in strict accordance with manufacturer recommendations. Proportion mixes in accordance with applicable ANSI 108-series standards. Terminate work neatly at obstructions, edges, and corners without disruption of pattern or joint alignments. Smooth exposed cut edges; clean cut edges before installing tiles. Fit tile carefully against trim and

around pipes, electric boxes, and other built-in fixtures so that escutcheons, plates, and collars will completely overlap cut edges.

3.4 SETTING METHODS

Provide setting beds as shown or, when not indicated, use applicable TCA installation specifications for setting and grouting materials specified.

3.5 GROUTING

Grout in accordance with manufacturer's recommendations.

3.6 CLEANING

Clean tile surfaces thoroughly after grouting. Remove grout film, observing tile manufacturer's recommendations for chemical cleaners. Rinse tile work thoroughly with clean water before and after using chemical cleaners. Polish surface of tile work with soft cloth.

3.7 PROTECTION

Protect tile work with heavy duty construction paper or other material to prevent damage. Prohibit construction traffic from using newly tiled areas. Upon Substantial Completion, tile work shall be complete and free from defects. Repair damaged work to match adjacent surfaces.

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SECTION 09900

PAINTING, GENERAL

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

ACGIH Limit Values (1999) Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 4258 (1999) Surface Cleaning Concrete for Coating

COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1788 (Canc. Notice 1)) Varnish, Oil; Interior

CID A-A-2246 (Rev B) Paint, Latex

CID A-A-2336 (Rev A) Primer Coating (Alkyd, Exterior Wood, White and Tints)

CID A-A-2962 (Rev A) Enamel, Alkyd (Metric)

CID A-A-2994 Primer Coating, Interior, for Walls and Wood

FEDERAL SPECIFICATIONS (FS)

FS TT-E-2784 (Rev A) Enamel (Acrylic-Emulsion, Exterior Gloss and Semigloss) (Metric)

FS TT-S-708 (Rev A; Am 2; Notice 1) Stain, Oil; Semi-Transparent, Wood, Exterior

FS TT-S-001992 (Basic; Notice 1) Stain, Latex, Exterior for Wood Surfaces

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC Paint 5 (1995) Zinc Dust, Zinc Oxide and Phenolic Varnish Paint

SSPC Paint 20 (1991) Zinc-Rich Primers (Type I - "Inorganic" and Type II - "Organic")

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SSPC Paint 25	(1991) Red Iron Oxide, Zinc Oxide, Raw Linseed Oil and Alkyd Primer (Without Lead and Chromate Pigments)
SSPC SP 1	(1982) Solvent Cleaning
SSPC SP 2	(1995) Hand Tool Cleaning
SSPC SP 3	(1995) Power Tool Cleaning
SSPC SP 7/NACE 4	(1994) Brush-Off Blast Cleaning

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Paint; FIO.

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

Mixing and Thinning; FIO. Application; FIO.

Manufacturer's current printed product description, material safety data sheets (MSDS) and technical data sheets for each coating system. Detailed mixing, thinning and application instructions, minimum and maximum application temperature, and curing and drying times between coats for epoxy, moisture-curing polyurethane, and liquid glaze coatings. Detailed application instructions for textured coatings shall be provided.

SD-09 Reports

Paint; FIO.

A statement as to the quantity represented and the intended use, plus the following test report for batches in excess of 50 gallons:

- a. A test report showing that the proposed batch to be used meets specified requirements:
- b. A test report showing that a previous batch of the same formulation as the batch to be used met specified requirements, plus, on the proposed batch to be used, a report of test results for properties of weight per gallon, viscosity, fineness of grind, drying time, color, and gloss.

SD-13 Certificates

Lead; FIO. Volatile Organic Compound (VOC) Content; FIO.

Certificate stating that paints for interior use contain no mercurial mildewcide or insecticide. Certificate stating that paints proposed for use contain not more than 0.06 percent lead by weight of the total

nonvolatile. Certificate stating that paints proposed for use meet Federal VOC regulations and those of the of the local Air Pollution Control Districts having jurisdiction over the geographical area in which the project is located.

SD-14 Samples

Paint; FIO.

While the material is at the site or source of supply, and at a time agreeable to the Contractor and the Contracting Officer, a 1 quart sample of each color and batch, except for quantities of 50 gallons or less, shall be taken by random selection from the sealed containers by the Contractor in the presence of a representative of the Contracting Officer. The contents of the containers to be sampled shall be thoroughly mixed to ensure that the sample is representative. Samples shall be identified by designated name, specification number, manufacturer name and address, batch number, project contract number, intended use, and quantity involved.

1.3 PACKAGING, LABELING, AND STORING

Paints shall be in sealed containers that legibly show the designated name, formula or specification number, batch number, color, quantity, date of manufacture, manufacturer's formulation number, manufacturer's directions including any warnings and special precautions, and name of manufacturer. Pigmented paints shall be furnished in containers not larger than 5 gallons.

Paints and thinner shall be stored in accordance with the manufacturer's written directions and as a minimum stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors and at temperatures between 40 and 95 degrees F. Paints shall be stored on the project site or segregated at the source of supply sufficiently in advance of need to allow 30 days for testing.

1.4 APPROVAL OF MATERIALS

When samples are tested, approval of materials will be based on tests of the samples; otherwise, materials will be approved based on test reports furnished with them. If materials are approved based on test reports furnished, samples will be retained by the Government for testing should the materials appear defective during or after application. In addition to any other remedies under the contract the cost of retesting defective materials will be at the Contractor's expense.

1.5 ENVIRONMENTAL CONDITIONS

Unless otherwise recommended by the paint manufacturer, the ambient temperature shall be between 45 and 95 degrees F when applying coatings other than water-thinned, epoxy, and moisture-curing polyurethane coatings.

Water-thinned coatings shall be applied only when ambient temperature is between 50 and 90 degrees F. Epoxy, and moisture-curing polyurethane coatings shall be applied only within the minimum and maximum temperatures recommended by the coating manufacturer. Moisture-curing polyurethane shall not be applied when the relative humidity is below 30 percent.

1.6 SAFETY AND HEALTH

Work shall comply with applicable Federal, State, and local laws and regulations, and with the ACCIDENT PREVENTION PLAN, including the Activity Hazard Analysis as specified in the CONTRACT CLAUSES. The Activity Hazard

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Analysis shall include analyses of the potential impact of painting operations on painting personnel and on others involved in and adjacent to the work zone.

1.6.1 Worker Exposures

Exposure of workers to hazardous chemical substances shall not exceed limits established by ACGIH Limit Values, or as required by a more stringent applicable regulation.

1.6.2 Toxic Compounds

Toxic products having ineffective physiological warning properties, such as no or low odor or irritation levels, shall not be used unless approved by the Contracting Officer.

1.6.3 Training

Workers having access to an affected work area shall be informed of the contents of the applicable material data safety sheets (MDSS) and shall be informed of potential health and safety hazard and protective controls associated with materials used on the project. An affected work area is one which may receive mists and odors from the painting operations. Workers involved in preparation, painting and clean-up shall be trained in the safe handling and application, and the exposure limit, for each material which the worker will use in the project. Personnel having a need to use respirators and masks shall be instructed in the use and maintenance of such equipment.

1.6.4 Coordination

Work shall be coordinated to minimize exposure of building occupants, other Contractor personnel, and visitors to mists and odors from preparation, painting and clean-up operations.

PART 2 PRODUCTS

2.1 PAINT

The term "paint" as used herein includes emulsions, enamels, paints, stains, varnishes, sealers, cement-emulsion filler, and other coatings, whether used as prime, intermediate, or finish coat. Paint shall conform to the requirements listed in the painting schedules at the end of this section, except when the required amount of a material of a particular batch is 50 gallons or less, an approved first-line proprietary paint material with similar intended formulation, usage and color to that specified may be used. Additional requirements are as follows:

2.1.1 Colors and Tints

Colors shall be as selected from manufacturer's standard colors, as indicated. Manufacturer's standard color is for identification of color only. Tinting of epoxy and urethane paints shall be done by the manufacturer. Stains shall conform in shade to manufacturer's standard color. The color of the undercoats shall vary slightly from the color of the next coat.

2.1.2 Lead

Paints containing lead in excess of 0.06 percent by weight of the total nonvolatile content (calculated as lead metal) shall not be used.

2.1.3 Chromium

Paints containing zinc chromate or strontium chromate pigments shall not be used.

2.1.4 Volatile Organic Compound (VOC) Content

Paints shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards and shall conform to the restrictions of the local air pollution control authority.

PART 3 EXECUTION

3.1 PROTECTION OF AREAS NOT TO BE PAINTED

Items not to be painted which are in contact with or adjacent to painted surfaces shall be removed or protected prior to surface preparation and painting operations. Items removed prior to painting shall be replaced when painting is completed. Following completion of painting, workmen skilled in the trades involved shall reinstall removed items. Surfaces contaminated by coating materials shall be restored to original condition.

3.2 SURFACE PREPARATION

Surfaces to be painted shall be clean and free of foreign matter before application of paint or surface treatments. Oil and grease shall be removed prior to mechanical cleaning. Cleaning shall be programmed so that dust and other contaminants will not fall on wet, newly painted surfaces. Exposed ferrous metals such as nail heads on or in contact with surfaces to be painted with water-thinned paints, shall be spot-primed with a suitable corrosion-inhibitive primer capable of preventing flash rusting and compatible with the coating specified for the adjacent areas.

3.2.1 Masonry Surfaces

Masonry surfaces shall be allowed to dry at least 30 days before painting, except concrete slab on grade which shall be allowed to cure 90 days before painting. Surfaces shall be cleaned in accordance with ASTM D 4258. Glaze, efflorescence, laitance, dirt, grease, oil, asphalt, surface deposits of free iron and other foreign matter shall be removed prior to painting. Surfaces to receive polyurethane or epoxy coatings shall be acid-etched or mechanically abraded as specified by the coating manufacturer, rinsed with water, allowed to dry, and treated with the manufacturer's recommended conditioner prior to application of the first coat.

3.2.2 Ferrous Surfaces

Ferrous surfaces including those that have been shop-coated, shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1. Surfaces that contain loose rust, loose mill scale, and other foreign substances shall be cleaned mechanically with hand tools according to SSPC SP 2, power tools according to SSPC SP 3 or by sandblasting according to SSPC SP 7/NACE 4. Shop-coated ferrous surfaces shall be protected from corrosion by treating and touching up corroded areas immediately upon detection.

3.2.3 Nonferrous Metallic Surfaces

Galvanized, aluminum and aluminum-alloy, lead, copper, and other nonferrous metal surfaces shall be solvent-cleaned or detergent-washed in accordance with SSPC SP 1.

3.2.4 Gypsum Board Surfaces

Gypsum board surfaces shall be dry and shall have all loose dirt and dust removed by brushing with a soft brush, rubbing with a cloth, or vacuum-cleaning prior to application of the first-coat material. A damp cloth or sponge may be used if paint will be water-based.

3.2.5 Wood Surfaces

Wood surfaces shall be cleaned of foreign matter. Moisture content of the wood shall not exceed 12 percent as measured by a moisture meter, unless otherwise authorized. Wood surfaces adjacent to surfaces to receive water-thinned paints shall be primed and/or touched up before applying water-thinned paints. Small, dry seasoned knots shall be scraped, cleaned, and given a thin coat of commercial 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 it is still soft, removed with mineral spirits or turpentine, and the resinous area shall be thinly coated with knot sealer. Finishing nails shall be set, and all holes and surface imperfections shall be primed. After priming, holes and imperfections in finish surfaces shall be filled with putty or plastic wood filler, colored to match the finish coat if natural finish is required, allowed to dry, and sanded smooth. Putty or wood filler shall be compatible with subsequent coatings.

3.2.5.1 Interior Wood Stain

Interior wood surfaces to receive stain shall be sanded. Oak and other open-grain wood to receive stain shall be given a coat of wood filler not less than 8 hours before the application of stain; excess filler shall be removed and the surface sanded smooth.

3.3 MIXING AND THINNING

When thinning is approved as necessary to suit surface, temperature, weather conditions, or application methods, paints may be thinned in accordance with the manufacturer's directions. When thinning is allowed, paints shall be thinned immediately prior to application with not more than 1 pint of suitable thinner per gallon. The use of thinner shall not relieve the Contractor from obtaining complete hiding, full film thickness, or required gloss. Thinning shall not cause the paint to exceed limits on volatile organic compounds. Paints of different manufacturers shall not be mixed.

3.4 APPLICATION

Painting practices shall comply with applicable federal, state and local laws enacted to insure compliance with Federal Clean Air Standards. Unless otherwise specified or recommended by the paint manufacturer, paint may be applied by brush, roller, or spray. At the time of application, paint shall show no signs of deterioration. Uniform suspension of pigments shall be maintained during application. Each coat of paint shall be applied so dry film shall be of uniform thickness and free from runs, drops, ridges,

waves, pinholes or other voids, laps, brush marks, and variations in color, texture, and finish. Hiding shall be complete. Rollers for applying paints and enamels shall be of a type designed for the coating to be applied and the surface to be coated. Special attention shall be given to insure that all edges, corners, crevices, welds, and rivets receive a film thickness equal to that of adjacent painted surfaces. Paints, except water-thinned types, shall be applied only to surfaces that are completely free of moisture as determined by sight or touch.

3.4.1 Ventilation

Affected areas shall be ventilated during paint application so that workers exposure to chemical substances shall not exceed limits as established by ACGIH Limit Values, or as required by a more stringent applicable regulation. Interior work zones having a volume of 10,000 cubic feet or less shall be ventilated at a minimum of 2 air exchanges per hour. Ventilation in larger work zones shall be maintained by means of mechanical exhaust. Solvent vapors shall be exhausted outdoors, away from air intakes and workers. Return air inlets in the work zone shall be temporarily sealed before start of work until the coatings have dried.

3.4.2 Respirators

Operators and personnel in the vicinity of operating paint sprayers shall wear respirators.

3.4.3 First Coat

The first coat on gypsum wallboard, and other surfaces shall include repeated touching up of suction spots or overall application of primer or sealer to produce uniform color and gloss. Excess sealer shall be wiped off after each application. Each varnish coat shall be sanded lightly prior to application of subsequent coats.

3.4.4 Timing

Surfaces that have been cleaned, pretreated, and otherwise prepared for painting shall be given a coat of the specified first coat as soon as practical after such pretreatment has been completed, but prior to any deterioration of the prepared surface. Sufficient time shall elapse between successive coats to permit proper drying. This period shall be modified as necessary to suit weather conditions. Oil-based or oleoresinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause the undercoat to lift or lose adhesion. Manufacturer's instructions for application, curing and drying time between coats of two-component systems shall be followed.

3.4.5 Stains

Stain shall be applied at the rate specified in the manufacturer's printed directions. Oil-type stain shall be applied by brushing with the grain for the full length of the board or course of siding.

3.5 SURFACES TO BE PAINTED

Surfaces listed in the painting schedules at the end of this section, other than those listed in paragraph SURFACES NOT TO BE PAINTED, shall be painted

as scheduled.

3.6 SURFACES NOT TO BE PAINTED

Surfaces in the following areas shall not be painted:

- a. Concrete (except interior concrete walls).
- b. Metals fully embedded in concrete (except aluminum)
- c. Factory name plates.
- d. Galvanized steel items.
- e. Aluminum items, including guardrail.
- f. Burnished concrete masonry units.
- g. Brick.
- h. Stone.
- i. In addition, surfaces of hardware, fittings, and other factory finished items shall not be painted.

3.7 CLEANING

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

3.8 PAINTING SCHEDULES

The following painting schedules identify the surfaces to be painted and prescribe the paint to be used and the number of coats of paint to be applied. Contractor options are indicated by -----or----- between optional systems or coats.

EXTERIOR PAINTING SCHEDULE

<u>Surfac</u>	<u>First Coa</u>	<u>Second Coa</u>	<u>Third Coat</u>
Wood, unless otherwise specified.	CID A-A-2336	FS TT-E-2784	FS TT-E-2784
	FS TT-E-2784 Type III	FS TT-E-2784	FS TT-E-2784
Wood: stain finish.	FS TT-S-708	None	None

EXTERIOR PAINTING SCHEDULE

<u>Surfac</u>	<u>First Coa</u>	<u>Second Coa</u>	<u>Third Coat</u>
	FS TT-S-001992 Class B	FS TT-S-001992 Class B	None
Ferrous metal unless otherwise specified	SSPC Paint 5	CID A-A-2962 Type I Grade C	CID A-A-2962 Type 1 Grade C
Ferrous metal: subject to high temperature, up to 232 degrees C (450 degrees F),	SSPC Paint 20 Type I	None	None
Galvanized metal.	FS TT-E-2784 Type III	FS TT-E-2784	FS TT-E-2784

INTERIOR PAINTING SCHEDULE

<u>Surfac</u>	<u>First Coa</u>	<u>Second Coa</u>	<u>Third Coat</u>
Gypsum board, concrete walls, and concrete masonry units	CID A-A-2994 Type II	CID A-A-2246	CID A-A-2246
Ferrous Metal unless otherwise specified	SSPC Paint 25	CID A-A-2962 Type I Grade C	CID A-A-2962 Type I Grade C
Galvanized metal:	FS TT-E-2784 Type III	FS TT-E-2784	None
Wood: stain and varnish finishes	Commercially available stain	CID A-A-1788 Type clear Class I	CID A-A-1788 Type clear Class I

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DIVISION 09 - FINISHES

SECTION 09915

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PART 3 EXECUTION (Not Applicable)

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SECTION 09915

COLOR SCHEDULE

PART 1 GENERAL

1.1 GENERAL

This section covers only the color of the exterior and interior materials and products that are exposed to view in the finished construction. The word "color" as used herein includes surface color and pattern. Requirements for quality and method of installation are covered in other appropriate sections of the specifications. Specific locations where the various materials are required are shown on the drawings. Items not designated for color in this section may be specified in other sections. When color is not designated for items, the Contractor shall propose a color for approval.

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-14 Samples

Color Schedule; GA

Two sets of color boards, 60 days after the Contractor is given Notice to proceed, complying with the following requirements:

- a. Color boards shall reflect all actual finish textures, patterns, and colors required for this contract.
- b. Materials shall be labeled with the finish type, manufacturer's name, pattern, and color reference.
- c. Samples shall be on size A4 or 8-1/2 by 11 inch boards with a maximum spread of size A1 or 25-1/2 by 33 inches for foldouts.
- d. Samples for this color board are required in addition to samples requested in other specification sections.

PART 2 PRODUCTS

2.1 REFERENCE TO MANUFACTURER'S COLOR

Where color is shown as being specific to one manufacturer, an equivalent color by another manufacturer may be submitted for approval. Manufacturers and materials specified are not intended to limit the selection of equal colors from other manufacturers.

2.2 COLOR SCHEDULE

Grand Forks Phase 1 Levees

The color schedule lists the colors, patterns and textures required for exterior and interior finishes, including both factory applied and field applied colors.

2.2.1 Exterior Colors

Exterior wall colors shall apply to exterior surfaces including recesses at entrances and projecting vestibules. Conduit shall be painted to closely match the adjacent surface color. Wall color shall be provided to match the colors listed below.

2.2.1.1 DeMers Pump Station

- a. Brick: "Cranberry Velour" by Souix City Brick and Tile Company.
- b. Horizontal Brick Accent Bands: "Welsford Ironspot" by Souix City Brick and Tile Company.
- c. Split Faced Stone: "Northern Buff" by Vetter Stone Co.
- d. Cut Stone: "Northern Buff" by Vetter Stone Co.
- e. Mortar: Standard Grey.
- f. Railing System: Black.
- g. Louvers: "Colonial Red" Kynar finish by Metal-Era Roof Edge System.
- h. Rolling Door, Hollow Metal Door Frames, Hollow Metal Doors and Panels: "Deep Maroon SW1287" by Sherwin-Williams.
- i. Exhaust Stack: Light Grey.

2.2.1.2 Lincoln Park

- a. Brick: "Cranberry Velour" by Souix City Brick and Tile Company.
- b. Horizontal Brick Accent Bands: "Welsford Ironspot" by Souix City Brick and Tile Company.
- c. Split Faced Stone: "Northern Buff" by Vetter Stone Co.
- d. Cut Stone: "Northern Buff" by Vetter Stone Co.
- e. Mortar: Standard Grey.
- f. Railing System: "Hartford Green" to match DeMers Pump Station railing system.
- g. Louvers: Match "Colonial Red" Kynar finish by Metal-Era Roof Edge System.
- h. Rolling Door, Hollow Metal Door Frame, Hollow Metal Door and Panels: "Deep Maroon SW1287" by Sherwin-Williams.
- i. Exhaust Stack: Light Grey.

Grand Forks Phase 1 Levees

2.2.1.3 Olson/Elmwood Pump Station

- a. Brick: "Cranberry Velour" by Souix City Brick and Tile Company.
- b. Horizontal Brick Accent Bands: "Welsford Ironspot" by Souix City Brick and Tile Company.
- c. Mortar: Standard Grey.
- d. Roof: "Slate Gray Dimensional Shake" by Celotex.
- e. Metal Fascia Systems, Gutters, and Downspouts: "Almond" by Metal-Era Roof System.
- f. Railing System: "Hartford Green" to match DeMers Pump Station railing system.
- g. Louvers: Match "Colonial Red" Kynar finish by Metal-Era Roof Edge System.
- h. Rolling Door: "Deep Maroon SW1287" by Sherwin-Williams.
- i. Hollow Metal Door and Panels: "Powder Grey SW1012" by Sherwin-Williams.
- j. Hollow Metal Frame: "Deep Marron SW1287" by Sherwin-Williams.
- k. Exhaust Stack: Light Grey.

2.2.1.4 North Lincoln Park

- a. Aluminum Siding: "Everest" by Alcoa Building Products.
- b. Aluminum Trim, Gutter, and Downspouts: "White" by Alcoa Building Products.
- c. Shingle Roofing: "Slate Gray Dimensional Shake" by Celotex.
- d. Railing System: Match "Brandywine" by Metal-Era Roof Edge System.
- e. Louvers: Match "Everest" by Alcoa Building Products.
- f. Exhaust Stack: Light Grey.
- g. Hollow Metal Doors, Panels, and Frame: "Powder Grey SW1012" by Sherwin-Williams.
- h. Rolling Door: White.

2.2.1.5 Wood Kiosk

- a. Recycled Rubber posting mat: "Black" by New Century Northwest Company.
- b. Header: "Robinhood Green" by Pratt and Lambert.
- c. Lettering on Header: "Silver Lining" by Pratt and Lambert.

2.2.1.6 Entry Kiosk

Grand Forks Phase 1 Levees

- a. Cut Stone: "Northern Buff' by Vetter Stone Co.
- b. Mortar: "Sombrero Buff' by L.M. Scofield.
- c. Metal Frame and Cabinet: Brushed aluminum.
- d. Metal Roof and Sign: "Leaf Green" by Tiger Drylac Powder Coatings.
- e. Sign Lettering: "Signal White" by Tiger Drylac Powder Coatings.

2.2.1.7 Trail Directional Signage

- a. Pictographs and directional arrows: "Robinhood Green" by Pratt and Lambert.
- b. Lettering and graphics on Pictographs, and directional arrows: "Silver Lining" by Pratt and Lambert.

2.2.1.8 Community Green Ornamental Railing

- a. Railing System: "Leaf Green" by Tiger Drylac Powder Coatings.

2.2.1.9 Floodwalls

- a. Cut Stone: "Northern Buff' by Vetter Stone Co.
- b. Split Faced Stone: "Northern Buff' by Vetter Stone Co.
- c. Mortar: Standard Grey.
- d. Simulated Stone surfaces: To match floodwall cut stone.
- e. Brick: "Cranberry Velour" by Sioux City Brick and Tile Company.

2.2.1.10 City of Grand Forks Entry Sign

- a. Cut Stone: "Northern Buff" by Vetter Stone Co.
- b. Mortar: "Sombrero Buff' by L.M. Scofield.
- c. Decorative fencing: "Signal Black" by Tiger Drylac Powder Coatings.
- d. Aluminum Sign panels: "Leaf Green" by Tiger Drylac Powder Coatings.
- e. Bronze Lettering and Diamonds: Satin Finish by Gruppo.
- f. Bronze Medallions: Satin Finish with black pebble background.

2.2.2 Interior Colors

2.2.2.1 All Buildings

- a. Concrete Block Walk, Structural Steel, and Metal Deck: "Spacious Grey SW1009" by Sherwin-Williams.
- b. Hollow Metal Doors, Panels, and Frames: Match exterior colors.

PART 3 EXECUTION (Not Applicable)

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SECTION 10170

PLASTIC TOILET COMPARTMENTS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 666 (1999) Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Product Data; GA

Submit detailed material and fabrication specifications and installation instructions. Include catalog cuts of hardware, anchors, fastenings and other data as required.

SD-14 Samples

Color Selections; GA

Submit samples of manufacturer's standard colors for selection.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Subject to compliance with the specified requirements, provide plastic toilet compartments by Accurate Partitions Corp., Comtec Industries, General Partitions Manufacturing Corp., or approved equal

2.2 TOILET COMPARTMENTS

- a. Style: Floor-mounted, overhead-braced.
- b. Panels, Doors, and Pilasters: High-density polyethylene (HDPE) with homogenous color throughout. Provide material not less than 1 in.

thick with seamless construction and eased edges in color selected by Contracting Officer.

- c. Pilaster Shoes and Sleeves (Caps): ASTM A 666, Type 302 or 304 stainless steel, not less than 0.312 in. thick and 3 in. high, finished to match hardware.
- d. Stirrup Brackets: Manufacturer's standard ear or U-brackets for attaching panels and screens to walls and pilasters of clear anodized aluminum or stainless steel.
- e. Full-Height (Continuous) Brackets: Manufacturer's standard design for attaching panels and screens to walls and pilasters of clear anodized aluminum or stainless steel.
- f. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile in manufacturer's standard finish.
- g. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum strip in manufacturer's standard finish.
- h. Coat Hook and Bumper: Inside compartment on in-swinging doors and outside of door on out-swinging doors of handicap accessible compartments if door opens against an adjacent wall.
- i. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories of clear anodized aluminum or stainless steel.
- j. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.3 FABRICATION

Provide standard doors, panels, screens, and pilasters fabricated for compartment system. Provide units with cutouts and drilled holes to receive compartment-mounted hardware, accessories, and grab bars, as indicated

Provide aluminum heat-sink strips at exposed bottom edges of HDPE units to prevent burning

Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, fasteners, and anchors at pilasters to suit floor conditions. Make provisions for setting and securing continuous head rail at top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.

Provide wall hung screens in sizes indicated of same construction and finish as compartment panels.

Unless otherwise indicated, provide 24 inch wide in-swinging doors for standard toilet compartments and 36 inch wide out-swinging doors with a minimum 32 inch wide clear opening for compartments indicated to be handicapped accessible.

Provide the following for each door in compartment system:

- a. Hinges: Manufacturer's standard self-closing type that can be adjusted to hold door open at any angle up to 90 degrees. Set hinges on in-swinging doors to hold open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return to fully closed position.
- b. Latch and Keeper: Recessed latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be handicapped accessible.
- c. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories
- d. Door Bumper: Manufacturer's standard rubber-tipped bumpers at out-swinging doors
- e. Door Pull: Manufacturer's standard unit that complies with accessibility requirements of authorities having jurisdiction at out-swinging doors. Provide units on both sides of doors at compartments indicated to be handicapped accessible.

PART 3 EXECUTION

3.1 INSPECTION

Examine substrates and conditions under which toilet compartments and related items are to be installed

Notify of conditions detrimental to proper and timely completion of the work

Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

Install compartments rigid, straight, plumb and level, with the panels laid out as shown. Provide clearances of not more than 1/2 inch between pilasters and panels, and not more than 1 inch between panels and walls. Locate wall bracket so that holes for wall anchorages occur in masonry or tile joints. Secure panels to supporting walls with manufacturer's recommended anchoring devices in accordance with shop drawings and manufacturer's instructions. Secure floor supports to the floor with not less than two lead expansion shields and sheet metal screws.

Secure pilasters to supporting floor with specified anchorage devices. Level, plumb, and tighten with leveling device. Set tops of doors parallel with overhead brace when doors are in the closed position.

Head rail shall extend across front of each toilet compartment and be securely anchored in a stainless steel wall bracket where it meets wall. End toilet compartment shall have an additional head rail running length of last panel and anchored securely to back wall

3.3 HARDWARE ADJUSTMENTS

Adjust and lubricate hardware for proper operation after installation.

3.4 PROTECTION AND CLEANING

Protect units during delivery, storage, and after erection so that there will be no indication of use or damage at the time of acceptance. Replace damaged work.

3.5 FINAL ADJUSTMENTS

Perform final adjustments to pilaster leveling devices, door hardware, and other operating parts prior to final inspection. Clean exposed surfaces of compartments, hardware, fittings and accessories, and touch up minor scratches and other finish imperfections using materials and methods recommended by compartment manufacturer.

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SECTION 10430

EXTERIOR SIGNAGE

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(1997ael) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 653/A 653M	(1999a) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 924/A 924M	(1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 62	(1993) Composition Bronze or Ounce Metal Castings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Stee
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1.2 GENERAL

All exterior signage shall be provided by a single manufacturer. Exterior signage shall be of the design, detail, sizes, types, and message content shown on the drawings, shall conform to the requirements specified, and shall be provided at the locations indicated. Signs shall be complete with lettering, framing as detailed, and related components for a complete installation.

1.3 CHARACTER PROPORTIONS AND HEIGHTS

Characters and numbers on indicated signs shall be sized as shown.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Modular Exterior Signage System; GA

Manufacturer's descriptive data and catalog cuts.

Installation; GA

Manufacturer's installation instructions and cleaning instructions.

SD-04 Drawings

Approved Detail Drawings; GA

Drawings showing elevations of each type of sign; dimensions, details, and methods of mounting or anchoring; shape and thickness of materials; and details of construction. A schedule showing the location, each sign type, and message shall be included.

SD-14 Samples

Exterior Signs; GA

One 12 inch length of framing for signs. One sample of each type of sign. Each sample shall consist of a complete sign panel with letters and symbols. Samples may be installed in the work, provided each sample is identified and location recorded. Two samples of manufacturer's standard color chips for each material requiring color selection and 12 inch square sample of sign face color sample.

SD-19 Operation and Maintenance Manuals

Protection and Cleaning; GA

Six copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. The instructions shall include simplified diagrams for the equipment as installed.

1.5 QUALIFICATIONS

Signs, plaques, and dimensional letters shall be the standard product of a manufacturer regularly engaged in the manufacture of the products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1.6 DELIVERY AND STORAGE

Materials shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area in accordance with manufacturer's instructions.

1.7 WARRANTY

Manufacturer's standard performance guarantees or warranties shall be provided.

PART 2 PRODUCTS

2.1 REGULATORY SIGNAGE

Grand Forks Phase 1 Levees

Regulatory signage shall be as shown and in accordance with the Minnesota Manual on Uniform Traffic Control Devices (MMUTCD) designation shown.

2.2 GRAPHICS FOR EXTERIOR SIGNAGE SYSTEMS

2.2.1 Graphics

Signage graphics shall conform to the following:

Bronze letters, 1/4 inch thick shall be provided and fastened to the message panel with concealed fasteners. Letters shall project 3/4 inches from face of panel.

2.2.2 Messages

See drawings for message content. Typeface: As indicated. Type size as indicated.

2.3 METAL PLAQUES

Design and location of plaques shall be as shown.

2.3.1 Cast Metal Plaques

2.3.1.1 Fabrication

Cast metal plaques shall have the logo, emblem and artwork cast in the bas relief technique. Plaques shall be fabricated from bronze.

2.3.1.2 Size

Plaque size shall be as shown.

2.3.1.3 Graphics

Graphics will be provided by City of Grand Forks.

2.3.1.4 Background

Background texture shall be fine pebble.

2.3.1.5 Mounting

Mounting shall be concealed.

2.3.1.6 Finish

Finishes shall consist of bronze with dark finish oxidized background. Letters shall be satin polished and entire plaque sprayed with two coats of clear lacquer.

2.4 CAST BRONZE

Components shall be fabricated with sharp corners, flat faces, and accurate profiles. Burrs and rough spots shall be removed and polished. Faces shall be finished to a uniform high luster. Cast bronze shall be in accordance with ASTM B 62.

2.5 ANCHORS AND FASTENERS

Exposed anchor and fastener materials shall be compatible with metal to which applied and shall match in color and finish and shall be non-rusting, non-corroding, and non-staining. Exposed fasteners shall be tamper-proof.

2.6 SHOP FABRICATION AND MANUFACTURE

2.6.1 Factory Workmanship

Work shall be assembled in the shop, as far as practical, ready for installation at the site. Work that cannot be shop assembled shall be given a trial fit in the shop to ensure proper field assembly. Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Welding to or on structural steel shall be in accordance with AWS D1.1. Welding shall be continuous along the entire area of contact. Exposed welds shall be ground smooth. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practical. Items specified to be galvanized shall be by hot-dip process after fabrication if practical. Galvanization shall be in accordance with ASTM A 123/A 123M and ASTM A 653/A 653M, as applicable. Other metallic coatings of steel sheet shall be in accordance with ASTM A 924/A 924M. Joints exposed to the weather shall be formed to exclude water. Drainage and weep holes shall be included as required to prevent condensation buildup.

2.6.2 Dissimilar Materials

Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of asphalt varnish or a coat of zinc-molybdate primer to prevent galvanic or corrosive action.

2.6.3 Shop Painting

Surfaces of miscellaneous metal work, except nonferrous metal, corrosion resisting steel, and zinc-coated work, shall be given one coat of zinc-molybdate primer or an approved rust-resisting treatment and metallic primer in accordance with manufacturer's standard practice. Surfaces of items to be embedded in concrete shall not be painted. Upon completion of work, damaged surfaces shall be recoated.

2.7 COLOR, FINISH, AND CONTRAST

Color of products shall be as shown. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

PART 3 EXECUTION

3.1 INSTALLATION

Signs, plaques, or dimensional letters shall be installed in accordance with approved manufacturer's instructions at locations shown on the approved detail drawings. Signs shall be installed plumb and true at mounting heights indicated, and by method shown or specified. Signs mounted on other surfaces shall not be installed until finishes on such surfaces have been completed.

3.1.1 Anchorage

Anchorage and fastener materials shall be in accordance with approved manufacturer's instructions for the indicated substrate. Anchorage not otherwise specified or indicated shall include slotted inserts, expansion shields, and powder-driven fasteners when approved for concrete; toggle bolts and through bolts for masonry; machine carriage bolts for steel; lag bolts and screws for wood.

3.1.2 Protection and Cleaning

The work shall be protected against damage during construction. Hardware and electrical equipment shall be adjusted for proper operation. Glass, frames, and other sign surfaces shall be cleaned in accordance with manufacturer's instructions. After signs are completed and inspected, the Contractor shall cover all project identification, directional, and other signs which may mislead the public. Covering shall be maintained until instructed to be removed by the Contracting Officer or until the facility is to be opened for business. Signs shall be cleaned, as required, at time of cover removal.

3.2 FIELD PAINTED FINISH

Miscellaneous metals and frames shall be field painted in accordance with Section 09900 PAINTING, GENERAL. Anodized metals, masonry, and glass shall be protected from paint. Finish shall be free of scratches or other blemishes.

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SECTION 10440

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- 2.3 ATTACHMENT DEVICES

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- 3.1 INSTALLATION

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SECTION 10440

SIGNS

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Signs; GA

Color Charts: Submit chart of color combinations for selection.

SD-04 Drawings

Signs; GA

Submit shop drawings, product data sheets, and schedules. Indicate type of sign, materials, dimensions, colors, graphics, and method of attachment.

1.2 REGULATORY REQUIREMENTS

Signs shall comply with the Americans with Disabilities Act (ADA) of 1990.

1.3 DELIVERY, STORAGE AND HANDLING

Ship sign materials including attachment devices carefully packaged to prevent surface damage. Include shop drawings to insure correct installation and arrangement of all materials.

PART 2 PRODUCTS

2.1 SIGNS, GENERAL

Signs which designate permanent rooms and spaces shall meet the following general requirements:

- a. Characters shall be raised 1/32 inch and shall be accompanied with Grade 2 braille.
- b. Raised characters shall be of height designated or shown, but not less than 5/8 inch, nor more than 2 inches.
- c. Pictograms, where designated, shall be accompanied by equivalent verbal description placed directly below pictogram. Border dimension of pictogram shall be 6 inches minimum in height.

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All signs shall meet the following general requirements:

- a. Characters and background of signs shall be eggshell, matte, or other non-glare finish.
- b. Characters shall contrast with their background - either light characters on a dark background or dark characters on a light background.

Where specific text height and sign size requirements are specified below, those specific requirements shall govern over these general requirements.

2.2 SIGNS

Machine-cut copy characters and symbols from matte-finish opaque acrylic sheet and chemically weld onto the opaque acrylic sheet forming sign panel face. Produce precisely formed characters with square cut edges free from burrs and cut marks. Pictogram/copy signs shall be 6 inches x 8 inches with rounded corners and 3/4 inch high helvetica medium, upper case characters. Provide international symbol of accessibility, graphics, and directional arrows as shown.

2.3 ATTACHMENT DEVICES

Provide adhesive suitable for attaching signs to exterior of building.

PART 3 EXECUTION

3.1 INSTALLATION

Install signs in accordance with shop drawings and manufacturer's recommendations. Mounting heights and locations shall comply with ADA requirements.

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SECTION 10800

TOILET ACCESSORIES

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Finishes; GA. Accessory Items; GA.

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, operation instructions, and cleaning instructions.

1.2 DELIVERY, STORAGE, AND HANDLING

Toilet accessories shall be wrapped for shipment and storage, delivered to the jobsite in manufacturer's original packaging, and stored in a clean, dry area protected from construction damage and vandalism.

1.3 WARRANTY

Manufacturer's standard performance guarantees or warranties shall be provided.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

Toilet accessories shall be provided where indicated in accordance with paragraph SCHEDULE. Each accessory item shall be complete with the necessary mounting plates and shall be of sturdy construction with corrosion resistant surface.

2.1.1 Anchors and Fasteners

Anchors and fasteners shall be capable of developing a restraining force commensurate with the strength of the accessory to be mounted and shall be suited for use with the supporting construction. Exposed fasteners shall be of tamperproof design and shall be finished to match the accessory.

2.1.2 Finishes

Except where noted otherwise, finishes on metal shall be provided as follows:

<u>Metal</u>	<u>Finish</u>
Stainless steel	No. 4 satin finish
Carbon steel, copper alloy, and brass	Chromium plated, bright

2.2 ACCESSORY ITEMS

Accessory items shall conform to the requirements specified below.

2.2.1 Grab Bar (GB)

Grab bar shall be 18 gauge, 1-1/4 inches OD Type 304 stainless steel. Grab bar shall be form and length as indicated. Concealed mounting flange shall have mounting holes concealed. Grab bar shall have satin finish. Installed bars shall be capable of withstanding a 500 pound vertical load without coming loose from the fastenings and without obvious permanent deformation. Space between wall and grab bar shall be 1-1/2 inch.

2.2.2 Mirrors, Glass (M1)

2.2.2.1 Mirrors

1/4 inch thick, No. 1 (mirror glazing) quality, clean polished plate/float mirror glass electrolytically copper plated, guaranteed against silver spoilage for 15 years.

2.2.2.2 Backing

Backing shall be resilient, non-absorbent filler material, with not less than 22 gauge galvanized steel backing plate attached to frame with concealed screws, one-piece construction, full height and width of mirror frame. Corrugated cardboard or other moisture absorbent filler material is not acceptable.

2.2.2.3 Hanger

Construct metal backing with hanger slots for concealed "tamper-proof" mounting. Provide manufacturer's standard hanger to engage with backing for concealed installation.

2.2.2.4 Frames

Use one piece roll formed frames, not less than 22 gauge, satin finish, Type 304 stainless steel, with square corners heli-arc welded and ground smooth.

2.2.2.5 Mirrors without Shelf

Provide of size as designated; Bobrick B-290 series.

2.2.3 Sanitary Napkin Disposer (SND)

Sanitary napkin disposal shall be constructed of Type 304 stainless steel with removable leak-proof receptacle for disposable liners. Fifty disposable liners of the type standard with the manufacturer shall be

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provided. Receptacle shall be retained in cabinet by tumbler lock. Disposer shall be provided with a door for inserting disposed napkins, and shall be surface mounted.

2.2.4 Soap Dispenser (SD)

4 inch Type 304 stainless steel spout, 16 ounce polyethylene liquid soap container; basin mounted.

2.2.5 Robe Hook (RH)

Robe hook shall have concealed wall fastenings, and a pin integral with or permanently fastened to wall flange. Maximum projection shall be 4 inches. Design shall be consistent with design of other accessory items. Finish shall be bright polish.

2.2.6 Toilet Paper Holder (TP)

Surface-mounted, double roll without controlled delivery.

2.2.7 Mop and Broom Holder (MH)

Satin finish stainless steel, with 3 anti-slip holders with spring loaded rubber cam, 24 inches.

2.2.8 Electric Hand Dryer (HD)

See Section 16600 ELECTRIC DRYERS.

2.2.9 Diaper Changing Station (CS)

Diaper changing station shall be surface mounted and shall be fabricated of high impact plastic with no sharp edges. Unit fold down platform shall be concave to the child's shape, equipped with nylon and velcro safety straps and engineered to withstand a minimum static load of 250 lb. Safety graphics shall be pictorial for universal use. Color shall be as shown in Section 09915 COLOR SCHEDULE.

PART 3 EXECUTION

3.1 INSTALLATION

Toilet accessories shall be securely fastened to the supporting construction in accordance with the manufacturer's approved instructions. Accessories shall be protected from damage from the time of installation until acceptance.

3.2 CLEANING

Material shall be cleaned in accordance with manufacturer's recommendations. Alkaline or abrasive agents shall not be used. Precautions shall be taken to avoid scratching or marring of surfaces.

3.3 SCHEDULE

Refer to drawings for schedule.

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SECTION 14602

CRANES, SINGLE-GIRDER BRIDGE, MONORAIL AND JIB

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN BEARING MANUFACTURERS ASSOCIATION (AFBMA)

AFBMA Std 9 (1990) Load Ratings and Fatigue Life for Ball Bearings

AFBMA Std 11 (1990) Load Ratings and Fatigue Life for Roller Bearings

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 9005-D (1994) Industrial Gear Lubrication

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C80.1 (1995) Rigid Steel Conduit - Zinc Coated

ANSI MH27.1 (1996) Cranes and Monorail Systems, Underhung

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M (1997a¹) Carbon Structural Steel

ASTM B 633 (1998) Electrodeposited Coatings of Zinc on Iron and Steel

ASTM E 10 (1998) Brinell Hardness of Metallic Materials

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (2000) Structural Welding Code - Steel

FEDERAL SPECIFICATIONS (FS)

FS RR-W-410 (Rev D; Am 1) Wire Rope and Strand

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6 (1993) Industrial Control and Systems, Enclosures

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NEMA KS 1	((1996) Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
NEMA WC 3	(1992; Rev 1) Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(1999) National Electrical Code
UNDERWRITERS LABORATORIES (UL)	
UL 50	(1995; Rev thru Nov 1999) Enclosures for Electrical Equipment
UL 674	(1994; Rev thru Oct 1998) Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

1.2.1.1 Standard Products

Materials and equipment shall be standard products of manufacturers regularly engaged in the fabrication of cranes and hoists and shall essentially duplicate items which have been in satisfactory use for at least 2 years prior to bid opening. Any company licensed by a crane and hoist manufacturer to manufacture cranes and hoists bearing their name shall have the design and components approved by the licensor prior to submission to the Government for approval.

1.2.1.2 Nameplates

Each major component of equipment shall have the manufacturer's name, address, type or style, model or catalog number, and serial number on a metal plate secured to the equipment.

1.2.1.3 Verification of Dimensions

The Contractor shall verify all dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing any work.

1.2.1.4 Welding

Welding shall be in accordance with AWS D1.1.

1.2.2 Design Criteria

The hoist(s) shall be designed to operate in the spaces indicated.

1.2.2.1 Hoist Characteristics

Hoist shall be an electric-wire rope hoist of operating characteristics specified. Each hoist shall have the capacity, lift-height, suspension, power source, and operating characteristics indicated and as follows:

- a. Each hoist shall have the capacity indicated on drawings.
- b. Each hoist shall have the minimum height of lift indicated on drawings.
- c. The hoist shall be the lug-suspension type mounted on an electric-motor-driven trolley.
- d. Components of the hoist shall be designed and constructed for safety of operation and durability of components. Replacement parts shall be interchangeable and readily accessible.

1.2.2.2 Monorail Characteristics

The monorail shall be of the wide flange or patented beam style.

1.2.2.3 Capacity Plates

Two capacity plates shall be provided, one for each side of the bridge. Each plate shall be lettered to indicate the total rated hoisting capacity of the crane. All lettering shall be of sufficient size to be easily read from the floor.

1.2.3 Definitions

1.2.3.1 Capacity

Capacity shall mean the rated load in pounds, or tons of 2,000 pounds each, specified by the manufacturer for the hoist and marked plainly on the hoist and loadblock so as to be clearly legible. In determining the applied load, the weight of the handling devices shall be included.

1.2.3.2 Hoisting Speed

Hoisting speed shall mean the velocity in feet per minute at which the hoist will lift the rated load. Actual lifting speed shall be within plus or minus 10 percent of the manufacturer's rating.

1.2.3.3 Rated Lift

Rated lift shall mean the distance between the upper and lower elevations of travel of the load block.

1.2.3.4 Headroom

Headroom shall be measured with the load hook in the highest position with full load which is the distance between the saddle of the load hook and the following points:

- a. The bottom of the beam when S-shape runways are used.
- b. The top of the bottom flange for all flat, wheel-bearing flange surfaces.

1.2.3.5 Minimum Radius

Minimum radius shall mean the smallest radius to the centerline of the beam or track on which the trolley will operate properly.

1.2.3.6 Trolley Speed

Trolley speed shall mean the velocity in feet per minute at which a motor-driven trolley with hoist will travel carrying the rated load on level track; actual speed shall be within plus or minus 10 percent of the manufacturer's rating.

1.3 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Hoist Hook Assembly; GA
Heat Treatment; FIO

Record of hook material and any heat treatment performed shall be submitted and shall be stamped on the hook shank or documented in certification papers furnished with the hooks.

Hoist; GA

Manufacturer's catalog data shall be submitted showing the equipment and accessories to be provided.

SD-04 Drawings

Wiring and Schematic diagrams; GA

Detailed drawings shall be submitted containing complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-09 Reports

Electrification System Tests; GA

Results of electrification system tests shall be submitted.

Acceptance Testing; GA

Test reports in booklet form shall be submitted showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. The report shall include the information as required by paragraph ACCEPTANCE TESTING.

SD-13 Certificates

Hoist; GA

Track Design; GA
Hoist controls; GA

Certification shall be submitted attesting that each hoist, hoist trolley and track, and hoist control has been factory tested for rated load capacity and operation, and that each hoist complies with the requirements specified.

Electric Hoists; GA
Trolleys; GA
Wiring; GA
Contact Conductors; GA
Hoist Controls; GA
Overcurrent Protection; GA
Grounding; GA

Certification shall be submitted attesting that electric hoists, trolleys, wiring, contact conductors, controls, overcurrent protection, and grounding conform to NFPA 70 and to UL standards. The label or listing with reexamination by the UL will be accepted as evidence that the materials conform to this requirement and to NFPA 70.

SD-19 Operation and Maintenance Manuals

Operation Manuals; GA

Two copies of operation manuals shall be furnished for each hoist. Operation manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operation manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their operating features. Operation manuals shall include a copy of the acceptance test report for information and future reference. Operation manuals shall include an overall description of the system describing any unique features that may need special attention.

Maintenance Manuals; GA

Two copies of maintenance manuals shall be furnished for each hoist. Maintenance manuals shall list routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping, layout diagrams, equipment layout diagrams, and wiring and control diagrams of the system as installed. Maintenance manuals shall include a spare parts list of manufacturers recommended spare parts that should be maintained onsite and any long lead time items should be clearly identified. Maintenance manuals shall contain replacement part numbers for the entire assembly.

1.4 DELIVERY AND STORAGE

Equipment delivered shall be placed in indoor storage, protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

PART 2 PRODUCTS

2.1 ELECTRIC HOIST

2.1.1 General

Electric hoist shall be of capacity, lift, type, suspension, headroom, and materials specified. Each unit shall be factory wired and ready for operation. Load-carrying parts of the hoist shall be designed so that the calculated static stress of the material, based on the rated capacity, will not exceed 20 percent of the average theoretical strength of the material. Each hoist shall be factory lubricated and shall be complete and ready for operation with the specified hoist controls and accessories.

2.1.2 Types of Electric Hoists

2.1.2.1 Electric Wire Rope Hoist

Electric wire rope hoists shall be equipped with the specified standard rope and hook assembly, with no corroding or sparking requirements.

2.1.3 Load and Motor Brakes

Load brake shall be a totally enclosed, automatic, mechanical-type brake with a hardened-steel, Weston-type ratchet and pawl mechanism that will hold the capacity load of the hoist at any point when the motor is stopped. Motor brakes are specified in paragraph MOTOR BRAKE.

2.2 HOIST MECHANICAL EQUIPMENT

2.2.1 Wire Rope Hoist

2.2.1.1 [Hoist Wire Rope

[Wire rope for standard applications shall be extra flexible, preformed, extra improved or improved plow steel, 6 by 37 fiber core sealed construction wire conforming to FS RR-W-410, Type I, Class 3.]

Wire rope shall be anchored to drum or dead end. Anchoring shall be of captive type, easily detached for changing and repair. Wire rope shall have a factor of safety of not less than 5, based on the minimum ultimate tensile strength of the material.]

2.2.1.2 Hoist-Rope Drum

Wire-rope drum shall be hardened steel or special grade alloy ductile iron. Minimum diameter of the drum shall be 20 times the diameter of the hoisting rope for hoists with a capacity of 2,000 pounds or less and 24 times the diameter of the hoisting rope for hoists over 2,000-pound capacity. Drum shall have accurate, machine-cut grooves, cut to full depth of wire-rope diameter, with rounded corners of dimension as required for the specified lift. In addition, the drum shall have not less than two complete turns of rope around it when the hook is in its lowest position. Groove diameter and pitch centers shall be 1/32 inch greater than diameter of rope. Drum shall be flanged at each end and shall have enclosed tops and sides to preclude cable binding and jamming. Cable reeving shall be arranged for double reeving. Hook shall remain centered under the drum at all times.]

2.2.1.3 Hoist Load Block and Sheaves

The cable load block shall be an enclosed, safety type that will shroud the sheave and protect the operator. The sheave assembly shall be mounted on a steel axle and carried on sealed, prelubricated antifriction bearings. Wire-rope sheaves shall be machine-grooved, hardened steel, or cast iron with chilled groove surfaces. The pitch diameter for running sheaves shall be not less than 18 times the diameter of the wire rope, and the diameter of the idler and equalizer sheaves shall be not less than 16 times the diameter of the rope used.

2.2.2 Hoist Hook Assembly

Hooks and hook swivels shall be heat-treated alloy steel forgings. Yokes, crossheads, and bars shall be of suitable strength steel or cast iron.

Hook assembly for electric-operated hoists shall be carried on antifriction bearings to permit free swivel under rated capacity load without twisting load chain or wire. Each hook shall have a spring-loaded safety latch. Each hook assembly shall include a machined and threaded shaft and swivel locknut with an effective locking device to prevent nut from backing off.

2.2.3 Hoist Gear Assembly

2.2.3.1 Gears

Gears shall be spur, helical, spiral, or bevel-type, accurately machined, and conforming to AGMA standards for this type of service.

2.2.3.2 Gear Shafts

Gear shafts shall be manufactured from high-carbon steel or alloy steel, machined and ground for accurate fit, and splined for fitting to the mating gear.

2.2.3.3 Gear Train Assembly

Gear train assembly shall be totally enclosed in the hoist frame casting and shall operate in a sealed oil bath. Frame casting shall be provided with lubrication fittings and inspection ports.

2.2.4 Hoist Bearings

2.2.4.1 Antifriction Bearings

Bearings in the hoist mechanism of electric-hoists shall be antifriction bearings.

2.2.4.2 Factory Sealed Bearings

Sprocket bearings, motor bearings, and load-block bearings shall be prelubricated factory sealed bearings.

2.2.5 Hoist Lubrication

Adequate lubrication shall be provided for moving parts of the hoist and trolley and for filling, draining, and checking the level of the lubricant.

Lubricant shall be designed for use in an ambient temperature of 30 to 100 degrees F. Hoist reduction gearing, load brake, and trolley wheel gears with electric motor drive shall operate in an oil bath. Lubrication and mechanism housing shall prevent leaking and shall prevent lubricant from

coming into contact with electric motors and equipment. Lubricant shall conform to AGMA 9005-D.

2.2.6 Hoist Frame and Housing

Operating parts of the hoist shall be mounted and enclosed in a sealed, factory-painted metal frame of malleable iron, cast steel, welded steel, or aluminum. Welded or bolted frames shall carry loads on the fabricated pieces. Welds or bolts shall be used only to hold the fabricated parts in position.

2.2.7 Hoist Paint Finish

Each hoist and accessory shall receive a factory-applied paint finish. Hooks shall not be painted.

2.3 TROLLEYS

2.3.1 Paint

Each trolley assembly shall be factory-painted, designed specifically for use with the specified hoist, and shall be furnished by the hoist manufacturer. Paint finish shall be the same type and quality specified for the hoist.

2.3.2 Wheels

2.3.2.1 Load Distribution

Each trolley assembly shall have not less than four wheels. Sufficient wheels shall be provided to properly distribute the load. The load on a wheel shall not exceed 1,200 DW pounds where D equals the diameter of the wheel in inches and W equals the width of the rail head or the nominal length of bearing on the tread.

2.3.2.2 Design and Type

Wheels shall be single-flange type manufactured from forged alloy steel with machined, hardened treads and flanges, or high-strength cast or nodular iron with machined flanges and treads, chill-hardened not less than 1/16 inch deep. Flanged wheels for motor-driven trolleys shall have treads and flanges hardened to not less than No. 320 Brinell hardness. Manually driven, trolley-wheel treads shall be hardened to not less than Brinell hardness No. 245 as defined in ASTM E 10. Wheels shall be designed to operate on sloped or flat flange I-beams.

2.3.2.3 Bearings

Trolley wheels shall be carried on sealed, permanently lubricated, antifriction bearings designed for axial and thrust loading. Bearings shall conform to the applicable requirements of AFBMA Std 9 and AFBMA Std 11. Bearings shall have an L-10 life of 3,000 hours or more, as defined by AFBMA Std 9 or AFBMA Std 11 as applicable.

2.3.3 Side Plates, Pins, and Axles

2.3.3.1 Side Plates

Side plates shall be fabricated from structural-quality rolled-steel plate

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milled to the required profile with integral bosses where necessary to support equalizing pins; side plates shall be fitted with steel end bumpers.

2.3.3.2 Pins and Axles

Equalizing pins and axles shall be heat-treated alloy steel, machined and finish ground to the required size.

2.3.4 Gearing

2.3.4.1 Gears

Gears shall be cut from heat-treated alloy steel accurately machined into spur, helical, and pinion gears, conforming to AGMA requirements.

2.3.4.2 Drive Pinions

Drive pinions shall be carburized alloy steel, malleable iron, or bronze, with cut or cast teeth, conforming to AGMA requirements.

2.3.4.3 Clamps

Plain trolleys and geared, manual-drive trolleys shall have suitable, quick-acting, steel track clamps. Clamps shall be adjustable for wear and shall not injure track flanges. They shall function satisfactorily on curved and straight track and shall be capable of withstanding a pull equivalent to one-third the rated capacity of the hoist when executed parallel to the track.

2.3.5 Safety Hangers or Lugs

Safety hangers or lugs shall be steel and shall be integral with, or fastened to, each hoist frame or to trolley frame. They shall ride free above the bottom flange of the beam. Hanger shall be of sufficient capacity to hold the hoist, fully loaded, in the I-beam in case of wheel or axle failure. Safety factor of each part of trolley assembly shall be not less than 5, based on the ultimate strength of the material used.

2.4 TROLLEY TYPE

2.4.1 Electric-Motor-Driven Trolleys

Trolley shall be an electric-motor-driven geared type conforming to NFPA 70, the specified general trolley requirements, and the requirements specified.

Trolley speed shall be not more than 75 feet per minute.

2.5 MONORAIL TRACK

Monorail track, splice plates, and hangers shall be painted, hot-rolled AISC structural steel "S" shapes or "W" shapes and plates conforming to ASTM A 36/A 36M, of size and weight as required for the specified hoist. The upper surface of the lower flange shall be free from bumps, depressions, and irregularities.

2.5.1 Track Design

The track shall be designed with a minimum safety factor of 5. Deflection of track shall not exceed 1/450 of the span, as determined by total load of

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trolley, track, hoist, and full-capacity load. Track curve radii shall permit smooth trolley operation without binding.

2.5.2 Flanges

Flanges shall be smoothly curved and without deformation.

2.5.3 Miscellaneous Track Items

Necessary clamps, hanger rods, hangers, track splice plates, safety end stops, fasteners, and fittings shall be provided as required for a complete system.

2.5.3.1 Splice Plates and Fasteners

Web-type splice plates or other suitable couplings shall be installed at track joints to provide flush and level connections, with maximum gap between adjacent ends at load-carrying ends not exceeding 1/16 inch; 3/16 inch at switches. Splice fasteners shall be regular hexagon or special, flat-head fasteners.

2.5.3.2 Safety End Stops

Safety stops capable of withstanding the impact of a fully loaded hoist and trolley shall be provided.

2.5.3.3 Fittings

Fittings with means for not less than 1 inch vertical adjustment of the track for level erection shall be provided, with provision for additional adjustment after the system has been in operation.

2.5.4 Finishing

The finished monorail shall be inspected after erection, and fasteners, welds, abrasions, and handling marks shall be painted in the finish color. Brackets and hangers of the monorail electrification system shall be painted in the finish color of the monorail track.

2.6 ELECTRICAL

Materials and installation, including electrical wiring, contact conductors, controls, overcurrent protection, and grounding shall meet the requirements of NFPA 70 and applicable UL and NEMA standards and specified requirements.

2.6.1 Power Supply

Electrical power for operation of the hoist will be supplied from the nominal 480 volt, 3 phase, 60-Hz alternating-current (a-c) power distribution system.

2.6.1.1 Trolley Power Supply

Power may be brought to the trolley by a cable reel or a festoon system.

- a. Festoon system shall consist of flexible power cable supported by cable trolleys running on a steel messenger cable, an I-beam rail, or a channel. The power cable shall be type G, 75-degree C,

600-volt insulation and heavy-duty neoprene or chlorosulfonated polyethylene jacket. The cable shall be sized as required by NFPA 70. The cable shall conform to the applicable requirements of NEMA WC 3, Part 7, and shall have class H or class K stranding. Cable conductors shall be terminated at both ends with terminal lugs on terminal blocks in terminal boxes. Cable ends shall have strain relief devices to protect the cable terminations.

2.6.2 Motor Controller

Motor controller shall be a reversing-type magnetic starter with thermal-overload protection, molded case circuit breaker, and control transformer operated by a pushbutton control station. Controller and control station shall be mechanically or electrically interlocked to preclude possibility of operating opposing control circuits simultaneously.

2.6.2.1 Contactor Fingers

Contacting fingers shall be adjustable and shall have renewable tips.

2.6.2.2 Transformer

Transformer shall reduce the control-circuit voltage to 120 volts AC.

2.6.2.3 Enclosure for Mounting

Motor controller shall be mounted in a gasketed sheet metal enclosure with hinged door conforming to the requirements of UL 50. Motor controller enclosures, complying with NEMA ICS 6, shall be NEMA, Type 12.

2.6.3 Pendant Control Station

Each hoist shall have a pendant-mounted conductor cable and pushbutton station with a strain-reliever chain or cable permanently attached to the hoist frame and integral with the pendant conductor cable. The control station shall be a full-guarded, momentary-contact, pushbutton type with each button clearly marked to indicate its function. A separate button or a single button providing steps for each speed of multispeed hoists or trolleys shall be provided. The pushbuttons shall return to the off (normally open contacts) position when pressure is released by operator. The pushbutton station shall be grounded to the hoist. The strain reliever chain or cable shall not be used as a grounding circuit.

2.6.4 Mainline Disconnect Switch

A mainline disconnect switch shall be provided and shall be a surface-mounted, heavy-duty, single-throw, air-break, enclosed type conforming to NEMA KS 1 as indicated. Disconnect switch shall be fused. Enclosure shall be NEMA Type 12.

2.6.5 Hoist Limit Switches

Adjustable upper-limit switch shall be provided to prevent overtravel of the hook or load block in the hoisting direction. Limit switch shall be arranged to stop the hoist motor and apply the motor brake before reaching the uppermost safe limit of travel. In case of hook overtravel, the motor shall automatically and momentarily be reversed. Adjustable lower-limit switch shall be provided to stop the hoist motor and apply the motor brake when the load hook reaches a predetermined lower limit.

2.6.6 Trolley Travel Limit Switches

Limit switches shall be mounted to the trolley, respectively, to interrupt current to the trolley controls. Adjustable limit switch actuators shall be installed on both ends to actuate the limit switches and stop the crane trolley prior to contacting the bumpers.

2.6.7 Hoist Motors

Hoist motor shall be a high-starting torque, high-slip, 30-minute time rated, reversible electric motor specifically designed for hoist duty and capable of operating at the specified duty class, capacity, and speed. The motor shall be 480-volts, 3-phase, 60-hertz and horsepower as recommended by manufacturer for capacity and lift speed of hoist. The hoist motors shall be provided with Class B insulation, and motor enclosures shall be totally enclosed, nonventilated (TENV). Enclosure shall be fitted with a UL-approved drain and breather and shall be certified and labeled in accordance with UL 674, Class 1, Groups C and D.

2.6.8 Trolley Motors

Trolley motors shall be single-speed, single-winding conforming to the requirements for hoist motors except they may be NEMA design B (high torque and slip not required).

2.6.9 Motor Brake

Motor brake shall be an externally adjustable, electrically operated single- or multiple-friction disk brake that shall apply automatically when the power is off. The brake shall be capable of holding 125 percent of the rated load from any operating speed. The brake shall hold a static load equal to 150 percent of the rated capacity of the hoist.

Trolley unit shall have an automatic, adjustable, solenoid-operated, electric brake designed for trolley application. Brake shall apply and release smoothly during starts and stops to minimize pendulum action of the load. Braking torque shall be not less than 100 percent of motor torque and shall match motor torque characteristics.

2.6.10 Conduit and Wire

2.6.10.1 Conduit

Conduit between feeder enclosure and disconnect switches and fixed control stations shall be zinc-coated rigid-steel conduit, couplings, elbows, bends, and nipples conforming to ANSI C80.1. Zinc coating shall be an electrodeposited coating conforming to ASTM B 633.

2.6.10.2 Wire

Building wire for use in conduits, raceways, and wireways in wet or dry locations shall be coordinated with requirements of Section 16120 INSULATED WIRE AND CABLE.

PART 3 EXECUTION

3.1 ERECTION

Erection shall be in accordance with the manufacturer's instructions.

3.2 INSTALLATION OF MONORAIL TRACK

Monorail tracks shall be installed in accordance with the applicable requirements of ANSI MH27.1. Tracks shall be accurately assembled to the lines and elevations indicated. Fastening of splices shall be performed after the abutting surfaces have been brought completely in contact. Connections shall be bolted or welded connections. Splices will be permitted only when indicated. Erection bolts used in welded construction may be tightened securely and left in place when they form no interference to trolley operation. If erection bolts are removed, the holes shall be plug welded and ground smooth. Monorail track shall be installed plumb and level to a tolerance of not more than 1 inch in 100 feet from the indicated elevation. The track shall be free of burrs, kinks, and deformation. Curves shall be smooth and even with no kinks or sharp bends. Track flanges shall be smooth and level. Welded joints and connections shall be ground smooth and offer no obstruction to trolley-wheel movement.

3.3 ONSITE ELECTRIFICATION SYSTEM TESTS

Electrification system shall be given continuity and insulation tests after the installation has been completed but before equipment is energized. Contractor shall provide necessary test equipment, labor, and personnel to perform the tests as specified. Electrification system equipment shall be completely isolated from all extraneous electrical connections. Substation and switchboard feeder breakers, circuit breakers in panelboards, and other disconnecting devices shall be used to isolate the equipment under test. Insulation tests on equipment and wiring shall be conducted using a 1,000-volt, insulation-testing instrument. Readings shall be recorded every minute and until three equal and consecutive readings are obtained. The resistance between phase conductors and between phase conductors and ground shall be not less than 1 megohm. Test data shall be recorded and shall include megohm readings versus time. Final acceptance shall depend upon satisfactory performance under test. Electrification system shall not be energized until recorded test data of the electrification system tests are approved.

3.4 ACCEPTANCE TESTING

Acceptance testing shall comply with the following paragraphs.

3.4.1 Acceptance Test

The Contractor shall provide all personnel necessary to conduct the tests including but not limited to operators, riggers, rigging gear, and test weights. Testing shall be performed in the presence of Contracting Officer. The Contractor shall notify the Contracting Officer 7 days prior to testing operations.

3.4.1.1 Test Sequence

The equipment shall be tested according to the applicable paragraphs of this procedure in the sequence provided.

3.4.1.2 Test Data

Operating and startup current measurements shall be recorded for electrical equipment (motors and coils) using appropriate instrumentation. Speed

measurements shall be recorded as required by the facility evaluation tests (normally at 100-percent load). Recorded values shall be compared with design specifications or manufacturer's recommended values; abnormal differences shall be explained in the remarks and submitted for approval or appropriate adjustments performed. In addition, high temperatures or abnormal operation of any equipment or machinery shall be noted, investigated, and corrected. Hoist and trolley speeds should be recorded during each test cycle.

3.4.1.3 Equipment Monitoring

During the load test, improper operation or poor condition of safety devices, electrical components, mechanical equipment, and structural assemblies shall be monitored. Observed defects critical to continued testing shall be reported immediately to the Contracting Officer and testing shall be suspended until the deficiency is corrected. During and immediately following each load test, the following inspections shall be made:

- a. Inspect for evidence of bending, warping, permanent deformation, cracking, or malfunction of structural components.
- b. Check for overheating in brake operation; check for proper stopping. All safety devices, including emergency stop switches and POWER OFF pushbuttons, shall be tested and inspected separately to verify proper operation of the brakes.
- c. Check for abnormal noise or vibration and overheating in machinery drive components.
- d. Check wire rope sheaves and drum spooling for proper operation, freedom of movement, abnormal noise, or vibration.
- e. Check electrical drive components for proper operation, freedom from chatter, noise, or overheating.
- f. Inspect external gears for abnormal wear patterns, damage, or inadequate lubrication.

3.4.1.4 Hooks

Hooks shall be measured for hook-throat spread before and after load test. A throat dimension base measurement shall be established by installing two tram points and measuring the distance between these tram points (to within 1/64 inch). This base dimension shall be recorded. The distance between tram points shall be measured before and after load test. An increase in the throat opening by more than 1 percent from the base measurement shall be cause for rejection.

3.4.2 No-Load Testing

3.4.2.1 Hoist Operating and Limit Switch Test

The load hook shall be raised and lowered through the full range of normal travel at rated speed and other speeds of the crane. The load hook shall be stopped below the geared limit switch upper setting. In slow speed only, proper operation of upper and lower limit switches shall be verified. The test shall be repeated a sufficient number of times (minimum of three) to demonstrate proper operation. Brake action shall be tested in each

direction.

3.4.2.2 Trolley Travel

The trolley shall be operated the full distance of the monorail rails exercising all drive speed controls in each direction. Brake operation shall be verified in each direction. In slow speed, the trolley bumpers shall contact the trolley stops located on the rails.

3.4.2.3 Hoist Loss of Power No-Load Test

The hooks shall be raised to a height of approximately 6 feet or less. While slowly lowering the hook, the main power source shall be disconnected verifying that the hook will not lower and that the brake will set.

3.4.2.4 Travel Loss of Power No-Load Test

With the hook raised to clear obstructions and the trolley traveling in slow speed, the main power source shall be disconnected, verifying that the trolley will stop and that the brake will set.

3.4.3 Load Test

3.4.3.1 Hoist

Unless otherwise indicated, the following tests shall be performed using a test load of 125 percent of rated load.

- a. Dynamic Load Test: The test load shall be raised and lowered through the full-range while operating in each speed. The machinery shall be completely stopped at least once in each direction to ensure proper brake operation.
- b. Hoist Loss of Power Test: After raising the test load to approximately 6 feet above ground level and while slowly lowering the test load, the main power source and the control pushbutton shall be released verifying that the brake will set and that the test load will stop lowering.
- c. Trolley Dynamic Load Test: While operating the trolley the full distance of the monorail rails in each direction with test load on the hook (one cycle), the proper functioning of drive speed control points and proper brake action shall be tested.

3.5 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, erection, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.6 FIELD TRAINING

A field training course shall be provided for designated operating staff members. Field training shall cover all of the items contained in the operating and maintenance instructions. The Contracting Officer shall be given at least 2 weeks advance notice of such training.

-- End of Section --

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DIVISION 15 - MECHANICAL

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SECTION 15050

SLUICE GATES, OPERATORS, AND FLAP VALVES

PART 1 GENERAL

1.1 SCOPE

This section includes the sluice gates, portable operators, and accessories to be furnished and installed as shown on the drawings and specified herein.

1.2 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

- | | |
|-------------|--|
| AASHTO M 29 | (1988) Fine Aggregate for Bituminous Paving Mixtures |
| AASHTO M 82 | (1975; Rev 1996) Cut-Back Asphalt (Medium Curing Type) |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|-------------|--|
| ASTM A 36 | (1997e1) Carbon Structural Steel |
| ASTM A 108 | (1999) Steel Bars, Carbon, Cold Finished, Standard Quality |
| ASTM A 126 | (1995e1) Gray Iron Castings for Valves, Flanges, and Pipe Fittings |
| ASTM A 148 | (1990) Steel Castings, High-Strength, for Structural Purposes |
| ASTM A 276 | (1998b) Stainless Steel Bars and Shapes |
| ASTM A 582 | (1995b) Free-Matching Stainless Steel Bars |
| ASTM B 21 | (1996) Naval Brass Rod, Bar, and Shapes |
| ASTM B 98 | (1998) Copper-Silicon Alloy Rod, Bar, and Shapes |
| ASTM B 584 | (1998a) Copper Alloy Sand Castings for General Applications |
| ASTM C 33 | (1999ael) Concrete Aggregates |
| ASTM D 2000 | (1999) Rubber Products in Automotive |

Applications

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI B5.10 (1994) Machine Tapers

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C 501 (1992) Standard for Sluice Gate

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Hoist Design Criteria; GA

Design computations and technical data showing factors of safety, calculations of stresses, and other information necessary to assure compliance with the drawings and specifications shall be submitted to the Contracting Officer.

The Contractor shall submit calculations which clearly show how the size of the operator was chosen. For the sluice gate lifts, a friction factor of 0.6 shall be used, and the gate size and the heads shall be those specified below.

Gate Vendors Erecting Engineer; FIO

Gate vendor information as specified in paragraph GATE VENDORS ERECTING ENGINEER shall be submitted.

SD-04 Drawings

Sluice Gates; GA
Flap Valves; GA

Shop drawings shall be submitted for sluice gates and flap valves showing details for mounting, materials, construction and installation procedures. Catalog data, including specifications and full descriptive data, shall be submitted for all materials and equipment furnished. Other shop drawings to be submitted include the following catalogue and performance data on the portable operator.

SD-19 Operation and Maintenance Manuals

Sluice Gates; GA

The Contractor shall submit, prior to delivery of gates to the project work site, five copies of a manual containing complete information in connection with the operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, and reassembly of the gates and accessories. Each set shall be permanently bound and shall have on the cover the following: (1) The words, "OPERATING AND MAINTENANCE INSTRUCTIONS", (2) the name and location of the project, (3) the

Contractor's name, and (4) the contract number. Flysheets shall be placed before instructions covering the subject. The sheets shall be approximately 8-1/2 x 11" which large sheets of drawings folded in. Each set shall include, but not be limited to, the following:

- a. Operating and maintenance instructions for each piece of equipment including lubrication instructions.
- b. Manufacturer's bulletins, cuts, and descriptive data.
- c. Parts lists and recommended spare parts.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

Sluice gates shall be the standard product of a reputable manufacturer having had at least 5 years of successful experience in the design and manufacture of sluice gates of the size and operating head specified. Gates and accessories shall be of the following design:

- a. Sluice gates shall be rising stem.
- b. Gates shall be flush bottom type, wall mounted as indicated on the drawings.
- c. Sluice gate frames shall be flange back type.
- d. Thimbles shall be sufficiently rigid to preclude distortion during installation.

2.1.1 General Design

Component parts shall be designed for the seating and unseating heads shown in TABLE 1 using a minimum factor of safety of 5, to be increased as desired and be sized and guided so that, unless otherwise shown on the drawings, the slenderness ratio (L/R) shall not exceed 200. The opening and closing forces for design of the stem and stem block anchorage shall include friction load based on the operating pressure shown in TABLE 1, with coefficient of friction of not less than 0.6 for sluice gates in addition to the weight of the gate and stem. Stem design shall include a factor of safety of 5 against failure in addition to the column buckling strength reduction effects as given by the Euler formula.

TABLE 1. GATE REQUIREMENTS

Pump Station	Gate Location	No. of Gate	Gate Size diam.(in)	Seat Pressure (ft)	Unseated Pressure (ft)	Hoisting Method
C3	Pump Station inlet sluice gate	1	60	22	22	P
	Discharge chamber inlet closure gate	2	60	41	28	E

D1	Pump Station inlet sluice gate	1	60	16	16	P

TABLE 1. GATE REQUIREMENTS

	Discharge chamber inlet closure gate	2	60	26	16	E
D2	Pump Station inlet sluice gate	1	48	17	17	P
	Discharge chamber inlet closure gate	1	54	35	23	E
E2	Pump Station inlet sluice gate	1	36	17	17	P
	Discharge chamber inlet closure gate	1	48	29	17	E

E = Electric motor-operated floor stand (one for each gate)

P = Portable operator (1 electrically operated, portable, tripod-mounted operator for entire project)

2.2 MATERIALS

Materials shall meet the requirements of the following referenced publications. Use of other grades or alloys shall be requested in writing and will be subject to approval.

2.2.1 Structural Steel

ASTM A 36.

2.2.2 Naval Brass

ASTM B 21, copper alloy No. 464 or 482; temper, optional.

a. Iron castings - ASTM A 126.

b. Steel castings - ASTM A 148.

2.2.3 Manganese Bronze

ASTM B 584, high-strength yellow brass, copper alloy No. 932.

2.2.4 Cold Rolled Steel

ASTM A 108, Grades 1010 through 1020.

2.2.5 Stainless Steel

a. ASTM A 276, Type 304, Condition A (annealed) or B (cold worked, high tensile), type of finish optional.

b. ASTM A 582, Type 303, Condition A (annealed), type of finish optional.

2.2.6 Bolting Materials

a. Bolts - ASTM A 582, Type 303 or 416.

b. Nuts - ASTM B 98, Alloy 655.

2.2.7 Asphalt Liquid

AASHTO M 82, medium core liquid asphalt type, Grade MC-30 or MC-70.

2.2.8 Sand

AASHTO M 29.

2.2.9 Seals

ASTM D 2000, Grade 4AA 625A13.

2.3 SLUICE GATES

2.3.1 General

Gates shall be heavy duty type as manufactured by Whipps, Rodney Hunt, Hydro Gate, Waterman, or equal. The sluice gate installations shall be furnished complete with frames, leaves, stems, adjustable stem guides, and anchor bolts, complete and operable in all respects as described herein and as indicated on the drawings. The gates shall be of the pressure seating type, and shall be designed for the seated pressures and unseated pressures indicated in TABLE 1. Gates that have either a seated or unseated design pressure greater than 30 feet shall be of cast iron construction. Gates that have both seated and unseated design pressures less than 30 feet may be of cast iron or stainless steel. The capacities of the operating stands shall be based upon the pressure exerted on the entire area enclosed by the gate sealing surfaces (seating faces). As used herein, operating pressure head is defined as the distance from the center of the slide, in its closed position, to the maximum water surface elevation. Sluice gates designated for power operation shall be sufficiently rugged to withstand operation by means of electric lifts or portable operators.

2.3.2 Wall Thimbles

Wall thimbles shall be of the F type. The thimbles shall be of cast iron or stainless steel with the front flange machined to a plane to provide a true seating surface for the sluice gate frame. Holes shall be drilled and tapped in the thimble to match the mounting hole pattern of the sluice gate frame. The gate frames shall be attached to the thimble by studs. The wall thimble shall be internally braced during concrete placement. Thimble shall be plumb in both planes with +1/16 inch.

2.3.3 Frames

The frames shall be cast iron or stainless steel of ample section to prevent distortion. Seat facings shall be naval brass or stainless steel and shall be machined to a smooth finish for making a tight seal meeting the requirements of AWWA C 501. The frame guides shall be of cast iron or stainless steel. The frame guides shall be equipped with adjustable side wedges, and the guides shall be of sufficient length so that not less than one-half of the gate is within the guides when the gate is wide open. The side wedges shall be faced with manganese bronze or stainless steel. Wedges shall be designed in such a manner that wedge fastening bolts may be replaced without the removal of the gate frame from the masonry or other setting, and their attachments adequate to resist tight closures of the

gates. Gates shall be provided with top wedges.

2.3.4 Gate Leaves

Gate leaves shall be of cast iron or stainless steel, consisting of flat castings with horizontal and vertical ribs of ample section to withstand all of the specified conditions of operation with limited distortion to prevent leakage. The seating surfaces shall be of naval brass or stainless steel not less than 3/4 inch wide and shall be machined to a 63 micro-inch finish or better and attached by dovetail notching to make a watertight seal. The gate shall be guided in the frame with a tongue and groove construction. The tongue and grooves shall be machined full length with a 1/8 inch overall clearance in the frame guide groove. Slide wedges shall be faced with manganese bronze or stainless steel and mounted and secured to prevent rotation that would interfere with their proper action or cause the gate to bind, in addition to meeting the requirements of AWWA C 501.

2.3.5 Stems

The stems shall be of stainless steel conforming to ASTM A 276, Type 302, 303, 304 with a 63 micro-inch finish if machine cut or 32 micro-inch if rolled threads, and shall be of the sizes recommended by the manufacturer. No detectable flaws or surface imperfections will be permitted. The stems shall be provided with thrust nuts of corrosion-resisting metal and shall have adjustable stop nuts to limit the upward and downward travel of the stems. The stems shall be of a size to withstand the axial compressive and tensile forces created during gate operation under the specified unbalanced heads and to transmit in compression at least two times the rated output of the lift with a 25 pound effort on the crank or handwheel. Threads on stems shall be machine cut or rolled with single or double lead threads of the Acme type. The exterior corners of the threads shall be given slight radius of approximately 0.015 inch in order to prevent them from acting as cutting edges as the stem passes through the left nut.

2.3.6 Stem Guides

Stem guides shall be a manufacturer's standard product, except as specified provided herein, and shall be adjustable in two directions to provide full adjustment for proper alignment of the stem. The stem bearing, in the stem guides, shall be brass or bronze brushed. The guides shall be anchored in an approved manner with not less than two bolts.

2.3.7 Asphalt and Sand

Asphalt and sand fill mixture shall be a relatively stiff mix of road asphalt and clean sand. The mixture shall be well tamped so as to have full contact with the embedded frame, and so as to provide a firm fill in the recess.

2.4 OPERATING HOISTS

2.4.1 Hoists

Sluice gates at the gatewell shall be provided with a manual hoisting unit.

Manual hoisting unit shall be designed to operate in conjunction with portable operators as specified below. Floor stands for the electric actuator shall be designed specifically for this purpose. Manual hoisting units shall be of the hand crank operated, enclosed, pedestal type, equipped with machine cut gears, having gear ratios recommended by the

hoist manufacturer. The hoisting units shall be made of cast iron or cast steel. Exposed fastening of 1-1/2 inch diameter and less shall have American Standard hexagon-socket (Allen) type wrench heads. The hoist shall have a cast bronze lift nut, threaded to match and engage with the stem threads. The lift nut shall be provided with ball or roller bearings both above and below a flange on the lift nut, to accommodate the opening and closing thrusts. Each hoist shall be provided with an integral position indicator. A brass plate shall be attached to the lift housing to show counter reading with gate in fully closed position. Each hoist shall be designed to unseat the slide from its wedging device at the maximum head with a maximum force of 40 pounds at 15 inch radius. Means for lubrication of the hoist shall be provided. No more than 16 turns of the hand crank or handwheel shall be required to move the gate 1 inch. A removable, cast-iron crank with a rotating brass grip and a radius of 15 inch shall be provided. All hoists shall be capable of being driven by the same portable operator.

2.4.2 Position Indicators

Weathertight and dust-tight stem position indicators shall be provided for all gate stands. The indicators shall be of the dial or counter type, mounted in a cast housing on top of the lift, and with the face of the counter showing through a recessed window in the housing and easily read from the crank location.

2.4.3 Stem Covers

Weathertight and dust-tight stem covers shall be provided to enclose and protect the threaded portion of the gate stem. Slotted galvanized steel stem covers shall be provided. The top of the stem shall be visible through the slot throughout its distance of travel during opening and closing operations. The slot shall be covered with a vandal resistant clear plastic material as recommended by the stem manufacturer and as approved. The above plastic material shall be installed as recommended by the stem manufacturer.

2.4.4 Bolts and Nuts

All anchor bolts for the rising stem type sluice gate frames and guides, stem guides, hoists and floor stands, and all bolts and studs used in the sluice gate leaves, frames and guides, and stem guides shall be stainless steel conforming to the requirements of ASTM A 276, type 304.

2.5 PORTABLE OPERATOR

One power operating device shall be provided for opening and closing of all gateway sluice gates in the project. The operator shall be portable, heavy duty drill type, mounted on a tripod.

2.5.1 Electric Motor Operated Drill

The operator shall be portable and capable of opening and closing the gates at the speed and torque specified. The drill shall be reversing type. The dimensions of the coupling for connecting the drill to the gates shall be determined by the Contractor after gate selection. The wrench shall be designed for outdoor service and operate on 120 volt, single phase, 60 hz service. The drill shall be capable of providing a minimum of 30 foot-pounds of torque for continuous duty while operating at a speed of not less than 140 RPM. The drill shall develop a stall torque of 75

foot-pounds. Fifty feet of three conductor, heavy duty cable, shall be provided with the drill for use as an extension cord. The cable shall be complete with a 3 pole plug. An operating stand shall be provided with the drill. The operating stand shall be designed to withstand the stall torque of the drill.

2.5.1.1 Torque Limiter Coupling

A detachable overload release type torque limiting device shall be furnished so as to cause the drill to turn free if the output torque exceeds 50 foot pounds. Resetting shall be accomplished simply by allowing the drill to stop and reversing the rotational direction. The torque coupling shall be manufactured and designed to be torsionally rigid and allow for angular misalignment similar to Model 405 as manufactured by American Autogard Corporation, Rockford, Illinois. The torque limiter coupling shall be factory set and equipped with tamper proof shield and dust and wash-down resistant cover. The input side of the coupling shall be equipped with an adapter shaft. The adapter shaft shall be tool steel with a minimum impact energy rating of 150 percent of the torque limit. The adapter shaft shall be of the diameter, as recommended by the coupling manufacturer and approved by the Contracting Officer and shall be set screwed and keyed to coupling. The other end of the adapter shaft shall be a No.3 external Morse Taper in accordance with ANSI B5.10 and shall properly mate with the approved power drill.

2.5.1.2 Adapter Sockets

The Contractor shall provide adapter sockets of each size and type necessary to connect the torque coupling of the power drill to each of the handwheel shafts of the approved sluice gate actuators. The coupling side of all the adapter sockets shall be shaft mounted of the diameter, set screwed and keyed as recommended by the coupling manufacturer and approved by the Contracting Officer. The handwheel side of the adapter sockets shall determined by the Contractor and individually configured to mate with the handwheel shafts of each approved permanently mounted actuators. The adapter sockets shall be tool steel with a minimum impact energy rating of 150 percent of the output torque of the portable actuator.

2.6 ELECTRIC MOTOR ACTUATOR (OPERATOR)

Electric motor actuators shall be provided for all discharge chamber sluice gates in the project. The actuator shall include as an integral unit the electric motor, gearing, drive coupling, torque switches, position limit switches, gear case, and a manual operator. The actuator shall be self-locking. Actuator shall be designed to provide 1 foot per minute of gate travel.

2.6.1 Gearing

Gears shall be spur, helical, bevel, and/or worm gears. All gearing shall be heat treated alloy steel.

2.6.2 Bearings

All gears and shafting shall be supported by bearings. Bearings shall be tapered roller bearings.

2.6.3 Lubrication

Grand Forks Phase 1 Levees

All gearing and bearings shall be oil lubricated. Seals shall be provided at all shaft penetrations of the gear case. Lubricant shall be suitable for ambient temperatures from -30 degrees F to 100 degrees F.

2.6.4 Handwheel

The operation of the motor shall not cause the handwheel to rotate and the operation of the motor shall not cause the motor to rotate. The handwheel shall have an arrow and the words "OPEN" or "CLOSE" indicating the direction of rotation.

2.6.5 Motors

Electric motors shall be specifically designed for sluice gate actuator service. Motors shall be 480 volt, 3-phase, 1800 rpm maximum. Motors shall be NEMA 4, watertight, construction. Motors shall be capable of operating through one complete cycle "open-close-open" or "close-open-close" without overheating. Motors shall have thermal overload protection.

2.6.6 Limit Switches

Open and close limit switches shall be geared to the drive mechanism and in step at all times whether the unit is operated electrically or manually. Switches shall be field adjustable type.

2.6.7 Torque Switches

Actuator shall include adjustable torque switch to break the control power circuit when the gate reaches the fully open or close position or when the gate hits an obstruction. Open and close torque switches shall be adjustable by means of individually calibrated dials marked "Open" and "Close".

2.6.8 Electric Control Enclosure

Terminal strips, space heater, limit switches, and torque switches shall be housed in an integral compartment to the actuator. Enclosure shall be NEMA 4, watertight, cast aluminum construction. All hardware shall be stainless steel. Motorized gate operators shall include a separate 120 volt source for space heaters. This will limit vandalism by permitting the power to be turned off to the motor controls, without disabling the space heaters. Each operator shall include a disconnect switch on the base of each pedestal. The disconnect switch shall include an auxiliary power contact to open the 120 volt space heater when the disconnect is opened.

2.6.9 Controls

Controls shall include reversing starter, local disconnect, control power transformer, open-stop-close pushbuttons, and position indicating lights. Control panel/station shall be cast aluminum.

2.7 FLAP VALVES

Provide flap valves with flange frame and steel anti-locking bar for mounting on ductile iron discharge piping. Provide lubrication fitting for all hinges. Circular opening for gravity flow.

2.7.1 Materials

Grand Forks Phase 1 Levees

- a. Frame and cover or flap Cast-iron, ASTM A 126, Class B.
- b. Seats: Bronze, ASTM B 21.
- c. Hinge arms: High strength malleable iron or high tensile bronze.
- d. Hinge pins: Stainless steel, Type 304 or silicon bronze, ASTM B 98.
- e. Anchor bolts: Stainless steel, Type 304.
- f. Bumper: Ductile iron leaf spring attached to the body and extended over the cover to limit cover travel to 90 degrees. Provide rubber pad at contact point.
- g. Size: As indicated on drawings.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Instructions

The setting, installation, assembly, lubrication, and testing of the gates and hoisting units shall be in accordance with the instructions of the gate manufacturer as approved by the Contracting Officer. These instructions shall be submitted for approval prior to any gate installation work. An erecting engineer shall inspect and determine the adherence to the above instructions for the setting of the gate thimble, rail assemblies, the stem guide anchor bolts, and the hoisting unit anchor bolts; the alignment and assembly of the stem to the sluice gate, stem guides, and hoisting unit; and observe the initial gate operations using the hoist. The Contractor shall make all arrangements for the presence of the erecting engineer for this inspection. The presence of the erecting engineer, however, will not relieve the Contractor of full responsibility.

Wall thimbles and anchor bolts shall be set in place prior to the placing of concrete. Each unit shall be accurately aligned and, if upon completion of the work there is any misalignment or other defective workmanship which is likely to impede the operation of the gate, the necessary corrections shall be made by the Contractor at no additional expense to the Government.

The bottom frame member of flush bottom sluice gates shall be embedded in an asphalt mixture as shown.

Asphalt and sand fill mixture shall be a relatively stiff mix of road asphalt and clean sand. The asphalt material shall be Asphalt Cement (AC), Penetration Grade 120/150. The asphalt content shall not be less than 7 percent of the mix. The sand shall conform to the quality and gradation of fine aggregate for concrete as specified in ASTM C 33. The mixture shall be well tamped so as to have full contact with the embedded frame and to provide a firm fill in the recess.

3.1.2 Gate Vendor's Erecting Engineer

This erecting engineer shall be experienced in the specific installation of sluice gates as a complete system. Installation experience shall include as a minimum three successful installations of which at least one must have been in the last two years and at least one must have been a gate of the larger size furnished with this project. The Gate Vendor shall coordinate with the Contractor on the most advantageous times and durations necessary

for his erecting engineer to be at construction site and be confident of the proper installation and operational function of their product. The Vendor's erecting engineer shall initiate instructions for all actions necessary for the proper receipt, inspections, handling, assembly, installation, operation, and testing of this sluice gate system furnished by his company under this contract. Discrepancies shall be reported to the Contracting Officer. The Vendor's erecting engineer shall also keep records of measurements and actions taken during his visits and shall furnish a copy to the Contracting Officer on request or at the completion of each visit. Multiple visits may be required depending on installation sequencing. One of the visits shall be during final preparation and performance of the installed acceptance test. The erecting engineer shall instruct the Contractor in the operation and maintenance features of his company's installed sluice gate product. The following information will be submitted with the submittal package to verify the qualifications of the engineer:

- a. Experience, years of service, etc., as an erecting engineer.
- b. List of successful gate installations with owner's address and phone number.
- c. Size and type control of the installed gates.

3.1.3 Assembly

Prior to assembly, the gate stems shall be thoroughly cleaned, for inspection by the Contracting Officer or his representative. All parts of the gates and operating mechanisms shall be installed and fitted together so that after final assembly there will be no interference through bad alignment, or any warping or twisting of the members that would in any way interfere with operation. All finished contact or bearing surfaces shall be true and exact to insure full and complete contact. All bolts for attaching the gate frames, stem guides, and operating hoists shall be accurately embedded at the time of placing concrete. Provisions for lubrication of the operating mechanisms shall be made and the lubrication systems shall be properly filled with suitable lubricant as recommended by the manufacturer of the hoists. When the sluice gate slide is in the fully closed position and wedged in position against the frame, maximum clearance between mating faces shall not exceed 0.004 inch.

3.2 TESTS

After final assembly, each gate shall be tested in the presence of the gate vendor's erecting engineer and the Contracting Officer or his representative by raising and lowering it throughout its complete travel by means of its operating mechanism and to demonstrate that it complies with the specifications. Any defective part or error in the construction or alignment of the complete gate discovered during the tests and trials shall be immediately corrected by the Contractor without cost to the Government.

Upon completion of the installation, each gate shall be lubricated and operated through as many cycles of opening and closing as may be necessary to demonstrate proper functioning of the gates and that the units are free from binding or other defects.

3.2.1 Testing

The portable operator shall be tested in the presence of the Contracting

Officer in raising and lowering the gates.

3.3 PAINTING

The gate manufacturer shall be responsible for shop prime and finish painting of all sluice gates and appurtenances supplied under this contract. All coatings shall conform with VOC Emission Regulations in effect at the manufacturing location and at project site to allow touch-up or recoating to be performed with the same products. The type of paint shall be as specified in the following schedule. Where required by application the coating shall be approved for contact with drinking water by the NSF, EPA, or other appropriate governing agencies. Number of coats, mil thickness and surface preparation shall be in accordance with the paint manufacturer's recommendations for that application, but in no case shall be less than the requirements in the following schedule. All coatings shall be free of carcinogens as listed on the IARC monographs. Colors are to be manufacturer's standards, provided they are selected for ease of manufacturer's standards, provided they are selected for ease of field touch-up and color match and are fade resistant. Colors shall be selected to provide contrast between the product and the prime coat, and between the prime coat and the finish coat, to insure uniform covering and coating thickness. All coatings shall be applied in accordance with the paint manufacturer's recommendations for thinning, technique and safety precautions.

3.3.1 Paint Schedule

<u>Applicatio</u>	<u>Materia</u>	<u>Preparatio</u>	<u>1st Coa</u>	<u>2nd Coa</u>	<u>3rd Coat</u>
Gates, wall thimbles	Cast Iron	SP 6	Amine Mod. Pol. Epoxy Amerlock 400 or Equal 5 mils min.	Amine Mod. Pol. Epoxy Amerlock 400 or Equal 5 mils min.	None

3.4 TOOLS

One set of wrenches and special tools required for the operation and maintenance of the sluice gates installed under this contract shall be furnished at the time of the trial operation.

3.5 QUALITY CONTROL

The Contractor shall establish and maintain quality control for work under this section to assure compliance with contract requirements and maintain records of his quality control for all construction operations including, but not limited to, the following:

- a. Materials and workmanship.
- b. Installation.
- c. Trial operations of each gate.
- d. Adjustment.

A copy of the records of inspections and tests, as well as the records of corrective action taken, shall be furnished to the Government as directed by the Contracting Officer.

-- End of Section --

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SECTION 15080

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SECTION 15080

THERMAL INSULATION FOR MECHANICAL SYSTEMS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. At the discretion of the Government, the manufacturer of any material supplied will be required to furnish test reports pertaining to any of the tests necessary to assure compliance with the standard or standards referenced in this specification.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 580/A 580M	(1998) Stainless Steel Wire
ASTM B 209M	(1995) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM C 449/C 449M	(1995) Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C 518	(1998) Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 533	(1995) Calcium Silicate Block and Pipe Thermal Insulation
ASTM C 534	(1999) Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C 610	(1995) Molded Expanded Perlite Block and Pipe thermal Insulation
ASTM C 795	(1998e1) Thermal Insulation for Use in Contact With Austenitic Stainless Steel
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 1136	(1995) Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM E 84	(1999) Surface Burning Characteristics of Building Materials

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

MSS SP-69 (1996) Pipe Hangers and Supports -
Selection and Application

MIDWEST INSULATION CONTRACTORS ASSOCIATION (MICA)

MICA Insulation Stds (1993) National Commercial & Industrial
Insulation Standards

1.2 GENERAL QUALITY CONTROL

1.2.1 Standard Products

Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening.

1.2.2 Installer's Qualifications

Qualified installers shall have successfully completed three or more similar type jobs within the last 5 years.

1.2.3 Surface Burning Characteristics

Unless otherwise specified, insulation not covered with a jacket shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Flame spread and smoke developed indexes shall be determined by ASTM E 84. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E 84.

1.2.4 Identification of Materials

Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-14 Samples

Thermal Insulation Materials; GA

A complete list of materials, including manufacturer's descriptive technical literature, performance data, catalog cuts, and installation instructions. The product number, k-value, thickness and furnished accessories for each mechanical system

requiring insulation shall be included. Materials furnished under this section of the specification shall be submitted at one time.

After approval of materials and prior to applying insulation a booklet shall be prepared and submitted for approval. The booklet shall contain marked-up MICA Insulation Stds plates (or detail drawings showing the insulation material and insulating system) for each pipe, duct, or piece of equipment required to be insulated per this specification. The MICA plates shall be marked up showing the materials to be installed in accordance with the requirements of this specification for the specific insulation application. The Contractor shall submit all MICA Plates required to show the entire insulating system, including Plates required to show insulation penetrations, vessel bottom and top heads, legs, and skirt insulation as applicable. If the Contractor elects to submit detailed drawings instead of marked-up MICA Plates, the detail drawings shall show cut-away, section views, and details indicating each component of the insulation system and showing provisions for insulating jacketing, and sealing portions of the equipment. For each type of insulation installation on the drawings, provide a label which identifies each component in the installation (i.e., the duct, insulation, adhesive, vapor retarder, jacketing, tape, mechanical fasteners, etc.) Indicate insulation by type and manufacturer. Three copies of the booklet shall be submitted at the jobsite to the Contracting Officer. One copy of the approved booklet shall remain with the insulation Contractor's display sample and two copies shall be provided for Government use.

After approval of materials actual sections of installed systems properly insulated in accordance with the specification requirements shall be displayed. Such actual sections must remain accessible to inspection throughout the job and will be reviewed from time to time for controlling the quality of the work throughout the construction site. Each material used shall be identified, by indicating on an attached sheet the specification requirement for the material and the material by each manufacturer intended to meet the requirement. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be closed and sealed.

Pipe Insulation Display Sections: Display sample sections shall include as a minimum an elbow or tee, a valve, dielectric unions and flanges, a hanger with protection shield and insulation insert, or dowel as required, at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and terminating points for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines, both interior and exterior, even when the same type of insulation is used for these services.

1.4 STORAGE

Materials shall be delivered in the manufacturer's unopened containers. Materials delivered and placed in storage shall be provided with protection from weather, humidity, dirt, dust and other contaminants. Insulation

material and supplies that become dirty, dusty, wet, or otherwise contaminated may be rejected by the Contracting Officer.

PART 2 PRODUCTS

2.1 GENERAL MATERIALS

Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

2.1.1 Adhesives

2.1.1.1 Lagging Adhesive

Lagging is the material used for thermal insulation, especially around a cylindrical object. This may include the insulation as well as the cloth/material covering the insulation. Lagging adhesives shall be nonflammable and fire-resistant and shall have a flame spread rating no higher than 25 and a smoke developed rating no higher than 50 when tested in accordance with ASTM E 84. Adhesive shall be pigmented white red and be suitable for bonding fibrous glass cloth to faced and unfaced fibrous glass insulation board; for bonding cotton brattice cloth to faced and unfaced fibrous glass insulation board; for sealing edges of and bounding fibrous glass tape to joints of fibrous glass board; for bonding lagging cloth to thermal insulation; or for attaching fibrous glass insulation to metal surfaces. Lagging adhesives shall be applied in strict accordance with the manufacturer's recommendations.

2.1.2 Contact Adhesive

Adhesive may be dispersed in a nonhalogenated organic solvent or, dispersed in a nonflammable organic solvent which shall not have a fire point below 200 degrees F. The adhesive shall not adversely affect, initially or in service, the insulation to which it is applied, nor shall it cause any corrosive effect on metal to which it is applied. Any solvent dispersing medium or volatile component of the adhesive shall have no objectionable odor and shall not contain any benzene or carbon tetrachloride. The dried adhesive shall not emit nauseous, irritating, or toxic volatile matters or aerosols when the adhesive is heated to any temperature up to 212 degrees F. The adhesive shall be nonflammable and fire resistant.

2.1.3 Caulking

ASTM C 920, Type S, Grade NS, Class 25, Use A.

2.1.4 Corner Angles

Nominal 0.016 inch aluminum 1 x 1 inch with factory applied kraft backing. Aluminum shall be ASTM B 209M, Alloy 3003, 3105, or 5005.

2.1.5 Finishing Cement

Mineral fiber hydraulic-setting thermal insulating cement ASTM C 449/C 449M. All cements that may come in contact with Austenitic stainless steel must include testing per ASTM C 795.

Grand Forks Phase 1 Levees

2.1.6 Fibrous Glass Cloth and Glass Tape

Fibrous glass cloth and glass tape shall have flame spread and smoke developed ratings of no greater than 25/50 when measured in accordance with ASTM E 84. Tape shall be 4 inch wide rolls.

2.1.7 Staples

Outward clinching type monel ASTM A 167, Type 304 or 316 stainless steel. Monel is a nickel rich alloy which has high strength, high ductility, and excellent resistance to corrosion.

2.1.8 Wire

Soft annealed ASTM A 580/A 580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2 PIPE INSULATION MATERIALS

Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.2.1 Aboveground Hot Pipeline

Insulation for above 60 degrees F, for outdoor, indoor, exposed or concealed applications shall meet the following requirements. Supply the insulation with manufacturers recommended factory applied jacket.

- a. Calcium Silicate: ASTM C 533, Type I indoor only, or outdoors above 250 degrees F pipe temperature.
- b. Perlite Insulation: ASTM C 610.

2.2.1.1 Domester Hot Water Piping

Hot water above ground shall be insulated with 1 inch thick fiberglass for sizes through 3 inch pipe and 1-1/2 inch thick fiberglass for sizes greater than 3 inch and with ASJ jacket. See hot water maintenance systems recommendations. Hot water underground shall be insulated with 1/2 inch thick plastic foam. Hot water piping concealed in walls or pipe chases may be insulated with 1/2 inch thick plastic foam.

2.2.2 Aboveground Cold Pipeline

Cold water above ground shall be insulated with 1 inch thick fiberglass insulation with ASJ jacket. Cold water underground shall be insulated with 1/2 inch thick plastic foam. Cold water piping concealed in walls or pipe chases may be insulated with 1/2 inch thick plastic foam.

2.3 DUCT INSULATION MATERIALS

Duct insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.3.1 Flexible Cellular

ASTM C 534 Type II.

2.4 EQUIPMENT INSULATION MATERIAL

2.4.1 Water Storage Tank

All surfaces shall be insulated with three pound density fiberglass board equal to Owens Corning #703 using 2 inch thickness. Insulation shall be cut, scored or mitered to fit the contour of equipment with edges tightly butted and secured with #18 galvanized hexagonal mesh wire and heavy coat of mineral fiber cement over insulation. Finish with 6 ounce canvas jacket applied with suitable adhesive. This contractor shall provide insulation on equipment furnished by him only unless otherwise specified. Break insulation at access panels, handholes, equipment, joints, etc.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

3.1.1 Installation

Except as otherwise specified, material shall be installed in accordance with the manufacturer's written instructions. Insulation materials shall not be applied until tests specified in other sections of this specification are completed. Material such as rust, scale, dirt and moisture shall be removed from surfaces to receive insulation. Insulation shall be kept clean and dry. Insulation shall not be removed from its shipping containers until the day it is ready to use and shall be returned to like containers or equally protected from dirt and moisture at the end of each workday. Insulation that becomes dirty shall be thoroughly cleaned prior to use. If insulation becomes wet or if cleaning does not restore the surfaces to like new condition, the insulation will be rejected, and shall be immediately removed from the jobsite. Joints shall be staggered on multi layer insulation. Mineral fiber thermal insulating cement shall be mixed with demineralized water when used on stainless steel surfaces. Insulation, jacketing and accessories shall be installed in accordance with MICA Insulation Stds standard plates except where modified herein or on the drawings.

3.1.2 Welding

No welding shall be done on piping, duct or equipment without written approval of the Contracting Officer. The capacitor discharge welding process may be used for securing metal fasteners to duct.

3.1.3 Pipes/Ducts/Equipment which Require Insulation

Insulation is required on all engine-generator exhaust pipes, engine-generator exhaust ducts, or equipment, except for omitted items, as specified.

3.2 PIPE INSULATION INSTALLATION

3.2.1 Pipe Insulation

3.2.1.1 General

Pipe insulation shall be installed on aboveground hot and cold pipeline systems as specified below to form a continuous thermal retarder, including straight runs, fittings and appurtenances unless specified otherwise. Installation shall be with full length units of insulation and using a

single cut piece to complete a run. Cut pieces or scraps abutting each other shall not be used. Pipe insulation shall be omitted on the following:

- a. Stormwater discharge piping.

3.2.1.2 Pipes Passing Through Walls, Roofs, and Floors

- a. Pipe insulation shall be continuous through the sleeve.
- b. An aluminum jacket with factory applied moisture retarder shall be provided over the insulation wherever penetrations require sealing.
- c. Where penetrating interior walls, the aluminum jacket shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.
- d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.
- e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.
- f. Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.
- g. Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor retarder coating. The insulation for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with caulking.

3.2.1.3 Pipes Passing Through Hangers

- a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed.
- b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69.
- c. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360 degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360 degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches

on each end beyond the protection shield. When insulation inserts are required per the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe which are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

- d. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible cellular insulation shall conform to ASTM C 1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.2 Aboveground Hot Pipelines

The following hot pipelines above 60 degrees F shall be insulated per Table II:

- a. Engine exhaust pipe.

3.2.2.1 Insulation Thickness

Insulation thickness for hot pipelines shall be determined using Table II.

LEGEND:

CS - Calcium Silicate
 PL - Perlite

Table II - Hot Piping Insulation Thickness
 Pipe Size (inches)

Type of Service (degrees F)	Material	Runouts up to 2 in *	1 in & less	1.25 - 2 in	2.5 - 4 in	5 - 6 in	8 in & larger
Engine Exhaust (-1200 F)	CS/PL	2.0	3.5	4.0	4.5	5.0	5.5

* When runouts to terminal units exceed 12 feet, the entire length of runout shall be insulated like the main feed pipe.

3.2.2.2 Jacket for Insulated Hot Pipe, Except Pipe Insulated with Flexible Cellular

Insulation shall be covered, in accordance with manufacturer's recommendations, with a factory applied Type II jacket or field applied aluminum where required or seal welded PVC.

3.2.2.3 Insulation for Straight Runs

- a. Insulation shall be applied to the pipe with joints tightly butted.
- b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches, and butt strips 3 inches wide shall be provided for circumferential joints.
- c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. Adhesive may be omitted where pipe is concealed.
- d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F and shall be installed in accordance with manufacturer's instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.
- e. Breaks and punctures in the jacket material shall be patched by either wrapping a strip of jacket material around the pipe and securing with adhesive and staple on 4 inch centers (if not factory self-sealing), or patching with tape and sealing with a brush coat of vapor retarder coating. Adhesive may be omitted where pipe is concealed. Patch shall extend not less than 1-1/2 inches past the break.
- f. Flexible cellular pipe insulation shall be installed by slitting tubular sections and applying onto piping or tubing. Alternately, whenever possible, slide unslit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used. Type II sheet insulation when used on pipe larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

3.2.2.4 Insulation for Fittings and Accessories

- a. Pipe insulation shall be tightly butted to the insulation of the fittings and accessories.
- b. Precut or preformed insulation shall be placed around all fittings and accessories and shall conform to MICA plates, except as modified herein: 5 for anchors; 10, 11, 12, and 13 for fittings; 14, 15 and 16 for valves; 17 for flanges and unions; and 18 for couplings. Insulation shall be the same as the pipe insulation, including same density, thickness, and thermal conductivity. Where precut/preformed is unavailable, rigid preformed pipe insulation sections may be segmented into the shape required.

Insulation of the same thickness and conductivity as the adjoining pipe insulation shall be used. If nesting size insulation is used, the insulation shall be overlapped 2 inches or one pipe diameter. Elbows insulated using segments shall conform to MICA Tables 12.20 "Mitered Insulation Elbow".

- c. Upon completion of installation of insulation on flanges, unions, valves, anchors, fittings and accessories, terminations and insulation not protected by factory vapor retarder jackets or PVC fitting covers shall be protected with two coats of adhesive applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. Adhesive shall extend onto the adjoining insulation not less than 2 inches. The total dry film thickness shall be not less than 1/16 inch.
- d. Insulation terminations shall be tapered to unions at a 45-degree angle.
- e. At the option of the Contractor, factory premolded one- or two-piece PVC fitting covers may be used in lieu of the adhesive and embedded glass tape. Factory premolded segments or factory or field cut blanket insert insulation segments shall be used under the cover and shall be the same thickness as adjoining pipe insulation. The covers shall be secured by PVC vapor retarder tape, adhesive, seal-welding or with tacks made for securing PVC covers.

3.2.2.5 Insulation for Fittings

Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of breather emulsion type weatherproof mastic (impermeable to water, permeable to air) recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above. Molded PVC fitting covers shall be provided when PVC jackets are used for straight runs of pipe. PVC fitting covers shall have adhesive welded joints and shall be weatherproof.

3.3 DUCT INSULATION INSTALLATION

Except for oven hood exhaust duct insulation, corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket. Duct insulation shall be omitted on exposed supply and return ducts in air conditioned spaces where the difference between supply air temperature and room air temperature is less than 15 degrees F unless otherwise shown. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

3.3.1 Duct Insulation Thickness

Duct insulation thickness shall be in accordance with Table III.

Table III - Minimum Duct Insulation (inches)

Type of Service (degrees F)	Material	Min. Thickness (in.)
Engine-Generator Exhaust Duct (-200)	Flexible cellular	3

Maximum thickness for flexible cellular insulation shall not exceed 1 inch and maximum thickness for polyisocyanurate foam insulation shall not exceed 1.5 inch, to comply with ASTM E 84 flame spread/smoke developed ratings of 25/50.

3.3.2 Installation on Exposed Duct Work

- a. For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches.
- b. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened to the duct using mechanical fasteners. When the height of projections is less than the insulation thickness, insulation shall be brought up to standing seams, reinforcing, and other vertical projections and shall not be carried over. Vapor retarder jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.
- c. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed or bent over.
- d. Joints in the insulation jacket shall be sealed with a 4 inchwide strip of tape. Tape seams shall be sealed with a brush coat of vapor retarder coating.
- e. Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with tape and stapled. Staples and joints shall be sealed with a brush coat of vapor retarder coating.
- f. At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled and the penetrations sealed with a brush coat of vapor retarder coating.
- g. Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor retarder coating finish. The coating shall overlap the adjoining insulation and uninsulated surface 2 inches. Pin puncture coatings shall extend 2 inches from the puncture in all directions.

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- h. Oval and round ducts, flexible type, shall be insulated with factory Type I jacket insulation with minimum density of 3/4 pcf, attached as per MICA standards.

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SECTION 15132

SUBMERSIBLE PUMP

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 27/A 27M	(1995) Steel Castings, Carbon, for General Application
ASTM A 36/A 36M	(1997ael) Carbon Structural Steel
ASTM A 108	(1999) Steel Bars, Carbon, Cold Finished, Standard Quality
ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 176	(1997) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 242/A 242M	(1998) High-Strength Low-Alloy Structural Steel
ASTM A 276	(1998b) Stainless Steel Bars and Shapes
ASTM A 297/A 297M	(1997; R 1998) Steel Casting, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application
ASTM A 312/A 312M	(1999) Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A 516/A 516M	(1990; R 1996) Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
ASTM A 576	(1990b; R 1995) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM A 668/A 668M	(1996) Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM B 148	(1997) Aluminum-Bronze Sand Castings
ASTM B 584	(1998a) Copper Alloy Sand Castings for

General Applications

ASTM D 2000 (1999) Rubber Products in Automotive Applications

ASME INTERNATIONAL (ASME)

ASME B46.1 (1995) Surface Texture (Surface Roughness, Waviness, and Lay)

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1 (2000) Structural Welding Code - Steel

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200 (1997) Steel Water Pipe - 6 In. (150 mm) and Larger

AWWA C203 (1997) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied

AWWA C207 (1994) Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)

AWWA C208 (1996) Dimensions for Fabricated Steel Water Pipe Fittings

HYDRAULIC INSTITUTE (HI)

HI 2.1-2.5 (1994) Vertical Pump

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Installation and Erection Instructions; GA.

The Contractor shall review printed and bound manuals describing the procedures for erecting, assembling, and installing the pumps and controls. These procedures will be followed by a pump installation contractor under the supervision of an erecting engineer. The manuals shall be submitted with any comments or questions at the time the pump shop drawings are reviewed.

The installation description is a complete, orderly, step-by-step explanation of the various operations required to install each type of pump including the guide rails or cables and discharge shoe. It describes all special procedures and outlines special precautions. It includes such things as bolt torque values, permissible wear ring clearances, recommended instrument set-ups, recommended gages and instruments, bearing clearances, and similar details.

The Description may be complemented and supplemented by Contractor comments, drawings, sketches, photographs, and similar materials as necessary. The overall result shall be a description which may be comprehended by an engineer or mechanic without extensive experience in erecting or installing pumps of the type required.

After review, the Government will furnish to the Contractor a recommended comments and direction as necessary or desirable for the installation procedure and return two copies of the previously reviewed manual back to the Contractor. Differences of opinion between the Contractor, pump manufacturer, and Contracting officer shall be reconciled in a manner mutually agreeable to all parties, and two copies of the reviewed and annotated manual shall be submitted to the Contracting Officer's Representative. The final approved installation instructions shall be followed by the installation personnel for the completion of pump installation work.

SD-19 Operation and Maintenance Manuals

Operating and Maintenance Manual; GA

The Contractor shall review, prior to installation of any pumps to the project work site, a copy of the manual containing complete information in connection with the operation, lubrication, adjustment, routine and special maintenance, disassembly, repair, and reassembly of the pumps and accessories. The manual may include a listing of special tools required for working on the pumps and controls. The manual shall incorporate complete information of the controls covered under this section and include operation and maintenance procedures, special features, and instructions for setting all adjustable controls and equipment. Comprehensive as-installed drawings, photographs, field test results, and sketches of the pump installations shall be included.

1.3 SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS

1.3.1 Operating Conditions

- a. The pump shall be capable of operating in the dry (for the purpose of maintenance and operating checks) for short periods of time as stated in the manufacturer's operating instruction.
- b. The pump manufacturer shall establish and state in the operating manual the procedures for starting and stopping the pumps, including setting of valves or any sequential operations.

1.3.2 Performance Requirements

- a. When operated in the dry, the maximum level of vibration of the assembled pumping unit shall not be greater than the value of the lower limit of the good range of the "General Machinery Vibration Severity Chart". This chart can be obtained from Entek IRD, 1700 Edison Drive, Cincinnati, Ohio 45150. Measurements shall be taken at pump operating speed during the field start-up test.
- b. The pump shall be capable of operating without instability over the required range of head.

1.4 SHIPPING AND STORAGE

The pump will be inspected for damage or other distress when received at the project site. The pump and associated equipment shall be stored indoors as recommended by the pump manufacturer, protected from construction or weather hazards at the project site. The pump and equipment shall have adequate short-term storage in a covered, dry, and ventilated location prior to installation. The manufacturer's instructions shall be followed for extended storage. Proper equipment for handling the pump shall be supplied and shall be considered as special tools if not completely standard.

1.5 SPECIAL TOOLS

Furnish one set of all special tools required to completely assemble, disassemble, or maintain the pumps. Special tools refers to oversized or specially dimensioned tools, special attachment or fixtures, or any similar items. Lifting devices required for use in conjunction with the [overhead] crane shall be furnished.

1.6 INSTALLATION AND START-UP ENGINEER

The Contractor shall furnish a competent installation engineer fluent in the English language who is knowledgeable and experienced with the installation and start-up procedures for submersible pumps and the associated equipment specified. Installation/erecting engineers provided by this section shall include those from Contractor's suppliers. When so requested, the installation engineer shall be responsible for providing complete and correct direction during installation, initial starting, and subsequent operation of equipment until field tests are completed. The installation engineer shall initiate instructions for actions necessary for proper receipt, inspection, handling, uncrating, assembly, and testing of equipment. The installation engineer shall also keep a record of measurements taken during erection and shall furnish one copy to the Contracting Officer on request or on the completion of the installation of assembly or part. The erecting engineer shall instruct the Contracting Officer or others as designated in the operation and maintenance features of the pump units.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

Submersible storm water pumps and sump pumps in this contract are Government-furnished. Pumps shall be installed at the pumping locations as shown. A total of 12 pumps, 4 at each pump station, shall be installed at Pump Stations C3, D1 and D2. A total of 3 pumps shall be installed at Pump Station E2. The term "pump" shall mean the assembled pump-motor for unit complete with electrical cable, discharge elbow, and guide rails or guide cables.

2.1.1 Coordination

The Contractor shall install the controls required for the installation contract work. Electrical requirements are given in Section 16415 ELECTRICAL WORK, INTERIOR. All pump shop drawings and control shop drawings shall be coordinated and all electrical and mechanical installation details submitted.

2.1.2 Nameplates

Each major item of equipment has the manufacturer's name, address, type/style, model, serial number, and catalog number on a plate secured to the item of equipment. Nameplates are made of corrosion resisting metal with raised or depressed lettering on a contrasting colored background. The Contractor shall review the nameplate data and report any discrepancies to the Contracting officer.

2.1.3 Instruction Plates

As necessary, each item of equipment has been equipped with suitably installed instruction plates including warning and cautions describing special and important procedures to be followed while starting, operating and servicing the equipment. The plates are made of corrosion resisting metal with raised or depressed lettering on a contrasting colored background.

2.1.4 Verification of Dimensions

The Contractor shall be familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy prior to performing the work.

2.2 MATERIALS AND METALWORK FABRICATION

2.2.1 Designated Materials

Designated materials shall conform to the following specifications, grades, and classifications.

MATERIALS	SPECIFICATION, GRADE, CLASS
Aluminum-Bronze	ASTM B 148, Alloy No. C95500 Castings
Cast Iron	ASTM A 48, Class Nos. 30A, 30B, and 30C
Cast Steel	ASTM A 27/A 27M Grade 65-35, annealed
Coal Tar Protective Coatings	AWWA C203
Cold-Rolled Steel Bars	ASTM A 108, min, Wt. Strm 65,000 psi
Copper Alloy Castings	ASTM B 584, Alloy No. C93700
Corrosion-Resistant Alloy Castings	ASTM A 297/A 297M, Grade CA-15, CAGNN and CF-8M
Dimensions for Steel Water Pipe Fittings	AWWA C208
Hot-Rolled Stainless	ASTM A 576, Graded G10200, G10450, and G11410
Ring Flanges	AWWA C207, Class B

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MATERIALS	SPECIFICATION, GRADE, CLASS
Rubber Products in Automotive Applications	ASTM D 2000
Seamless and Welded Austenitic Stainless Steel Pipe	ASTM A 312/A 312M
Stainless Bars and Shapes	ASTM A 276, Grades S30400 and S41000
Steel Forging	ASTM A 668/A 668M, Class F
Steel Pipe 6 in. and Larger	AWWA C200
Steel Plates, Pressure Vessel	ASTM A 516/A 516M, Grade 55
Steel Plate	ASTM A 242/A 242M
Stainless Steel Plate	ASTM A 167, UNS S30400 or ASTM A 176, UNS S40500
Quality Steel	ASTM A 36/A 36M
Surface Texture	ASME B46.1

2.2.2 Bolted Connections

2.2.2.1 Bolts, Nuts, and Washers

Bolts, nuts, and washers shall conform to requirements herein specified and the paragraphs SUBMERSIBLE PUMP, DISCHARGE TUBE [AND DISCHARGE ELBOW], and the subparagraph, NUTS AND BOLTS for types required. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to bolt axis.

2.2.2.2 Materials Not Specifically Described

Materials not specifically described shall conform to the latest ASTM specification or to other listed commercial specifications covering class or kinds of materials to be used.

2.2.3 Flame Cutting of Material

Flame cutting of material other than steel shall be subject to the approval of the Contracting Officer. Shearing shall be accurately done, and all portions of work neatly finished. Steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a smooth surface free from cracks and notches is secured. Surfaces and edges to be welded shall be prepared in accordance with Section 3 of AWS D1.1. Chipping and/or grinding will not be required except where specified and as necessary to remove slag and sharp edges of technically guided or hand-guided cuts not exposed to view. Visible or exposed hand-guided cuts shall be chipped, ground, or machined to metal free of voids, discontinuities, and foreign materials.

2.2.4 Alignment of Wetted Surfaces

Exercise care to ensure that the correct alignment of wetted surfaces being joined by a flanged joint is being obtained. Where plates of the water passage change thickness, a transition shall occur on the outer surface, leaving the inner surface properly aligned. When welding has been completed and welds have been cleaned, but prior to stress relieving, joining of plates shall be carefully checked in the presence of a Government inspector for misalignment of adjoining parts.

2.3 DISCHARGE ELBOW

2.3.1 General

The installation of the discharge elbow shall be in accordance with the pump manufacturer's instructions. For purposes of performance and this specification it shall be treated as part of the pumping unit. The discharge elbow shall be of such size to accommodate the dimensions of the pump supplied in accordance with the manufacturer's requirements. It shall be permanently installed in the pump sump as shown on the drawings. The design shall be such that the pumps will be automatically and firmly connected to the discharge tube when lowered into place and shall be in accordance with the pump manufacturer's instructions. A locking device shall be provided that prohibits rotational movement of the pump within the tube. The pumps shall be easily removable for inspection or service without need to enter the pump sump. The pumps shall not require any bolts, nuts, or fasteners for connection to the discharge housing. Stiffening, guides, or other features shall be provided at the pump support to ensure concentric positioning of the pump in the discharge tube. Means shall be provided such that an effective seal is obtained between the pump and discharge tube. Power cable penetrations shall be watertight.

2.3.2 Flanged Joints

Design flanged joints to be airtight and watertight, without the use of preformed gaskets, except that the use of a gasketing compound will be permitted. Mating flanges shall be male/female rabbet type or doweled with not less than four tapered dowels equally spaced around the flange. Flanges and drill bolt holes shall be machined concentric with the centerline, having a tolerance of plus or minus 1/4 of the clearance between the bolt and the bolt hole. When fabricated from steel plate, flanges shall not be less than 1 1/2 in. thick after machining. Flange machining shall not vary more than 10 percent of the greatest flange thickness. Fabricated flanges, as a minimum, shall be constructed to the dimensions of AWWA C207, Class B. Flanges shall be connected to the column tube [and discharge elbow] with two continuous fillet welds, one at the inside diameter of flange-to-pump-tube and the other at the outside diameter of pump-tube-to-flange. Weld design is the pump manufacturer's responsibility. Mating flanges shall be machined parallel to a tolerance of 0.002 in. The machine mating flange surface shall be finished to 125 microns or better.

2.3.3 Nuts and Bolts

Nuts and bolts shall be of the hexagonal type. Bolts, including assembly, anchor, harness, and dowels, shall be 300 stainless steel. Nuts shall be bronze; washers shall be 300 series stainless steel.

2.3.4 Dissimilar Metals

When dissimilar metals are used in intimate contact, suitable protection

against galvanic corrosion shall be applied. The anodic member shall be protected by proper electrical insulation of the joint.

2.4 NAMEPLATE

The pumping unit shall be identified by means of a separate nameplate permanently affixed in a conspicuous location. The plate shall bear the manufacturer's name, model designation, serial number if applicable, and other pertinent information such as horsepower, speed, capacity, type, and direction of rotation. The plate shall be made of corrosion-resistant metal with raised or depressed lettering and a contrasting background.

2.5 INSTRUCTION PLATES

The pumping unit shall be equipped with suitably located instruction plates, including any warnings and cautions, describing any special and important procedures to be followed in starting, operating, and servicing the equipment. Plates shall be made of corrosion-resistant metal with raised or depressed lettering and a contrasting background.

PART 3 EXECUTION

3.1 INSTALLATION

Correct installation and assembly of the pumping unit shall be the Contractor's responsibility and shall be in accordance with the drawings and with the manufacturer's installation and erection instructions. The Contractor shall furnish all bolts, shims, tools, and other devices necessary for installing the pumping units. The manufacturer's representative(s) familiar with the equipment being installed shall supervise the handling, installation, start-up, and testing of the equipment as required in the paragraph INSTALLATION AND START-UP ENGINEER.

3.2 CLEANUP PRIOR TO START

After the pumping unit is installed and prior to start-up, complete clean up of the sump area of any accumulated construction debris shall be done. This final cleaning of the sump area will be witnessed by a representative of the Government. Any damage to the pumping units or related equipment during initial start-up due to foreign objects left in the sump areas shall be corrected at the Contractor's expense.

3.3 PUMP FIELD TESTS

Field testing shall be conducted by an experienced field test engineer and will be witnessed by the Contracting Officer. Before initially energizing the pump/motors, the Contractor shall have successfully tested all pumping plant control, monitoring, and protective circuits. This thorough electrical checkout procedure shall have followed a detailed step-by-step approved test plan. The motor and other pumping unit elements undergoing tests should also be checked at this time.

3.3.1 Dry Test

Each pumping unit shall be tested in the dry in accordance with the pump manufacturer's instructions to determine whether it has been properly installed. Such tests shall be made when, and as, directed by the Contracting Officer. The pump shall be operated at full rated speed for 2 periods of 2 minutes each, or as otherwise recommended by the pump

manufacturer. During the tests, the operation of the pumping units shall be observed carefully and measurement of vibration and motor-bearing temperatures recorded. Vibration limits shall not exceed those recommended by HI 2.1-2.5. Without additional cost to the Government, the Contractor shall make all changes and correct any errors for which the Contractor is responsible.

3.3.2 Wet Test

Each unit shall be given an operating test under load for a period of at least 4 hours or as directed by the Contracting Officer. The tests shall be conducted by the Contractor and will be witnessed by the Government. During the tests, the operation of the pumping units shall be observed carefully and measurement of vibration and motor-bearing temperatures recorded. Vibration limits shall not exceed those recommended by HI 2.1-2.5.

Without additional cost to the Government, the Contractor shall make all changes and correct any errors for which the Contractor is responsible. Should there be insufficient water to perform the testing, the Contracting Officer may as an option, waive such testing.

3.3.3 Field Test Report

A test report of the field testing shall be prepared and submitted in accordance with paragraph SUBMITTALS.

3.3.4 Pump Removal

The Contractor shall demonstrate the removal and installation procedures of the submersible pump by removing and then reinstalling at least 1 submersible pump and 1 sump pump at each pump station utilizing the electric overhead monorail hoist.

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SECTION 15200

PUMP DISCHARGE PIPELINES

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997aef) Carbon Structural Steel
ASTM A 47M	(1999) Ferritic Malleable Iron Castings (Metric)
ASTM A 167	(1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 181/A 181M	(1995b) Carbon Steel Forgings, for General-Purpose Piping
ASTM A 183	(1983; R 1998) Carbon Steel Track Bolts and Nuts
ASTM A 307	(1997) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 576	(1990b; R 1995) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM D 1248	(1998) Polyethylene Plastics Molding and Extrusion Materials
ASTM D 3892	(1993) Packaging/Packing of Plastics
ASTM E 814	(1997) Fire Tests of Through-Penetration Fire Stops
ASTM F 402	(1993) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

ASME INTERNATIONAL (ASME)

ASME B16.1	(1989) Cast Iron Pipe Flanges and Flanged Fittings
ASME B31.1	(1998) Power Piping

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ASME B31.3 (1999) Process Piping

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104 (1995) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C105 (1993) Polyethylene Encasement for Ductile-Iron Pipe Systems

AWWA C110 (1993) Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (75 mm Through 1200 mm), for Water and Other Liquids

AWWA C111 (1995) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C115 (1996) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges

AWWA C150 (1996) Thickness Design of Ductile-Iron Pipe

AWWA C151 (1996) Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids

AWWA C153 (1994; Errata Nov 1996) Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm Through 610 mm) and 54 In. Through 64 In. (1,400 mm Through 1,600 mm) for Water Service

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 Occupational Safety and Health Standards

DUCTILE IRON PIPE RESEARCH ASSOCIATION (DIPRA)

DIPRA-Restraint Design (1997) Thrust Restraint Design for Ductile Iron Pipe

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

MSS SP-25 (1998) Standard Marking System for Valves, Fittings, Flanges and Unions

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (1996) Pipe Hangers and Supports - Selection and Application

MSS SP-89 (1998) Pipe Hangers and Supports - Fabrication and Installation Practices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

Grand Forks Phase 1 Levees

NFPA 49	(1994) Hazardous Chemicals Data
NFPA 325-1	(1994) Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids
NFPA 704	(1996) Identification of the Fire Hazards of Materials for Emergency Response

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE 3	(1994) Commercial Blast Cleaning
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1.2 SYSTEM DESCRIPTION

This specification covers the requirements for above and below grade discharge piping for all pumps in the project, pipe supports, fittings, equipment and accessories located both inside and outside of pump stations.

1.2.1 Design Requirements

Support systems shall be selected and designed within the specified spans and component requirements. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout facility.

1.2.2 Performance Requirements

The pressure ratings and materials specified represent minimum acceptable standards for piping systems. The piping systems shall be suitable for the services specified and intended. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

1.2.2.1 Buried Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.

1.2.2.2 Above Grade Piping Systems

Piping systems shall be suitable for design conditions, considering the piping both with and without internal pressure, and installation factors such as insulation, support spans, and ambient temperatures. Consideration shall be given to all operating and service conditions both internal and external to the piping systems.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Qualifications; GA

A statement certifying that the Contractor has the specified experience.

Welders; FIO

The names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc.

Waste Water Disposal; FIO

The method proposed for disposal of waste water from hydrostatic tests and disinfection, and all required permits, prior to performing hydrostatic tests.

Assistance and Training; FIO

A signed statement certifying that the installation is satisfactory and in accordance with the contract drawings and specifications and the manufacturer's prescribed procedures and techniques, upon completion of the project and before final acceptance.

Delivery, Storage and Handling; FIO

Material safety data sheets.

Materials and Equipment; GA

Manufacturer's descriptive and technical literature for each piping system, including design recommendations; pressure and temperature ratings; dimensions, type, grade and strength of pipe and fittings; thermal characteristics (coefficient of expansion and thermal conductivity); and chemical resistance to each chemical and chemical mixture in the liquid stream.

Installation; FIO

The manufacturer's installation recommendations or instructions for each material or procedure to be utilized, including materials preparation.

Pipe Schedule; FIO

A list of piping systems, pressure ratings and source of supply for each piping system broken out by material, size and application as indicated on the contract drawings. A list of any special tools necessary for each piping system and appurtenances furnished for adjustment, operation, maintenance and disassembly of the system.

Valve Schedule; FIO

A list of valve materials, pressure ratings, source of supply, and reference identification as indicated in the contract drawings. A list of any special tools necessary for each valve type and appurtenances furnished for adjustment, operation, maintenance and disassembly.

SD-04 Drawings

Pipe and Equipment; GA

Equipment shop drawings and support system detail drawings showing piping systems and appurtenances, such as mechanical joints, valves, local indicators and hangers, including a complete list of equipment and materials. As-built drawings showing pipe anchors and guides, and layout of piping systems relative to other parts of the work including clearances for maintenance and operation. As-built piping and instrumentation diagrams (P&IDs) identifying and labeling equipment, instrumentation, valves, vents, drains, and all other inline devices; if the contract drawings contained P&IDs, the P&IDs found in the contract drawings shall be revised to reflect the constructed process system, as directed by the Contracting Office .

1.4 QUALIFICATIONS

1.4.1 Contractor

Contractor shall have successfully completed at least [3 projects of the same scope and size or larger within the last [6 years. Contractor shall demonstrate specific experience in regard to the system installation to be performed.

1.5 GENERAL JOB REQUIREMENTS

Piping materials and appurtenances shall be as specified and as shown on the drawings, and shall be suitable for the service intended. Piping materials, appurtenances and equipment supplied as part of this contract shall be new and unused except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the piping systems are indicated by service in the Pipe Schedule.

1.5.1 Components

Piping equipment and appurtenances shall be new products of equal material and ratings as the connecting pipe.

1.5.2 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacturing of the products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Nominal sizes for standardized products shall be used. Pipe, valves, fittings and appurtenances shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

1.5.3 Identification

Each piece of pipe shall bear the ASTM designation and all other markings required for that designation. Valves shall bear a securely attached tag with the manufacturer's name, valve model number, and valve identification permanently displayed and be marked in accordance with MSS SP-25.

1.6 DELIVERY, STORAGE AND HANDLING

Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense. During installation, piping shall be capped to keep out dirt and other foreign matter. A material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical delivered for use in pipe installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling shall be in accordance with ASTM F 402. Storage facilities shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325-1. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendation. Plastic pipe shall be packed, packaged and marked in accordance with ASTM D 3892.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Verification of Dimensions

After becoming familiar with all details of the work, the Contractor shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

1.8 SEQUENCING AND SCHEDULING

For slab, floor, wall, and roof penetrations, the Contractor shall have onsite pertinent wall pipes and sleeves before they are required for placement in concrete forms. The Contractor shall verify and coordinate the size and location of building and structure pipe penetrations before forming and placing concrete.

PART 2 PRODUCTS

2.1 DUCTILE IRON PIPING SYSTEM

All pump discharge piping located inside the pump stations shall be ductile iron pipe with flanged joints. All pump discharge piping located outside the pump stations shall be ductile iron pipe with restrained mechanical joint fittings.

2.1.1 Ductile Iron Pipe

Ductile iron pipe for pressure service shall have a design and wall thickness conforming to AWWA C150, AWWA C151, and AWWA C115. Ductile iron pipe shall have a standard double thickness cement lining conforming to AWWA C104 standard asphaltic lining.

2.1.2 Ductile Iron Joints

Joints shall have a working pressure rating for liquids equal to the pressure rating of the connected pipe. Mechanical joints conforming to AWWA C110 and AWWA C111 and flanged joints conforming to AWWA C110 shall be used. Gaskets, glands, bolts and nuts shall be furnished with mechanical joints; bolts and nuts shall be provided with flanged joints; in sufficient

quantity for the complete assembly of each joint. Dielectric fittings or isolation joints shall be provided between all dissimilar metals.

2.1.2.1 Mechanical Joints

Glands shall be ductile iron with an asphaltic coating. Gaskets shall be vulcanized synthetic rubber, reclaimed rubber is not acceptable. Nitrile nuts shall be heat treated carbon steel, ASTM A 183, minimum tensile 110,000 psi. Mechanical joints shall have bolt holes oriented straddling the vertical centerline of the valves and fittings.

2.1.3 Ductile Iron Fittings

Fittings shall be ductile iron AWWA C110 or AWWA C153. Up to 12 inches inclusive, the fittings shall be 150 psig rated. Flanges and flanged fittings shall conform to AWWA C110 ASME B16.1 and shall be rated for 150 psig service. Materials shall be ductile iron. Bolts and nuts shall be carbon steel conforming to ASTM A 307, Grade B. Bolts shall be provided with washers of the same material as the bolts. Gaskets shall be rubber ring full face, maximum 0.125 in thick.

2.1.4 Corrosion Control

All underground ductile iron piping shall be protected from corrosion with polyethylene tubing in accordance with AWWA C105. Polyethylene tubing shall conform to the requirements of ASTM D 1248. The nominal thickness shall be 0.004 inch for high-density cross-laminated polyethylene film. Installation shall be in accordance with AWWA C105.

2.2 ISOLATION JOINTS AND COUPLINGS

2.2.1 Isolation Joints

Isolation joints shall be provided between nonthreaded ferrous and nonferrous metallic pipe fittings and valves. Isolation joints shall consist of an isolation gasket of the dielectric type, isolation washers and isolation sleeves for flange bolts. Isolation gaskets shall be full faced with an outside diameter equal to the flange outside diameter. Bolt isolation sleeves shall be full length. Units shall be of a shape to prevent metal-to-metal contact of dissimilar metallic piping elements.

2.2.2 Metallic Piping Couplings

Thrust ties shall be provided where shown on the contract drawings and where required to restrain the force developed by 1.5 times the maximum allowable operating pressures specified. For metallic pipe other than ductile iron, thrust ties shall be attached with fabricated lugs. For ductile iron pipe, thrust ties shall be attached with socket clamps against a grooved joint coupling or flange. For exposed installations, zinc-plated nuts and bolts shall be used. However, high-strength, low-alloy steel, in accordance with AWWA C111, may be substituted for use on cast iron and ductile iron couplings. For buried and submerged installations, TP304 stainless steel bolts and nuts shall be provided. Steel middle rings and followers shall be fusion bonded epoxy-lined and coated in accordance with Section 09900 PAINTING, GENERAL and pressure tested beyond yield point.

2.3 PIPE SUPPORTS AND PENETRATIONS

Auxiliary steel shall be provided by the Contractor where the support of

piping systems and equipment is required between building structural elements. Light gauge and structural steel shapes shall conform to the requirements of ASTM A 36/A 36M. The Contractor shall have the option to use pre-engineered support systems of electrogalvanized steel products. However, a mixture of support system manufacturers products is not permitted. Where auxiliary steel is indicated as stainless steel, the Contractor shall provide TP304 stainless steel conforming to ASTM A 167, No. 1 Finish.

2.3.1 Pipe Supports

Pipe supports shall conform to the requirements of MSS SP-58, MSS SP-69, and MSS SP-89. Where pipe supports contact bare piping or in-line devices, provide supports of compatible material so that neither shall have a deteriorating action on the other.

2.3.1.1 Beam Clamps

For upper attachments on structural steel, the Contractor shall provide beam clamps of ASTM A 36/A 36M carbon steel or ASTM A 181/A 181M forged steel and MSS SP-58 Types 19 through 23, 25 or 27 through 30. Holes drilled in structural steel for hanger support rods will not be permitted. Clamps shall be provided with hardened steel cup-point set screws and lock-nuts for anchoring in place. Clamp size selection shall only be based on the support of the required load.

2.3.1.2 Riser Clamps

Vertical runs of piping shall be supported at each floor, or closer where required, with ASTM A 36/A 36M carbon steel clamps bolted around pipes and attached to the building construction. Copper plated clamps shall be provided for copper tubing support. Two bolt-type clamps designed for installation under insulation shall be used on insulated pipe runs.

2.3.1.3 Brackets

Where piping is run adjacent to walls or steel columns, the Contractor shall provide welded ASTM A 36/A 36M steel brackets, pre-punched with a minimum of two fastener holes.

2.3.1.4 Offset Pipe Clamp

Where pipes are indicated as offset from wall surfaces, a double-leg design two-piece pipe clamp shall be supplied by the Contractor.

2.3.1.5 Hangers

Hangers shall be fabricated of malleable iron, ASTM A 47M or ASTM A 36/A 36M carbon steel. All hangers shall be of a uniform type and material for a given pipe run and application. Coated or plated hangers shall be used to isolate steel hangers from dissimilar metal tube or pipe. Hangers for pipe sizes 2.5 inches or larger shall incorporate a means of vertical adjustment after erection while supporting the load. For piping systems with liquid temperatures up to 122 degrees F the following shall be used: MSS SP-58 Types 1,3 through 12, Types 24 and 26 with overhead support, or Types 35 through 38 with support from below.

2.3.1.6 Hanger Rods

Hanger rods shall be carbon steel conforming to ASTM A 576. The diameter of the rods for piping system support shall conform to ASME B31.1.

2.3.2 Pipe Guides

2.3.2.1 Intermediate Guides

For piping 6 inch and smaller, a pipe clamp with an oversize pipe sleeve shall be provided for a minimum 0.16 inch clearance. For piping 8 inch and larger, U-bolts with double nuts that are manufactured for the purpose shall be used to provide a minimum 0.28 inch clearance around pipe. The stock sizes for the U-bolts are as follows: for a 8 inch pipe use a 0.625 inch U-bolt; for a 10 inch pipe, use a 0.75 inch U-bolt; for a 12 inch to 16 inch pipe, use a 0.875 inch U-bolt; and for 18 inch to 30 inch pipes use 1 inch U-bolts.

2.3.2.2 Alignment Guides

For piping, 8 inch and smaller, alignment guides shall be galvanized steel, spider or sleeve type. For piping, 10 inch and larger, alignment guides shall be galvanized steel, roller type guides.

2.3.3 Flashing Sleeves

Galvanized steel flashing sleeves shall be installed wherever piping passes through concrete roof structures. Where piping penetrates roofs, 4 lb. lead flashing shall be provided. The flashing shall extend 8 inches from the pipe in all directions, extend up the pipe, and shall be fitted with double-threaded flashing for pipes 3 inches and smaller. Flashing shall turn down inside the pipe for 4 inches and larger pipes.

2.3.4 Wall Penetrations

2.3.4.1 Above Grade Wall Penetrations

Piping which passes through fire-rated or smoke-rated walls, floors, or ceilings shall be provided with insulated and encased pipe sleeves. Penetrations through an existing fire or fire barrier wall shall be sealed with a fire stop system that has an "F" rating not less than the required fire resistance rating of the penetrated wall. The fire stopping sealant for metal piping systems shall be a water based vibration resistant, polysiloxane (also known as silicone) based, nonslumping, premixed sealant with intumescent properties, that is rated for 3 hours pursuant to ASTM E 814 and UL requirements. The fire stopping sealant for plastic and insulated piping systems shall be a polysiloxane (also known as silicone) based, nonslumping, premixed sealant with intumescent properties acrylic based, nonslumping, premixed sealant with intumescent properties, that is vibration and moisture resistant, and is rated for 3 hours pursuant to ASTM E 814 and UL requirements with metal collars. Vented plastic pipe penetrations shall be fitted with galvanized steel collars that have intumescent inlays.

2.3.4.2 Below Grade Wall Penetrations

Below-grade wall penetrations shall be provided with hydrostatic seals designed to seal opening between pipe or conduit and a through-structure opening. The seals shall be modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

Pipe and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

3.1.2 System Preparation

3.1.2.1 Pipe and Fittings

Pipe and fittings shall be inspected before exposed piping is installed or buried piping is lowered into the trench. The Contractor shall clean the ends of pipes thoroughly, remove foreign matter and dirt from inside of pipes, and keep piping clean during and after laying.

3.1.2.2 Damaged Coatings

The Contractor shall repair damaged coating areas in the field with material equal to the original coating, except for damaged glass-lined pipe which shall be promptly removed from the site. The Contractor shall not install damaged piping materials.

3.1.2.3 Field Fabrication

The Contractor shall notify the Contracting Officer at least 2 weeks prior to the field fabrication of pipe or fittings and at least 3 days prior to the start of any surface preparation or coating application work. Fabrication of fittings shall be performed in accordance with the manufacturer's instructions.

3.2 EXPOSED PIPING INSTALLATION

Exposed piping shall be run as straight as practical along the alignment shown on the contract drawings and with a minimum of joints. Piping and appurtenances shall be installed in conformance with reviewed shop drawings, manufacturer's instructions and ASME B31.3. Piping shall be installed without springing or forcing the pipe.

3.2.1 Anchors and Fasteners

Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.

3.2.2 Pipe Flanges

Pipe flanges shall be set level, plumb, and aligned. Flanged fittings shall be installed true and perpendicular to the axis of the pipe. The bolt holes shall be concentric to the centerline of the pipe and shall straddle the vertical centerline of the pipe.

3.3 BURIED PIPE PLACEMENT

3.3.1 Excavation and Backfilling

Earthwork shall be performed as specified in Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Backfilling shall be accomplished after inspection by the Contracting Officer. The Contractor shall exercise care when lowering pipe into the trench to prevent damage or twisting of the pipe.

3.3.2 Fittings

At valves and connections, the trench bottom shall be dug out with sufficient length, width, and depth to ensure clearance between the undisturbed trench bottom and the valves and such connections.

3.3.3 Restrained Joints

For ductile iron pipe, restrained joints shall be designed by the Contractor or the pipe manufacturer in accordance with DIPRA-Restraint Design.

3.3.4 Marking Tape

Pipe marking tape shall be provided and installed in accordance with the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.4 CONNECTING DISSIMILAR PIPE

Flexible transition couplings, dielectric fittings and isolation joints shall be installed in accordance with the manufacturer's instructions.

3.5 EXTERNAL CORROSION PROTECTION

Protect all pipe and piping accessories from corrosion and adverse environmental conditions.

3.5.1 Underground Metallic Piping

Buried metallic piping shall be protected from corrosion using polyethylene tubing. Where dissimilar metals are joined underground, gas-tight isolation joints shall be used. Insulating joint material shall be provided where shown to control galvanic or electrical action.

3.5.2 Above Grade Metallic Piping

Nonferrous and stainless steel piping shall not be painted except for aluminum alloy piping. Where dissimilar metals are joined, isolation joints shall be used.

3.5.2.1 Ferrous Piping

Shop primed surfaces shall be touched up with ferrous metal primer. Surfaces that have not been shop primed shall be solvent cleaned. Surfaces that contain loose rust, mill scale or other foreign substances shall be mechanically cleaned by commercial sand blasting conforming to SSPC SP 6/NACE 3 and primed with a ferrous metal primer. Primed surfaces shall be finished with two coats of exterior oil paint in accordance with Section 09900 PAINTING, GENERAL.

3.6 FLEXIBLE JOINTS AT CONCRETE STRUCTURES

Flexible joints shall be provided at the face of all structures, whether or not shown on the contract drawings. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints shall be considered flexible joints; welded pipe joints shall not. Joints may be flush with the structure face or may be located up to 1 pipe diameter away from face, but not further than 17.7 inches away from face. For pipelines larger than 18 inches in diameter the first joint shall be within 1 pipe diameter.

3.7 PENETRATIONS

Cast iron wall sleeves shall be provided at all above grade and below grade pipe penetrations. Embedded metallic piping shall be isolated from concrete reinforcement using coated pipe penetrations. Coatings shall be as specified in Section 09900 PAINTING, GENERAL. Wall pipes shall be securely supported by form work to prevent contact with reinforcing steel and tie-wires. Joints shall be sealed with a wall penetration seal.

3.8 PIPING SUPPORT SYSTEMS INSTALLATION

The absence of pipe supports and details on the contract drawings shall not relieve the Contractor of responsibility for sizing and providing supports throughout plant.

3.8.1 General Support Requirements

Pipe support systems shall meet the requirements of MSS SP-58. Contractor-designed and selected support systems shall be installed in accordance with MSS SP-69, and as specified herein. Piping connections to equipment shall be supported by pipe supports and not off the equipment. Large or heavy valves, fittings, and/or equipment shall be supported independently of associated piping. Pipes shall not be supported off other pipes. Supports shall be provided at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the contract drawings. Pipe supports and hangers shall not be installed in equipment access areas or bridge crane runs. Hanging pipes shall be braced against horizontal movement by both longitudinal and lateral sway bracing. At each channel type support, every pipe shall be provided with an intermediate pipe guide, except where pipe anchors are required. Existing support systems may be used to support additional new piping only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads. Pedestal type pipe supports shall be provided under base flanges adjacent to rotating equipment and where required to isolate vibration. Piping 2.5 inches in diameter and larger shall be braced for seismic forces. Lateral supports for seismic loads shall be installed at all changes in direction.

3.8.2 Dielectric Barriers

Dielectric barriers shall be installed between supports and copper or stainless steel piping, and between stainless steel supports and non-stainless steel ferrous piping.

3.9 FIELD QUALITY CONTROL

3.9.1 Piping

3.9.1.1 Buried Piping

After the pipe is laid, the joints completed and the trench partially backfilled leaving the joints exposed for examination, the newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for 1 hour to a hydrostatic test pressure of 1.5 times the design operating pressure. Each valve shall be opened and closed several times during the test. Exposed pipe, joints, fittings, and valves shall be carefully examined during the partially open trench test. Joints showing visible leakage shall be replaced as necessary. Defective pipe, joints, fittings, and valves found during the pressure test shall be removed and replaced with new material, and the test repeated until the test results are satisfactory. The requirement for the joints to remain exposed for the hydrostatic tests may be waived by the Contracting Officer when one or more of the following conditions are encountered: (1) wet or unstable soil conditions in the trench; (2) compliance would require maintaining barricades and walkways around and across an open trench in a heavily used area that would require continuous surveillance to assure safe conditions; or (3) maintaining the trench in an open condition would delay completion of the Contract. The Contractor may request a waiver, setting forth in writing the reasons for the request and stating the alternative procedure proposed to comply with the hydrostatic tests. Backfill placed prior to the tests shall be placed in accordance with the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS.

3.9.1.2 Exposed Piping

Hydrostatic testing shall be conducted in accordance with ASME B31.3. Piping systems shall be tested under normal service conditions to demonstrate compliance. The test pressure shall not be less than 1.5 times the design pressure. Water shall be used as the hydrostatic test fluid. The Contractor shall provide clean test water of such quality to prevent corrosion of the piping system materials. Air release vents shall be opened at all high points of the piping system in order to purge air pockets while the piping system is filling.

- a. For rigid piping hydrostatic testing, the maximum test pressure shall be calculated according to ASME B31.3, but shall not exceed the yield strength of the piping system. The maximum velocity during filling shall be 0.25 fps applied over full area of pipe in accordance with the manufacturer's instructions. Venting during filling may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents. The Contractor shall test all parts of the piping system. The hydrostatic test pressure shall be maintained continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage. All joints and connections shall be examined by the Contractor for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking. The Contractor shall correct visible leakage and retest. Unless otherwise directed by the Contracting Officer, the piping system shall be left full of water after leaks are repaired.

3.9.1.3 Time for Making Test

Except for joint material setting or where concrete thrust blocks necessitate a delay, underground piping jointed with rubber gaskets,

mechanical or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill. Tests for above ground pressure piping shall be conducted after the piping has been completely installed, including all supports, hangers, and anchors, and inspected for proper installation but prior to installation of insulation.

3.10 FINAL CLEANING

3.10.1 Interim Cleaning

The Contractor shall prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication. The piping shall be examined to assure removal of these and other foreign objects prior to assembly and installation.

3.10.2 Flushing

Following assembly and testing, and prior to final acceptance, piping systems shall be flushed with water to remove accumulated construction debris and other foreign matter. The piping shall be flushed until all foreign matter is removed from the pipeline. The Contractor shall provide all hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties. The minimum flushing velocity shall be 2.5 fps. For large diameter pipe where it is impractical to flush the pipe at the minimum flushing velocity, the pipeline shall be cleaned in-place from the inside by brushing and sweeping, then flushing the pipeline at a lower velocity. Cone strainers shall be installed in the flushing connections of attached equipment and left in place until cleaning is completed. Accumulated debris shall be removed through drains, or by removing spools or valves.

3.11 WASTE WATER DISPOSAL

The water used for testing, cleaning, flushing and/or disinfection shall be disposed of in accordance with all applicable regulations. Disposal is solely the responsibility of the Contractor. The method proposed for disposal of waste water shall be provided to, and approved by, the Contracting Officer prior to performing any testing, cleaning, flushing and disinfection activities.

-- End of Section --

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SECTION 15400

PLUMBING

PART 1 GENERAL

1.1 SCOPE

Applicable provisions of Division 1 shall govern work under this section. The Contractor shall provide all items, articles, materials, operations or methods listed, mentioned or scheduled on the drawings and/or herein specified, including all materials, equipment, and incidentals necessary to produce a complete and operating system.

1.2 DESCRIPTION OF THE SYSTEM

Provide fixtures, specialties, equipment and all related piping as shown on floor plans, scheduled, and/or specified for a complete working system.

Provide all necessary sanitary waste, vent, and water piping, and ventilating as shown on floor plans, scheduled, and/or specified for a complete working system.

Provide electric water heater as shown on floor plans, schedule and/or specified.

Provide all sanitary waste and vent piping as shown from a point 5 feet outside building wall to all fixtures and/or appliances. Coordinate location and invert on sanitary sewer connection point to sewer line 5 feet outside building wall before proceeding with any work.

Provide all water piping as shown from a point 5 feet outside building wall to all fixtures and/or appliances.

All water piping shall be installed with pitch for seasonal drainage. This building is or seasonal use.

Contractor to properly instruct the Contracting Officer's Representative in the winterizing of the plumbing systems which includes the draining down water piping and removing water in service to meter, drainage of storage tank, and using RV anti-freeze. Winterize all traps by water removal and filling with RV anti-freeze.

1.3 REFERENCES

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

AMERICAN SOCIETY OF SANITARY ENGINEERING FOR PLUMBING AND SANITARY RESEARCH (ASSE)

ASSE 1052

(1993) Hose Connection Backflow Preventers

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53/A 53M	(2000) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B 32	(1996) Solder Metal
ASTM B 42	(1998) Seamless Copper Pipe, Standard Sizes
ASTM B 88	(1999) Seamless Copper Water Tube
ASTM D 321	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 2564	(1996a) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2665	(1998) Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D 2855	(1996) Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3034	(1998) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

ASME INTERNATIONAL (ASME)

ASME B16.18	(1984; R 1994) Cast Copper Alloy Solder Joint Pressure Fittings
ASME B16.22	(1995; B16.22a1998) Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.23	(1992; Errata Jan 1994) Cast Copper Alloy Solder Joint Drainage Fittings - DWV
ASME B16.26	(1988) Cast Copper Alloy Pip Flanges, Class 150, 300, 400, 600, 900, 1500, and 2500, and Flanged Fittings, Class 150 and 300
ASME B16.29	(1994) Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(1997) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(1997) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

ENGINEERING MANUALS (EM)

EM 385-1-1

(1996) U.S. Army Corps of Engineers Safety
and Health Requirements Manual

UNDERWRITERS LABORATORIES (UL)

UL 723

(1996; Rev thru Dec 1998) Test for Surface
Burning Characteristics of Building
Material

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Shop Drawings; GA.

Shop drawings shall contain complete dimensional, operational, material quality and manufacturer information on all fixture, specialty and equipment items. The Contractor shall be responsible for transmitting copies of the approved shop drawings to the other affected trades. Shop drawings are required on the following items:

- a. Fixtures and Trim
- b. Drains and Cleanouts
- c. Valves
- d. Water Heater EWH-1
- e. Storage Tank ST-1

1.5 GENERAL PROVISIONS

1.5.1 Drawings

Plans of piping and fixtures shown on scale drawings, are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction and approximate general arrangement of one phase of work to another, but not to the exact detail or arrangement of construction. Plans are based on equipment scheduled. Contractor shall be responsible for changes resulting from equipment other than scheduled.

If it is found before installation, that a more convenient, suitable or workable arrangement for any or all phases of the project would result by varying or altering the arrangement indicated on the drawings, Contractor may change the location or arrangement of his work without additional cost to the Government but only after obtaining a written approval by the Contracting Officer.

Mechanical systems are shown on drawings that were closely coordinated with the Architectural drawings, however, minor variations may occur. Contractor shall verify dimensions, heights, door swings, and any other information critical to the placement of devices, with the architectural drawings to

assure proper installation. Field measurements shall take precedence over drawing dimensions and shall be verified. Plans shall not be scaled to locate equipment.

All plumbing piping installations shall closely match the drawings as approved by the current North Dakota Plumbing Code. Any variation from or additions to the piping arrangement will require a revision or resubmittal to the Contracting Officer at the Contractor's expense.

1.5.2 Materials

Each major component of the equipment shall have the manufacturer's name, address, catalog and serial number permanently attached in a conspicuous place.

The same brand or manufacturer shall be used for each specific application of fixtures, pumps, valves, fittings, controls and other equipment.

All materials shall be new and of the quality specified and meet approval as per current North Dakota Plumbing Code.

All equipment shall be listed, approved or rated by a nationally recognized testing and rating bureau or the recognized manufacturers association responsible for setting industry standards. All electrical equipment and apparatus shall be U.L. listed. Examples of recognized associations are:

- American Concrete Pipe Association
- American Pipe Fitting Institute
- American Water Works Association
- Plastic Pipe Institute
- Thermal Insulation Manufacturers Association

1.5.3 Equipment Substitutions

It is the intent of this specification to permit the use of the materials of any nationally recognized manufacturer so long as they are fully equal to the quality and performance of the named item in the opinion of the Contracting Officer. Materials or equipment of other manufacturers may be used upon the following conditions:

- a. The proposed substitute is equal in design, materials, construction and performance in the opinion of the Contracting Officer. No compromise in quality level will be allowed.
- b. The service capabilities, availability of service parts and stability of the manufacturer are adequate in the opinion of the Contracting Officer.
- c. The Contractor assumes responsibility for any modifications required for the installation of substitute equipment.
- d. Substitute equipment shall fit into the space provided with adequate provisions for service and maintenance and must meet product approval as per current North Dakota Plumbing Code. Any substitute equipment that causes variation of or deviation from original piping arrangement may require a revision to be submitted to the Contracting Officer at the Contractor's expense.

1.5.3.1 Approval of Substitutions

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Approval of materials and equipment will be by review and approval of project shop drawings.

PART 2 PRODUCTS

2.1 PIPING SYSTEMS

2.1.1 Exterior Water

Type "K" soft temper copper pipe with a working pressure of 150 psig at 73.4° F. and in accordance with ASTM B 42 and ASTM B 88 standards.

2.1.1.1 Fittings

Wrot copper solder joint fittings in accordance with ASME B16.22 and ASME B16.29.

Cast copper alloy solder joint fittings in accordance with ASME B16.18; ASME B16.23; and ASME B16.26.

2.1.1.2 Soldered Joints

Clean all surfaces per manufacturers installation recommendations. Apply non-toxic flux to all joint surfaces. Jointing shall be made with lead-free solder conforming to ASTM B 32.

2.1.1.3 Pipe and Fittings

All pipe and fittings shall be installed per manufacturer's recommendations.

2.1.1.4 Valves for Water Service

Valves for water service shall have ends suited for proper installation in piping. Valves shall meet local standards or, in absence of such standards, the requirements below.

- a. Curb stop (3/4 inch thru 2 inch size) Minneapolis pattern H-15150 or H-15250 equal to Mueller Co. or McDonald.
- b. Curb Box. Minneapolis pattern base, cast iron extension type, 1 foot telescope length, 7 foot length minimum, cast iron lid with plug.

2.1.1.5 Blow Out Tee

Provide and install curb box with water line blow out tee in main service to building.

2.1.2 Interior Water

2.1.2.1 Piping Below Floor Slab

Type "K" soft temper copper with wrot copper solder joint fittings and jointing material shall be lead free solder and non-toxic flux.

2.1.2.2 Piping Above Floor

Type "L" hard tempered copper with wrot copper solder joint fittings and jointing material shall be lead free solder and non-toxic flux.

2.1.3 Exterior Sanitary Building Sewer

PVC Pipe, ASTM D 3034, with rubber gasket joints, ASTM D 3212. Schedule 40 PVC, ASTM D 2665, with solvent cement joints, ASTM D 2564. Fittings required shall meet specifications for respective piping. Provide cleanouts as required per current North Dakota Plumbing Code.

2.1.4 Frost Protection - Sanitary Sewers

Piping shall be protected per current North Dakota Plumbing Code. The insulation shall be built up with 1 inch extruded polystyrene insulation to required thickness with staggered joints.

2.1.5 Interior Sanitary and Vent

- a. Cast iron no-hub pipe (CISPI 301) with mechanical sleeve joints (CISPI 310). Tyler pipe and fittings.
- b. Galvanized steel pipe, above ground only, (ASTM A 53/A 53M) with screwed or cast iron drainage pattern fittings.
- c. Schedule 40 PVC pipe (ASTM D 2665) with socket solvent cemented joints (ASTM D 2855). PVC piping shall not run in air plenum ceilings, air shafts or ducts.
- d. Fittings required shall meet specifications for respective piping.
- e. Extend vents 12 inches above finished roof or above normal snow depth.
- f. Provide approved roof flashing to correspond with roof covering being installed or with existing roof covering. Verify with roof installer so as to not void warranty of roof.

2.1.6 Horizontal Soil and Storm Lines

Lines shall pitch down a minimum of 1/8 inch per foot in the direction of flow, or as indicated on the drawings. Soil and waste branch piping shall pitch down 1/4 inch per foot. All vent piping shall drip back into waste piping. Stacks shall be run vertically. Changes of direction 45° or more from vertical to horizontal shall be made with long sweep elbows. Horizontal changes in direction shall be made with "Y" or "Y" and 1/8 bend combination fitting.

2.2 PIPE HANGERS

Furnish and install suitable hangers and supports for all horizontal lines.

Hangers and supports shall be Grinnell, Mason, F&M, Michigan or equal. Heavy pipes shall be carried by pipe hangers supported by rods secured to structure. No piping shall be hung from other piping or ductwork. In no case shall hangers be supported by means of vertical expansion bolts.

2.2.1 Support Spacing

Piping shall be supported at distances not to exceed those specified.

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Pipe Material	Maximum Horizontal Spacing (feet)	Maximum Vertical Spacing (feet)
Acrylonitrile Butadiene Styrene (ABS)	4	10
Brass	10	10
Cast Iron	5a	15
Copper or Copper-Alloy Pipe	12	10
Copper or Copper-Alloy Tubing		
£ 1-1/4 inch diameter	6	10
³ 1-1/2 inch diameter	10	10
Chlorinated Polyvinyl Chloride (CPVC):		
£ 1 inch diameter	3	5b
³ 1-1/4 inch diameter	4	6b
Crosslinked Polyethylene (PEX)	2-2/3	4
Ductile Iron	5a	15
Galvanized Steel	12	15
Lead	Continuous	4
Polybutylene (PB)	2-2/3	4
Polyvinyl Chloride	4	10
Stainless Steel	12	15

Note A: The maximum horizontal spacing for supports may be increased to 10 feet when 10-foot lengths of pipe are employed.

Note B: Mid-story guide is to be employed.

Note C: " " means less than or equal to.
 " " means greater than or equal to.

2.3 VALVES

2.3.1 General

Provide all valves shown on the plans and as required by applicable state and local codes. Valves manufactured by Milwaukee, Nibco, Jomar, Watts or Apollo are acceptable. All valves shall be suitable for 125 psig working pressure unless otherwise specified.

2.3.2 Control Valve

A control valve for water supply piping 3/4 inches through 4 inches in diameter which serves 2 or more plumbing fixtures shall have a nominal diameter at least equal to the piping.

2.3.3 Hot and Cold Water

2.3.3.1 Ball Valves

4 inches and smaller. Two or three piece bronze body, full port, blow out proof stainless steel stem, brass ball with hard chrome plating, TFE seat rings, plated steel handle.

2.3.3.2 Check Valves

3 inches and smaller. Bronze body horizontal swing, Buna-N disc, stainless

steel pin and lever.

2.4 INSULATION

2.4.1 General

The work covered by this specification consists in furnishing all labor, equipment, accessories and materials and in performing all operations necessary for the installation of all insulation for the plumbing piping systems. Insulation shall be installed in strict accordance with the insulation section of this specification and applicable drawings, subject to the terms and conditions of the contract. All insulation shall be installed in a workmanlike manner by skilled workmen regularly engaged in this type of work. Insulation shall be Johns-Manville, Armstrong, Fiberglass, Knauph, or products of equal quality and performance.

2.4.1.1 Fire and Smoke Hazard Ratings

All insulation shall have composite (insulation, jacket, or facing, and adhesive used to adhere the facing or jacket to the insulation) fire and smoke hazard ratings as tested by procedure UL 723 not exceeding: Flame spread 25; Smoke developed 50; fuel contributed 50; UL fire hazard Classification 1. Accessories, such as adhesives, plastics, cements, taps or glass fabric for fittings shall be the same component ratings as listed above.

2.4.1.2 Thickness

Insulation thickness specified herein is based on a conductivity of 0.22 BTU/sq ft/degree F/hour at 75 degrees F mean temperature. If insulating materials with substantially different thermal properties are used the thickness of insulation shall be adjusted to provide the overall insulating efficiency of the material specified.

2.4.1.3 Vapor Seal

Insulation on all cold surfaces where vapor barrier jackets are used shall be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold surfaces must be adequately insulated and vaporsealed to prevent condensation.

2.4.1.4 Openings

All insulation shall be continuous through walls and ceiling openings and sleeves where applicable.

2.4.1.5 Preformed Pipe Insulation

Preformed pipe insulation shall be two-piece or one-piece fiberglass composite with vinyl coated embossed vapor barrier laminate and pressure sealing lap similar to Owens Corning's Fiberglass 25ASJ or Johns-Manville A.P. The insulation systems shall be suitable for piping operating between 50 degrees F to 450 degrees F. The insulation system shall be vermin-proof, rot-free, non-shrinking with a moisture absorption not exceeding 0.2 percent by volume after 96 hours at 120 degrees F and 95 percent relative humidity. Jacket permanence shall not exceed 0.2 percent perms and shall have a Beach puncture rating of at least 50 units.

2.4.1.6 Fittings, Valve Bodies, and Flanges

Fittings, valve bodies and flanges for pipe sizes 6 inch and smaller shall be finished with fiberglass inserts and PVC fitting covers. One (1) insert to be used for pipe insulation of 1 inch thickness. An additional insert to be used for each additional 1 inch or fraction thereof for pipe insulation above 1 inch thickness.

2.4.1.7 Pipe Expansion

Make adequate provisions for expansion of piping. Unions to be left uncovered and clean. Finished surfaces of insulation are to be suitable for painting.

2.4.2 Insulation Protection

2.4.2.1 High Moisture

Insulation exposed to high moisture of interior areas shall be encased with 15 mil. vinyl film.

2.4.2.2 Weather Exposure

Insulation exposed to weather shall be encased with 20 mil. vinyl film.

2.4.2.3 Joints

All joints sealed as recommended by manufacturer.

2.4.3 Domestic Water Piping

2.4.3.1 Cold Water Above Ground

Cold water above ground shall be insulated with 1 inch thick fiberglass insulation with ASJ jacket.

2.4.3.2 Hot Water Above Ground

Hot water above ground shall be insulated with 1 inch thick fiberglass for sizes through 3 inch pipe and 1-1/2 inch thick fiberglass for sizes greater than 3 inch and with ASJ jacket. See hot water maintenance systems recommendations.

2.4.3.3 Water Under Ground

Hot and cold water underground shall be insulated with 1/2 inch thick plastic foam.

2.4.3.4 Concealed Water

Hot and cold water piping concealed in walls or pipe chases may be insulated with 1/2 inch thick plastic foam.

2.4.4 Water Storage Tank

All surfaces shall be insulated with three pound density fiberglass board equal to Owens Corning #703 using 2 inch thickness. Insulation shall be cut, scored or mitered to fit the contour of equipment with edges tightly butted and secured with #18 galvanized hexagonal mesh wire and heavy coat of mineral fiber cement over insulation. Finish with 6 oz. canvas jacket

applied with suitable adhesive. This contractor shall provide insulation on equipment furnished by him only unless otherwise specified. Break insulation at access panels, handholes, equipment, joints, etc.

2.5 PLUMBING SPECIALTIES

2.5.1 Traps

Every fixture and floor drain shall be provided with a proper trap placed near the outlet and properly vented. Traps shall be cast iron hub and spigot where used in soil pipe or nohub with approved stainless steel couplings. Traps for threaded pipe shall be screwed drainage pattern cast iron "P" traps. Where approved, PVC traps with adjustable compression fittings may be used. All exposed traps for sinks, lavatories and similar fixtures shall be chrome plated "P" traps, or as specified with the fixture trim. All traps shall have a minimum seal of 2 inch.

2.5.2 Cleanouts - Floor

Based on product by Zurn. Cleanouts of equal quality by Wade, Sioux Chief, Josam or Ancon are acceptable. Cleanout shall be set flush with floor. Covers shall be round or square scoriated nickel bronze. All cleanouts shall be full size of the pipe it serves thru 6 inches and 6 inches for sizes 8 inches and larger. Zurn Z-1400NH or NL, gasketed seal - bronze or PVC plug (light to medium traffic).

2.5.3 Cleanouts - Wall Access

Based on product by Sioux Chief Products Co. Wall access plates of equal quality by J.R. Smith, Wade, Josam, Ancon, and Zurn are acceptable. Wall access covers shall be heavy duty round stainless steel for size 5-1/2 inch diameter thru 8-1/2 inch diameter and standard duty round stainless steel for diameters 10-1/2 inches and 12-1/2 inches. Each wall access cover shall be secured to wall by a tapped, behind the wall, bar and a chrome plated threaded bolt. Sioux Chief wall access covers #SS-1015 HD, SS-1016HD, SS-1018HD, SS-1010 and SS-1025.

2.5.4 Floor Drains

Provide and install floor drains where shown and size indicated on the drawings of the type listed below. Floor drains shall be set level and at the proper elevation to drain the surrounding floor area. All floor drains set in floors above habitable space shall be equipped with 4# per square foot sheet lead safing or approved vinyl type extending a minimum of 18 inches beyond rim of floor drain in all directions. Based on product by Zurn.

Ventonite, Inc. - Atlanta, Georgia.

ACD Pourable Underlayment, International, Inc. - Pittsburgh, PA

Ardex V-800, Levelcrete by Ardex, Inc. - Pittsburgh, PA

Latex Cement by Master Builders/Martin Marretta - Cleveland, OH

FD-1 Floor Drain

Zurn ZN-415 w/Type B Strainer

Cast iron body, reversible clamping collar for high or low setting, round nickel bronze adjustable strainer. Strainer diameter shall be 5" for 2" outlets, 6" for 3" outlets thru 8" for 4" outlets.

Floor Drains of equal quality by Wade, Josam, Ancon or Smith are acceptable.

2.5.5 Water Hammer Arrestors

Provide water hammer arrestors on hot and cold water piping where shown on drawings. Water hammer arrestors shall be sized and located in accord with the hydraulic design of the piping system served and to the manufacturer's recommendations. Mechanical water hammer arrestors shall be accessible. Arrestors manufactured by J.R. Smith, Wade, Josam, Zurn, Sioux Chief or Precision Plumbing Products are acceptable.

ARRESTOR SIZING TABLE

P.D. I. Units	Fixture Units	Plan Symbol
A	1-11	"A"
B	12-32	"B"
C	33-60	"C"
D	61-113	"D"
E	114-154	"E"
F	155-330	"F"

2.5.6 WH-1 Wall Hydrants

Provide and install where shown on the drawings Woodford Model #67 automatic draining freezeless wall hydrant with chrome plated finish, removable "T" handle key, vacuum breaker and anti-siphonage outlet (ASSE #1052). Seal hole through all around hydrant with grout or caulking to make water tight and air tight. Provide stop and waste valves in lines preceding all hydrants. Wall hydrants equal in quality by J.R. Smith, Josam, Wade or Zurn are acceptable.

2.5.7 Thermometers

Provide thermometers in water systems for monitoring system. Thermometers shall be industrial grade with 9 inch aluminum case, black finish, aluminum stems, 2-1/2 inch insertion, clear acrylic window, red indicator on white scale, and brass well socket. Thermometers shall be adjustable type with range as best suited to application. Mount thermometers in a position so as to be visible from a convenient floor location. Instruments shall be Trerice Series A005. Enrst Gauge Co. or Crosby are acceptable. Provide thermometers in the following locations:

- a. Water heaters in hot building supply.

2.5.8 HB-1 Hose Bibb

Woodford Model 26, 3/4 inch chrome plated brass faucet with loose key handle and vacuum breaker (ASSE 1052) with 3/4 inch male hose thread, or equal product.

2.6 EQUIPMENT

2.6.1 Electric Water Heaters

See Schedule for size and characteristics. Heaters shall be glass lined steel, tested under 125 psi hydrostatic pressure prior to lining, and provided with anodic protection, external drain valve and ASME rated temperature and pressure relief valve. Heating elements shall be direct

immersion type, heavy duty, Incoloy sheathed, low voltage density (75 watts per square inch) of capacity and arrangement as scheduled. Controls shall include contactors, adjustable thermostats and high limit thermostat (set point 205 degrees F). Tank shall be insulated with polyurethane foam insulation with a minimum R-value of 16. The entire unit shall be U.L. approved and labelled. Heater by Rheem, Lockinvar, A.O. Smith, or State Industries are acceptable.

2.6.2 Water Storage Tank

(Small Volume) Provide and install where shown on plans and as scheduled a carbon steel, cement lined, constructed, designed and stamped in accordance with ASME Code for working pressure of 125 psig as manufactured by Cemline, or equal. Provide pressure relief valve (see Schedule).

Also provide unions, ball valves bypass piping, pressure relief valve set at 75 psig, and drain valve as per detail. Insulate exterior of pressure tank as per specifications.

2.6.3 Water Heater/Storage Tank Safety Devices

2.6.3.1 Storage Type Water Heaters and Tanks

All pressurized storage-type water heaters and unfired hot water storage tanks shall be equipped with one or more combination temperature and pressure relief valves. The temperature steam rating of a combination temperature and pressure relief valve or valves shall equal or exceed the energy input rating in BTU per hour of the water heater. No shut off valve or other restricting device may be installed between the water heater or storage tank and the combination temperature and pressure relief valve.

2.6.3.2 Non-Storage Type Water Heaters

All pressurized non-storage type water heaters shall be provided with a pressure relief valve installed at the hot water outlet with no shut off valve between the heater and the relief valve.

2.6.3.3 Temperature and Pressure Relief Valves

Temperature and pressure relief valves shall be installed so that the sensing element of the valve extends into the heater or tank and monitors the temperature in the top 6 inches of the heater or tank.

2.6.3.4 Relief Valve

Every relief valve which is designed to discharge water or steam shall be connected to a discharge pipe. The discharge pipe and fittings shall have a diameter not less than the diameter of the relief valve outlet. The discharge pipe may not be trapped. No valve may be installed in the discharge pipe. The discharge pipe shall be installed to drain by gravity flow to a floor served by a floor drain. The outlet of the discharge pipe shall terminate within 6 inches over the floor or receptor, but not less than a distance equal to twice the diameter of the outlet pipe. The outlet of the discharge pipe may not be threaded. The discharge pipe for a water heater shall terminate within the same room or enclosure within which the water heater or hot water storage tank is located.

2.6.3.5 Safety Devices

Relief valves shall be listed by the American Gas Association, Underwriters Laboratories, Inc. or American Society of Mechanical Engineers when the heat input to a water heater is less than or equal to 200,000 BTU per hour.

Relief valves shall be listed by the American Society of Mechanical Engineers when the heat input to a water heater exceeds 200,000 BTU per hour. Pressure relief valves shall be set to open at either the maximum allowable working pressure rating of the water heater or storage tank or 150 psig, whichever is smaller. Temperature and pressure relief valves shall be set to open at a maximum of 210 degrees F and in accordance with subpar. f.3).

2.7 FIXTURES AND TRIM

This section of the work includes plumbing fixtures furnished and installed by the Contractor.

2.7.1 Vitreous China Fixtures

All vitreous china fixtures shall be of the best quality conforming in all respects to classification "Regulation Selection" in accord with the uniform grading rules of "Vitreous China". Fixtures to be "roughed-in" in accord with manufacturer's dimensions. All fixtures shown on the drawings and/or specified herein shall be set firm and true, connected to all the piping services required and ready for use without the offsetting of supplies. Equipment shall be suitably protected against damage before and after installation. Any damaged plumbing fixture or piece of equipment shall be replaced at the expense of the plumbing contractor. All fixtures to be acceptable for final inspection shall be free of chips, flaws, scratches, abrasions, discolorations or any defect which, in the opinion of the Contracting Officer would classify the fixture as unsuitable for use intended.

2.7.2 Exposed Trim

All exposed trim including pipe nipples to plumbing fixtures shall be chromium plated and shall be completely free of tool marks, abrasions, or flattening of tubing, etc. All fixtures included in this specification and shown on the drawings shall be completed by the plumbing contractor together with all necessary hangers, bolted, anchors and brackets.

2.7.3 Fixture Location

All fixture heights, spacing apart and distances from walls shall be in accordance with Architectural details (floor plans and elevation). Deviation may necessitate alteration to comply with plans. Verify dimensions with General Trades. All fixtures shall be set level.

2.7.4 Water Flow

Repair all leaks, dripping faucets, etc. Regulate flow to water closets, showers, etc., for proper operation. Provide shutoffs at all individual fixtures.

2.7.5 Fixtures and Trim

Fixtures and trim of equal quality as listed by other manufacturers may be submitted.

2.7.6 Fixture Support

Fixture support. Provide and install proper supports and carriers for plumbing fixtures as scheduled or required for the application. Carriers shall be set in accordance with manufacturer's recommendations with adequate anchors and fasteners to provide required support. Wall hung water closet outlets shall be fully grouted for support in masonry walls.

2.7.7 Caulk

Caulk around all plumbing fixtures.

2.8 PLUMBING FIXTURES

2.8.1 WC-1 Water Closet (ADA)

Kohler K-4330, American Standard 2257.103, Crane 3-446E. Vitreous china elongated bowl siphon jet rear outlet water closet with top spud. Rim 18 inches A.F.F. Provide fixture carrier.

2.8.1.1 Flush Valve

Sloan Regal 111 or Sloan Royal, Zurn Z-6000XL-WS1 or Aquavantage, Delany 402-1. Exposed chrome plated flush valve for 1.6 gallon flush, quiet action with screw-driver stop, vacuum breaker, escutcheon and spud flange.

2.8.1.2 Seat

Bemis No. 1955-C, Beneke 523, Kohler K-4670-C, Olsonite 10-CC. Extra heavy white solid plastic open front seat with check hinge for elongated bowl.

2.8.1.3 Grab Bars

2.8.1.4 Carrier

Zurn 1203/1204 Series, Wade, J.R. Smith. No hub, horizontal/vertical, siphon jet carrier. Right or left hand, double/single to be determined by Plumbing Contractor. Note: As per ADA code, flush handle must be located on open accessible side of stall.

2.8.2 WC-2 Water Closet

Kohler K-4330, American Standard 2257.103, Crane 3-446E. Vitreous china elongated bowl siphon jet rear outlet water closet with top spud. Rim 18" A.F.F. Provide fixture carrier.

2.8.2.1 Flush Valve

Sloan Regal 111 or Sloan Royal, Zurn Z-6000XL-WS1 or Aquavantage, Delany 402-1. Exposed chrome plated flush valve for 1.6 gallon flush, quiet action with screw-driver stop, vacuum breaker, escutcheon and spud flange.

2.8.2.2 Seat

Bemis No. 1955-C, Beneke 523, Kohler K-4670-C, Olsonite 10-CC. Extra heavy white solid plastic open front seat with check hinge for elongated bowl.

2.8.2.3 Grab Bars

2.8.2.4 Carrier

Zurn 1203/1204 Series, Wade, J.R. Smith. No hub, horizontal/vertical, siphon jet carrier. Right or left hand, double/single to be determined by Plumbing Contractor. Note: As per ADA code, flush handle must be located on open accessible side of stall.

2.8.3 SS-1 Service Sink

E.L. Mustee 63M, Fiat MSB-2424, Zurn 24. 24 inch x 24 inch x 10 inch deep resin bonded white with black accents one piece mop basin with 3 inch cast brass drain body, dome strainer/lint basket. Provide 3 inch neoprene gasket 3 place mop hanger, vinyl bumper guard and silicone sealant. Provide 12 inch x 24 inch stainless steel wall panels and seal around basin at top of basin and wall panels.

2.8.3.1 Faucet

Zurn Z-841M1, Chicago 897, T&S Brass B-0667-POL, Kohler K-8904. Polished chrome plated brass exposed wall mount service sink faucet with threaded spout, pail hook, wall bracket and loose key or integral stops. Install Watts No. 8A chrome plated vacuum breaker on threaded spout. Provide 36 inch long hose kit. Install faucet at 36 inch AFF.

2.8.4 DF-1 Drinking Fountain

Elkay EDFP-117-C, Halsey-Taylor OVL-II-SEBP, Haws 1114, Oasis MLFMRSL. Two level lead-free, wall mounted, stainless steel fountain with wall plate and safety bubbler.

2.8.4.1 Supply

EBC VA-16, Brass Craft OCR-1412-AZC. 1/2 inch compression chrome plated cast brass angle stop with brass stem, wheel handle and chrome escutcheon.

2.8.4.2 Trap

EBC TA140, McGuire 8902, Keeney 311XPC. Chrome plated 1-1/4 inch x 1-1/2 inch, 17 gauge ground joint "P" trap.

PART 3 EXECUTION

3.1 Execution

3.1.1 Workmanship

All work shall be done by qualified licensed plumbers that are knowledgeable and experienced in the operations they are performing. Fabrications and installation methods, procedures and materials shall be in accordance with accepted industry practice and with the standard of manufacturing and contracting associations applicable to the work. All work shall be neatly done with special emphasis on the appearance of work exposed to view. All piping shall be run plumb and square unless otherwise required for a functional reason. Gradients of pitched lines shall be continuous.

3.1.2 Painting

Furnish all equipment completely finished unless specifically noted otherwise. Touch up all abrasions, nicks, scratches or other paint defects to restore equipment to its original condition. Severely marred equipment shall be factory refinished if so desired by Contracting Officer. Clean all surfaces to make them suitable for painting, on all equipment furnished, which are to be painted by other.

3.1.3 Excavation and Backfill

Refer to Section 02300 EARTHWORK which is applicable; especially note references to "Site Information, Protection, Excavation, Unforeseen Obstacles, Filling and Grading, Compaction Tests, Disposal of Excess and Waste Materials, Dewatering, Etc.

Contractor shall perform all excavation required for related underground piping inside building and for all exterior underground piping. Include all necessary clearing of excavated area, and all trenching, tunneling, sheet piling, shoring, underpinning, pumping, bailing, transportation of earth, fill and backfilling. Reference is made to the Working Drawings for subsurface soil data, contours, site conditions, etc. Excavate whatever material is encountered to depth required. Excavation shall extend one foot out from each side of pipe. Bottom of trench or excavation shall be level and solidly compacted to assure firm foundation. All excavated materials shall be removed from site or deposited as directed by the Contracting Officer. Protect excavation from caving or washing and erect necessary barricades, complying with regulations set forth in EM 385-1-1.

Lay all pipe in open trenches unless Contracting Officer gives written approval for tunneling. Trenches for sewers and water shall have a minimum of 8 feet of space between each service. All underground piping shall be supported on a bedding of sand or granular material at least 4 inches thick. Backfill with sand to one foot above top of piping and thoroughly compacted with earth free of cinders, stones and debris. Remove forms, shoring, etc., as backfill is placed. All backfilling under footings must be compacted within 8 feet of all footings. When running a pipe below a footing and parallel to it, same shall in all cases be at least one foot greater in distance away from footing than below its bottom. Where possible, run lines at center point between two parallel footings and maintain above mentioned distances at minimum. When running under a footing, disturb as little of the soil under footing as possible. Provide concrete fill under all footings where excavations wider than 18 inches are required. Backfilling shall not be placed until the work has been inspected, tested and approved. Concrete, asphalt or gravel paved areas, sidewalks, curb, gutters and lawn areas which are disturbed shall be replaced and restored to original condition by Contractor unless specifically stated to the contrary.

3.1.4 Cutting and Patching

Skilled tradesmen shall be employed to do cutting and patching. Each trade shall be responsible for cutting and patching new openings for their use, in existing or previously constructed walls, ceilings, floors, roofs, etc., unless otherwise designated. Provide personnel protection under coring operations in occupied areas. Submit methods of supporting and sealing floor sleeves for approval. Holes cut in roof and exterior wall shall be weatherproofed immediately. Provide temporary dust barriers for cutting operations in occupied spaces. Refer to Architectural drawings for lintels

provided by General trades. When lintels are not indicated in other division of the work, they shall be provided by the trade requiring the opening. All piping penetrations through masonry structure shall be drilled or core drilled. All penetrations for access panels, etc. shall be saw cut before removal. Jack hammering without saw cutting is prohibited.

3.1.5 Access

All plumbing fixtures and/or equipment shall be located so that parts requiring service and/or adjustment, fixture traps and valves shall be readily accessible. Provide access doors or panels to make service convenient. Doors by Milcor or as per architectural specifications.

3.1.6 Equipment and Piping

Below 7 feet-6 inches above finished floor shall have a resilient material (foam rubber, etc.) attached to all potentially dangerous edges.

3.2 SLEEVES AND INSERTS

At all fire rated penetrations only use UL listed, tested, and approved materials and methods. All pipes passing through masonry walls, floors, ceilings or partitions shall be provided with sleeves having internal diameters at least 1/4 inch greater than the outside diameter of uninsulated pipes and/or outside diameter of the insulation of insulated piping. Sleeves for pipes passing through fire rated floor slabs and fire rated walls shall be Schedule 40 steel pipe extending 1 inch above the finished slab and sealed. If holes must be cut through finished construction they must be core drilled to avoid damage to construction. Exterior wall sleeves shall be caulked weathertight. Sleeves through equipment room also shall be filled with glass fiber insulation. Where chases are formed for passage of several pipes, they shall have a 1 inch high curb above finished slab and sealed. Whenever sleeves occur as penetrations of rated construction, the void space shall be sealed with U.L. rated foam sealant similar to Chase Foam, CTC PR855; 3M Fire Barrier Caulk CP25 and putty 303; Dow Corning Fire Stop 2000 or Specified Technologies, Inc. Spec Seal Firestop Products installed in strict accordance with the manufacturer's instructions. Use sealant thickness as required to provide the full fire protection rating of the structure. Insulation shall not pass through rated assemblies. Insulation shall butt tight against the rated assembly after the sealant is installed and inspected. Inserts in floor slabs shall be galvanized individual type with accommodation for removable nuts and threaded rods up to 3/4 inch diameter, permitting lateral adjustment. Any fastener in a beam shall be midway above the bottom of the beam. Piping that passes through outside walls below grade and above grade shall be permanently sealed with a water-tight rubber compression seal between the pipe and the sleeve equal to Link-Seal modular wall and casing seal as manufacturer by Thunderline Corporation. The pipe sleeve and seal must meet UL listed, tested, and approved materials and methods.

3.3 MOUNTING PADS

Floor mounted mechanical equipment shall be set on reinforced concrete pads 4 inches high and extending 4 inches beyond the equipment base on all sides. See drawings for specific requirements.

3.4 IDENTIFICATION

Identify all mechanical equipment with nameplate bearing equipment name and number, using 1-1/2 inch white bakelite with 1/2 inch black letters permanently mounted in a conspicuous place. Use mechanical fasteners instead of adhesive to mount nameplates wherever possible.

Each piping system furnished and installed shall be identified. The direction of flow shall be identified by means of stenciled legends and flow arrows. The marking shall be applied after all painting and cleaning of the piping and insulation is completed and before ceilings are installed. Marking shall be in accordance with EM 385-1-1 and ASME A 13.1 1996 "Scheme for Identification of Piping Systems".

The legend and flow arrow shall be applied at all valve locations at all points where piping enters or leaves a wall, partition, bulkhead, cluster of piping, or similar obstruction and at approximately 30 foot intervals on pipe runs with at least one in each space or room. Color shall be black with stencils sized as follows: Over 2" -1" high; 2" under - 1/2" high. The marking shall be located so as to be conspicuous and legible at all times from any reasonable point. Install markings before ceilings are installed.

3.4.1 Valve Identification

Valve charts shall be provided for each piping system which shall identify each valve with a numbered 1-1/4 inch round brass metal tag, stating valve number, valve location and describe valve function. Upon completion of the project, provide two copies of each chart enclosed in a glass front metal frame and shall be mounted in the mechanical room in a place as directed by the Contracting Officer. Tags shall be attached with metal "S" hooks or by metal chain. Tags shall be equal to Seton #2960. Provide valve identification charts in each Government's service and maintenance manual. Identification Symbols as follows:

DCW Domestic Cold Water
DHW Domestic Hot Water

3.4.2 Concealed Valves and Equipment Identification

All valves, controls, or other equipment requiring service located above removable ceilings, shall have the ceiling tile directly below identified with a colored tack inserted into the tile or a colored sticker applied to grid system designating a valve above.

3.5 ESCUTCHEONS

Escutcheons shall be installed on all exposed pipes wherever they pass through floors, ceilings, walls, or partitions. Escutcheons for pipes passing through floors in unfinished areas shall be split hinged type designed to fit the pipe and to cover the projecting pipe sleeve. Escutcheons for pipes exposed to view in finished areas shall be chrome plated brass. Escutcheons shall be properly sized to fit snugly around the pipe and shall be sized to completely cover the wall or floor opening.

3.6 TESTS AND ADJUSTMENTS

The Contractor shall conduct tests of systems as required by codes, regulatory agencies and this specification. Tests shall be made with the medium and under pressure as stated in the test requirements. Notify the Contracting Officer and/or regulatory agencies prior to conducting tests. The Contractor shall complete the attached certification form and submit to

the Contracting Officer when tests have been completed and include in O&M Manuals.

3.6.1 Tests

Type of System	Gauge Pressures	Test Medium
	(lbs. per sq. inch, or vacuum in inches)	
Building Sewers, Building Drains, All Branches, Vents and Stacks of Sanitary, Storm or Clear Water Piping Systems	Minimum of 10 foot head on each joint for a minimum of 15 minutes with no head loss.	Water
	Uniform gauge pressure of 3 psi for a minimum of 15 minutes without adding air.	Air
Water		
a) Service and Bldg. Distribution Piping.	100 psi gauge pressure for a 2 hour period	Water

(1) The pressure in pounds per square inch, or inches of vacuum, gauge, are given as an initial pressure to be applied to lines being tested, together with test medium. Tests are to be applied for a minimum period of 4 hours and until tests are complete. Final pressures at the end of test period may vary only by that caused by expansion of the test medium due to temperature changes.

(2) Check of systems during application of test pressures should include visual check for water medium leakage, soap bubble or similar for air and nitrogen medium.

3.6.1.1 Start Up of Piping Systems

Potable water system shall be cleaned and disinfected in accordance with state and local codes or in the absence of such codes shall be treated by accepted methods to provide a system free of harmful contaminants and acceptance to regulatory agencies. All lines shall be thoroughly flushed to remove dirt and construction debris.

3.7 REQUIREMENTS FOR SUBSTANTIAL COMPLETION

3.7.1 Cleaning Equipment and Premises

Thoroughly clean all parts of the piping, valves and fixtures. Exposed parts which are to be painted shall be thoroughly cleaned of cement, plaster and other materials and all oil and grease spots removed. Such surfaces shall be carefully wiped and all cracks and corners scraped out. Exposed metal work shall be carefully brushed down with steel brushes to remove rust and other spots and left smooth and clean. Remove all construction debris, excess materials and equipment. Caulk around all plumbing fixtures at walls and around base of water closets, service sinks, etc.

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3.7.2 Operating and Maintenance Manuals

3.7.2.1 Manuals

The Contractor shall furnish to the Contracting Officer five operating manuals for furnished equipment. Information sheets shall be bound in standard 3-ring binders labeled to show the contractor's name, address, regular business phone number, emergency phone number and date. Operating manuals shall be submitted prior to completion of the work to allow time for review. The manual shall contain the following information:

- a. The Certification of Tests and Adjustments completed and signed.
- b. A list (keyed with identification numbers used) of each item of equipment, which required service giving the name of the item, model number, manufacturer's name and address and the name address and phone number of the nearest representative or authorized service organization.
- c. A copy of the approved shop drawing for each item.
- d. A complete operating and maintenance manual with parts listed, wiring diagrams, lubrication requirements, and service instructions for each major item including faucet and mixing valve repair.
- e. Complete control diagrams with description of all operating sequences and control devices.
- f. Properly executed and registered manufacturer's warranties.
- g. A copy of valve chart.

3.7.2.2 Training

Provide a minimum of 2 hours training on operations of major equipment with Government maintenance staff. Contractor shall provide training on the proper methods of winterizing a seasonal building.

3.8 PENETRATIONS OF FIRE RESISTIVE ASSEMBLIES

Plumbing piping systems that penetrate fire rated assemblies shall be installed in accordance with current North Dakota Plumbing and HVAC Code and U.L. or current acceptable methods. Also refer to requirements for sleeves.

3.9 ATTACHMENTS

- (1) Certification of Tests and Adjustments - Plumbing

-- End of Section --

CERTIFICATION OF TESTS AND ADJUSTMENTS - PLUMBING

Plumbing Trade Name:

Project Name

Project Number

The Plumbing Trade named above certifies that the tests and adjustments indicated below have been completed in accordance with the specifications on the date indicated.

TESTS	DATE
Building Sewers, Building Drains, Branches, Vents and Stacks	_____
Sanitary Waste and Vent	_____
Water:	
1) Building Service	_____
2) Building Distribution	_____
Start-up of Piping System and Pumps	_____
Flushing and Disinfection of Potable Water System	_____
Training Government on Methods of Winterizing a Seasonal Building	_____

Contract _____

Signed By Plumbing Contractor _____

Date _____

Signed By Project Manager _____

Date _____

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SECTION 15556

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SECTION 15556

UNIT HEATERS

PART 1 GENERAL

1.1 REFERENCES

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

ASME INTERNATIONAL (ASME)

ASME B31.1 (1998) Power Piping

ASME BPV IX (1998) Boiler and Pressure Vessel Code;
Section IX, Welding and Brazing
Qualifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment
(1000 Volts Maximum)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Spare Parts; FIO

Spare parts data for each different item of material and equipment specified, after approval of the related submittals and not later than 3 months prior to the date of beneficial occupancy. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.

Welding; FIO

Three copies of qualified procedures and list of names and identification symbols of qualified welders and welding operators, prior to welding operations.

Framed Instructions; FIO

Proposed diagrams, instructions, and other sheets, prior to posting. The instructions shall show wiring and control diagrams and complete layout of the entire system. The instructions shall include, in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking

the system for normal safe operation and procedures for safely starting and stopping the system.

SD-04 Drawings

Heating System; GA

Detail drawings consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, performance charts and curves, catalog cuts, and installation instructions. Drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work including clearances for maintenance and operation.

SD-09 Reports

Testing and Cleaning; FIO

Performance test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.

SD-13 Certificates

Bolts; FIO

Written certification that the bolts furnished comply with the requirements of this specification, provided by the bolt manufacturer. The certification shall include illustrations of product-required markings, the date of manufacture, and the number of each type of bolt to be furnished based on this certification.

SD-19 Operation and Maintenance Manuals

Heating System; GA

Six copies of operation and six copies of maintenance manuals for the equipment furnished. One complete set, prior to performance testing and the remainder upon acceptance. Operating manuals shall detail the step-by-step procedures required for system startup, operation, and shutdown. Operating manuals shall include the manufacturer's name, model number, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall list routine maintenance procedures, water treatment procedures, possible breakdowns and repairs, and troubleshooting guides. Maintenance manuals shall include piping and equipment layout and simplified wiring and control diagrams of the system as installed. Manuals shall be provided prior to the field training course.

1.3 QUALIFICATIONS

Procedures and welders shall be qualified in accordance with the code under

which the welding is specified to be accomplished.

1.4 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be stored with protection from the weather, excessive humidity and excessive temperature variation; and dirt, dust, or other contaminants.

1.5 FIELD MEASUREMENTS

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing the work.

PART 2 PRODUCTS

2.1 GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

2.1.1 Standard Products

Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.1.2 Nameplates

Each major item of equipment shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a plate secured to the item of equipment.

2.1.3 Equipment Guards and Access

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded in accordance with OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified. Catwalks, operating platforms, ladders, and guardrails shall be provided where shown and shall be constructed in accordance with Section 05500 MISCELLANEOUS METAL.

2.1.4 Asbestos Prohibition

Asbestos and asbestos-containing products shall not be used.

2.1.5 Electrical Work

Electrical motor driven equipment specified shall be provided complete with motors, motor starters, and controls. Electric equipment (including motor efficiencies), and wiring shall be in accordance with Section 16415 ELECTRICAL WORK, INTERIOR. High efficiency motors shall be used. Electrical characteristics shall be as specified or indicated. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or

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automatic control and protective or signal devices required for the operation specified, and any control wiring, conduit, and connection to power required for controls and devices but not shown shall be provided.

2.2 UNIT HEATERS

Heaters shall be sized as scheduled on the contract drawings, and shall have a heating capacity not in excess of 125 percent of the capacity indicated. Noise level of each unit heater for areas noted shall not exceed the criteria indicated.

2.2.1 Propeller Fan Heaters

Heaters shall be designed for suspension and arranged for horizontal discharge of air as indicated. Casings shall be not less than 20 gauge black steel and finished with lacquer or enamel. Suitable stationary deflectors shall be provided to assure proper air and heat penetration capacity at floor level based on established design temperature. Suspension from heating pipes will not be permitted. Horizontal discharge type unit heaters shall have discharge or face velocities not in excess of the following:

Unit Capacity,	cfm	Face Velocity, fpm
Up to 1,000		800
1,001 to 3,000		900
3,001 and over		1,000

2.2.2 Motors

Motors shall be provided with NEMA 250 general purpose enclosure. Motors and motor controls shall otherwise be as specified in Section 16415 ELECTRICAL WORK, INTERIOR.

2.2.3 Motor Switches

Motors shall be provided with manual selection switches with "Off," and "Automatic" positions and shall be equipped with thermal overload protection.

2.2.4 Controls

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING, AND AIR CONDITIONING HVAC CONTROL SYSTEMS.

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be installed as indicated and in accordance with the manufacturer's diagrams and recommendations.

3.2 COLOR CODE MARKING AND FIELD PAINTING

Color code marking, field painting of exposed pipe, and field painting of factory primed equipment shall be as specified in Section 09900 PAINTING, GENERAL.

3.3 WELDING

Piping shall be welded in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. Welding and nondestructive testing procedures for piping shall be as specified in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS.

3.4 MANUFACTURER'S SERVICES

Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment specified shall be provided. The representative shall supervise the installation, adjustment, and testing of the equipment.

3.5 FRAMED INSTRUCTIONS

Framed instructions containing wiring and control diagrams under glass or in laminated plastic shall be posted where directed. Condensed operating instructions, prepared in typed form, shall be framed as specified above and posted beside the diagrams. The framed instructions shall be posted before acceptance testing of the system.

-- End of Section --

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SECTION 15895

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SECTION 15895

AIR SUPPLY, VENTILATION, AND EXHAUST SYSTEM

PART 1 GENERAL

1.1 REFERENCES

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

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 210 (1985) Laboratory Methods of Testing Fans for Rating

AMCA 300 (1996) Reverberant Room Method for Sound Testing of Fans

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 300 (1996) Reverberant Room Method for Sound Testing of Fans

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

ASHRAE 68 (1986) Laboratory Method of Testing InDuct Sound Power Measurement Procedures for Fans

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 53 (1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 123/A 123M (1997ael) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 924/A 924M (1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

ASTM D 520 (1984; R 1995el) Zinc Dust Pigment

ASTM D 1654 (1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ASTM D 3359 (1997) Measuring Adhesion by Tape Test

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ASTM E 437	(1997) Industrial Wire Cloth and Screens (Square Opening Series)
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA MG 1	(1998) Motors and Generators
SHEET METAL & AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)	
SMACNA HVAC Duct Const Stds	(1995; Addenda Nov 1997) HVAC Duct Construction Standards - Metal and Flexible
SMACNA Leakage Test Mnl	(1985) HVAC Air Duct Leakage Test Manual
UNDERWRITERS LABORATORIES (UL)	
UL 181	(1996; Rev Dec 1998) Factory-Made Air Ducts and Air Connectors
UL 214	(1997) Tests for Flame-Propagation of Fabrics and Films
UL Bld Mat Dir	(1999) Building Materials Director

1.2 COORDINATION OF TRADES

Ductwork, piping offsets, fittings, and accessories shall be furnished as required to provide a complete installation and to eliminate interference with other construction.

1.3 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Components and Equipment; GA

Manufacturer's catalog data shall be included with the detail drawings for the following items. The data shall be highlighted to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with contract requirements for the following:

- a. Ductwork Components
- b. Air Systems Equipment

Test Procedures; FIO

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Proposed test procedures for piping hydrostatic test, ductwork leak test, and performance tests of systems, at least 2 weeks prior to the start of related testing.

Welding Procedures; FIO

A copy of qualified welding procedures, at least 2 weeks prior to the start of welding operations.

System Diagrams; FIO

Proposed diagrams, at least 2 weeks prior to start of related testing. System diagrams that show the layout of equipment, piping, and ductwork, and typed condensed operation manuals explaining preventative maintenance procedures, methods of checking the system for normal, safe operation, and procedures for safely starting and stopping the system shall be framed under glass or laminated plastic. After approval, these items shall be posted where directed.

Similar Services; FIO

Statement demonstrating successful completion of similar services on at least 5 projects of similar size and scope, at least 2 weeks prior to submittal of other items required by this section.

Welding Joints; FIO

A list of names and identification symbols of qualified welders and welding operators, at least 2 weeks prior to the start of welding operations.

Field Training; FIO

Proposed schedule for field training, at least 2 weeks prior to the start of related training.

SD-04 Drawings

Drawings; GA
Installation; GA

Drawings shall consist of equipment layout including assembly and installation details and electrical connection diagrams; ductwork layout showing the location of all supports and hangers, typical hanger details, gauge reinforcement, reinforcement spacing rigidity classification, and static pressure and seal classifications; and piping layout showing the location of all guides and anchors, the load imposed on each support or anchor, and typical support details. Drawings shall include any information required to demonstrate that the system has been coordinated and will properly function as a unit and shall show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

SD-09 Reports

Performance Tests; FIO

Test reports for the piping hydrostatic test, ductwork leak test, and performance tests in booklet form, upon completion of testing. Reports shall document phases of tests performed including initial test summary, repairs/adjustments made, and final test results.

SD-13 Certificates

Bolts; FIO

Written certification from the bolt manufacturer that the bolts furnished comply with the requirements of this specification. The certification shall include illustrations of product markings, and the number of each type of bolt to be furnished.

SD-19 Operation and Maintenance Manuals

Operating and Maintenance Instructions; GA

Six manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 2 weeks prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of providing 4 hour onsite response to a service call on an emergency basis.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Components and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of products that are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years before bid opening. The 2-year experience shall include applications of components and equipment under similar circumstances and of similar size. The 2 years must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization.

2.2 ASBESTOS PROHIBITION

Asbestos and asbestos-containing products shall not be used.

2.3 NAMEPLATES

Equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.4 EQUIPMENT GUARDS AND ACCESS

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts exposed to personnel contact shall be fully enclosed or guarded according to OSHA requirements. High temperature equipment and piping exposed to contact by personnel or where it creates a potential fire hazard shall be properly guarded or covered with insulation of a type specified.

2.5 ELECTRICAL WORK

Electrical motor-driven equipment specified shall be provided complete with motor, motor starter, and controls. Unless otherwise specified, electric equipment, including wiring and motor efficiencies, shall be according to Section 16415 ELECTRICAL WORK, INTERIOR. Electrical characteristics and enclosure type shall be as shown. Unless otherwise indicated, motors of 1 hp and above shall be high efficiency type. Motor starters shall be provided complete with thermal overload protection and other appurtenances necessary. Each motor shall be according to NEMA MG 1 and shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Manual or automatic control and protective or signal devices required for the operation specified, and any control wiring required for controls and devices, but not shown, shall be provided.

2.6 CONTROLS

Controls shall be provided as specified in Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS.

2.7 DUCTWORK COMPONENTS

2.7.1 Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with SMACNA HVAC Duct Const Stds unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class 1/2, 1, and 2 inch w.g. ductwork shall meet the requirements of Seal Class C. Class 3 through 10 inch shall meet the requirements of Seal Class A. Sealants shall conform to fire hazard classification specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA HVAC Duct Const Stds. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

2.7.1.1 Transitions

Diverging air flow transitions shall be made with each side pitched out a

maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging air flow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

2.7.1.2 Metallic Flexible Duct

Metallic type duct shall be single-ply two-ply aluminum, self supporting to 8 foot spans. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to 1/2 duct diameter. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of 15 inches water gauge at 350 degrees F when duct is aluminum.

2.7.1.3 General Service Duct Connectors

A flexible duct connector approximately 6 inches in width shall be provided where sheet metal connections are made to engine-generator radiator, operating floor exhaust fan, and sump area exhaust fan or where ducts of dissimilar metals are connected. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL Bld Mat Dir.

2.7.2 Ductwork Accessories

2.7.2.1 Duct Access Doors

Access doors shall be provided in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system, and unless otherwise shown, shall conform to SMACNA HVAC Duct Const Stds. Access doors shall be provided upstream and downstream of air flow measuring primaries and heating and cooling coils. Doors shall be minimum 15 x 18 inches, unless otherwise shown. Where duct size will not accommodate this size door, the doors shall be made as large as practicable. Doors 24 x 24 inches or larger shall be provided with fasteners operable from both sides. Doors in insulated ducts shall be the insulated type.

2.7.3 Duct Sleeves, Framed Prepared Openings, Closure Collars

2.7.3.1 Duct Sleeves

Duct sleeves shall be provided for round ducts 15 inches in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15 inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20 gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide 1 inch clearance between the duct and the sleeve or 1 inch clearance between the insulation and the sleeve for

insulated ducts.

2.7.3.2 Framed Prepared Openings

Openings shall have 1 inch clearance between the duct and the opening or 1 inch clearance between the insulation and the opening for insulated ducts.

2.7.3.3 Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4 inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15 inches in diameter or less shall be fabricated from 20 gauge galvanized steel. Collars for round ducts larger than 15 inches and square, and rectangular ducts shall be fabricated from 18 gauge galvanized steel. Collars shall be installed with fasteners on maximum 6 inch centers, except that not less than 4 fasteners shall be used.

2.7.4 Louvers

Louvers for installation in exterior walls which are associated with the air supply and distribution system shall be as specified in Section 07600 SHEET METALWORK, GENERAL.

2.7.5 Bird Screens and Frames

Bird screens shall conform to ASTM E 437, No. 2 mesh, aluminum stainless steel. Aluminum screens shall be rated "medium-light". Stainless steel screens shall be rated "light". Frames shall be removable type, or stainless steel or extruded aluminum.

2.8 AIR SYSTEMS EQUIPMENT

2.8.1 Tube Axial Blower

Provide 1 tube axial blower for the entire project. Blower shall use 480volt/3-phase/60 hz power with a totally enclosed manual starter. Unit shall provide a minimum of 5,500 cfm free air delivery using a 2 horsepower, 3,500 rpm motor. Blower construction shall include heavy gauge steel housing with epoxy powder coating, skid mounting, inlet and outlet screens to meet OSHA standards and beaded connections at inlet and outlet for ductwork connection. Provide a minimum 8 foot power cord, 12/3 with ground, extra hard usage, type S.O., flexible cable with plug. Plug shall be L16-20P configuration, and connected to cord end. Provide one, 25-foot long, 16-inch diameter flexible duct for connection to either end of blower. Blower design and construction shall be similar to Coppus Model TA-16 Tube Axial Blower.

2.8.1.1 Panel Type Power Wall Ventilators

Fans shall be propeller type, assembled on a reinforced metal panel with venturi opening spun into panel. Fans with wheels less than 24 inches diameter shall be direct or V-belt driven and fans with wheels 24 inches diameter and larger shall be V-belt drive type. Fans shall be furnished with wall mounting collar. Lubricated bearings shall be provided. Fans

shall be fitted with wheel and motor side metal or wire guards which have a corrosion-resistant finish. Motor enclosure shall be totally enclosed fan cooled type. Heavy-duty, motorized backdraft dampers shall be provided for both operating floor exhaust fans and sump area exhaust fan. Fans shall be sized according to fan schedule on drawings.

2.8.2 Fans

2.8.2.1 General

Roof exhaust fans shall be provided with combination motor starter and disconnect mounted on the frame of the fan. Fans shall be tested and rated in accordance with AMCA 210, AMCA 300 and ASHRAE 68. Fans shall be connected to the motors either directly or indirectly with V-belt drive as specified below or as scheduled on the drawings. V-belt drives shall be designed for not less than 150 percent of the connected driving capacity and motor sheaves shall be adjustable to provide not less than 20 percent fan speed variation. Sheaves shall drive the fan at such speed as to produce the specified capacity when set at the approximate midpoint of the sheave adjustment. Motors for V-belt drives shall be provided with adjustable rails or bases. Removable metal guards shall be provided for all exposed V-belt drives, and speed-test openings shall be provided at the center of all rotating shafts. Fans shall be provided with personnel screens or guards on both suction and supply ends, except that the screens need not be provided, unless otherwise indicated, where ducts are connected to the fan. Fan and motor assemblies shall be provided with vibration-isolation supports or mountings. Vibration-isolation units shall be standard products with published loading ratings, and shall be single rubber-in-shear, double rubber-in-shear, or springs unless otherwise indicated. Each fan shall be selected to produce the capacity required at the fan total pressure indicated. Fan performance curve for each fan shall be submitted at the time the proposed testing program is submitted. Sound power data for each fan in all octave bands at mid-frequencies shall be submitted. The sound power level values shall be obtained in accordance with AMCA 300. Standard AMCA arrangement, rotation, and discharge shall be as indicated.

2.8.2.2 Power Roof Ventilators

Power roof ventilators shall be of the centrifugal type with a weathertight housing and turned down rectangular base constructed of aluminum. Fan discharge openings shall be provided with framed and removable 2-inch stainless steel wire mesh bird screens suitable for the weathertight housings. All fasteners shall be stainless steel. Sealed, permanently lubricated sleeve, roller, or ball bearings with provision for end thrust shall be provided. Motor enclosures shall be totally enclosed type. Combination motor starters and disconnects shall be provided with the fans. Motor-operated backdraft dampers shall be provided as indicated. Motors shall be provided with factory installed and wired safety disconnect switch mounted under the fan housing adjacent to the motor.

2.9 FACTORY PAINTING

Units which are not of galvanized construction according to ASTM A 123/A 123M or ASTM A 924/A 924M shall be factory painted with a corrosion resisting paint finish. Internal and external ferrous metal surfaces shall be cleaned, phosphatized and coated with a paint finish which has been tested according to ASTM B 117, ASTM D 1654, and ASTM D 3359. Evidence of satisfactory paint performance for a minimum of 125 hours for units to be

installed indoors and 500 hours for units to be installed outdoors shall be submitted. Rating of failure at the scribe mark shall be not less than 6, average creepage not greater than 1/8 inch. Rating of the inscribed area shall not be less than 10, no failure. On units constructed of galvanized steel which have been welded, exterior surfaces of welds or welds that have burned through from the interior shall receive a final shop docket of zinc-rich protective paint according to ASTM D 520 Type I.

PART 3 EXECUTION

3.1 INSTALLATION

Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.

3.1.1 Access Panels

Access panels shall be provided for concealed valves, vents, controls, dampers, and items requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced and maintained or completely removed and replaced. Access panels shall be as specified in Section 05500 MISCELLANEOUS METALS.

3.1.2 Flexible Connectors

Pre-insulated flexible connectors and flexible duct shall be attached to other components in accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the connector or duct manufacturer and shall be provided at the intervals recommended.

3.1.3 Sleeved and Framed Openings

Space between the sleeved or framed opening and the duct or the duct insulation shall be packed as specified in Section 07900 JOINT SEALING for nonfire rated penetrations.

3.1.4 Metal Ductwork

Installation shall be according to SMACNA HVAC Duct Const Stds unless otherwise indicated. Duct supports for sheet metal ductwork shall be according to SMACNA HVAC Duct Const Stds, unless otherwise specified. Friction beam clamps indicated in SMACNA HVAC Duct Const Stds shall not be used. Risers on high velocity ducts shall be anchored in the center of the vertical run to allow ends of riser to move due to thermal expansion. Supports on the risers shall allow free vertical movement of the duct. Supports shall be attached only to structural framing members and concrete slabs. Supports shall not be anchored to metal decking unless a means is provided and approved for preventing the anchor from puncturing the metal decking. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided. Where C-clamps are used, retainer clips shall be provided.

3.1.5 Insulation

Thickness and application of insulation materials for ductwork, piping, and equipment shall be according to Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.1.6 Power Transmission Components Adjustment

V-belts and sheaves shall be tested for proper alignment and tension prior to operation and after 72 hours of operation at final speed. Belts on drive side shall be uniformly loaded, not bouncing. Alignment of direct driven couplings shall be to within 50 percent of manufacturer's maximum allowable range of misalignment.

3.2 DUCTWORK LEAK TEST

Ductwork leak test shall be performed for the entire air distribution and exhaust system, including fans, coils, filters, etc. Test procedure, apparatus, and report shall conform to SMACNA Leakage Test Mnl. Ductwork leak test shall be completed with satisfactory results prior to applying insulation to ductwork exterior.

3.3 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of foreign matter. A temporary bypass shall be provided for water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Inside of ducts, plenums, and casing shall be thoroughly cleaned of debris and blown free of small particles of rubbish and dust and then shall be vacuum cleaned before installing outlet faces. Equipment shall be wiped clean, with traces of oil, dust, dirt, or paint spots removed. Temporary filters shall be provided prior to startup of all fans that are operated during construction, and new filters shall be installed after all construction dirt has been removed from the building, and the ducts, plenums, casings, and other items specified have been vacuum cleaned. System shall be maintained in this clean condition until final acceptance. Bearings shall be properly lubricated with oil or grease as recommended by the manufacturer. Belts shall be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment shall be adjusted to setting indicated or directed. Fans shall be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.4 PERFORMANCE TESTS

After testing, adjusting, and balancing has been completed as specified, each system shall be tested as a whole to see that all items perform as integral parts of the system and temperatures and conditions are evenly controlled throughout the building. Corrections and adjustments shall be made as necessary to produce the conditions indicated or specified. Capacity tests and general operating tests shall be conducted by an experienced engineer.

3.5 FIELD TRAINING

The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Training shall be provided for a period of 8 hours of normal working time and shall start after the system is functionally complete but prior to the performance tests. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

-- End of Section --

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SECTION 15950

HEATING AND VENTILATION

PART 1 GENERAL

1.1 REFERENCES

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

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

AMCA 500-D (1997) Laboratory Methods of Testing
Dampers for Rating

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (1997) Enclosures for Electrical Equipment
(1000 Volts Maximum)

UNDERWRITERS LABORATORIES (UL)

UL 508 (1999) Industrial Control Equipmen

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

HVAC Control System; GA
Service Organizations; FIO

Six copies of a list of service organizations qualified to service the HVAC control system. The list shall include the service organization name, address, technical point of contact and telephone number, and contractual point of contact and telephone number.

Equipment Compliance Booklet; FIO

An HVAC control system equipment compliance booklet (ECB) in indexed booklet form with numbered tabs separating the information on each device. It shall consist of, but not be limited to, data sheets and catalog cuts which document compliance of all devices and components with the specifications. The ECB shall be indexed in alphabetical order by the unique identifiers. Devices and components which do not have unique identifiers shall follow the devices and components with unique identifiers and shall be indexed in alphabetical order according to their functional name.

The ECB shall include a bill of materials for each HVAC control system. The bill of materials shall function as the table of contents for the ECB and shall include the device's unique identifier, device function, manufacturer, model/part/catalog number used for ordering, and tab number where the device information is located in the ECB.

Commissioning Procedures; GA

a. Six copies of the HVAC control system commissioning procedures, in indexed booklet form, 60 days prior to the scheduled start of commissioning. Commissioning procedures shall be provided for each HVAC control system, and for each type of terminal-unit control system. The commissioning procedures shall reflect the format and language of this specification, and refer to devices by their unique identifiers as shown. The commissioning procedures shall be specific for each HVAC system, and shall give detailed step-by-step procedures for commissioning of the system.

Performance Verification Test Procedures; FIO

Six copies of the HVAC control system performance verification test procedures, in indexed booklet form, 60 days before the Contractor's scheduled test dates. The performance verification test procedures shall refer to the devices by their unique identifiers as shown, shall explain, step-by-step, the actions and expected results that will demonstrate that the HVAC control system performs in accordance with the sequences of operation. An HVAC control system performance verification test equipment list shall be included that lists the equipment to be used during performance verification testing. The list shall include manufacturer name, model number, equipment function, the date of the latest calibration, and the results of the latest calibration.

Training Course Requirements; FIO

Six copies of HVAC control system training course material 30 days prior to the scheduled start of the training course. The training course material shall include the operation manual, maintenance and repair manual, and paper copies of overheads used in the course. An HVAC control system training course, in outline form, with a proposed time schedule. Approval of the planned training schedule shall be obtained from the Government at least 60 days prior to the start of the training.

SD-04 Drawings

Drawings; GA

Drawings on A1 34 by 22 inch sheets in the form and arrangement shown. The drawings shall use the same abbreviations, symbols, nomenclature and device identifiers shown. Each control-system element on a drawing shall have a unique identifier as shown. All HVAC control system drawings shall be delivered together as a complete submittal. Drawings shall be submitted for each HVAC system.

a. HVAC control system drawings shall include the following:

Sheet One: Drawing index, HVAC control system legend.

Sheet Two: damper schedule.

Sheet Three: HVAC control system schematic and equipment schedule.

Sheet Four: HVAC control system sequence of operation and ladder diagram.

Sheet Five: Motor starter and relay wiring diagram.

b. An HVAC control system drawing index showing the name and number of the building, military site, State or other similar designation, and Country. The drawing index shall list all HVAC control system drawings, including the drawing number, sheet number, drawing title, and computer filename when used.

c. A damper schedule showing each damper and actuator's identifier, nominal and actual sizes, orientation of axis and frame, direction of blade rotation, spring ranges, operation rate, positive positioner ranges, locations of actuators and damper end switches, arrangement of sections in multi-section dampers, and methods of connecting dampers, actuators, and linkages. The damper schedule shall include the maximum leakage rate at the operating static-pressure differential. The damper schedule shall contain actuator selection data supported by calculations of the torque required to move and seal the dampers, access and clearance requirements.

d. An HVAC control system equipment schedule showing the device unique identifier, device function, setpoint, input range, and additional important parameters (i.e. output range).

e. An HVAC control system sequence of operation.

f. An HVAC control system ladder diagram showing all relays, contacts, pilot lights, switches, fuses and starters connected to the control system.

g. HVAC control system wiring diagrams showing functional wiring diagrams of the interconnection of conductors and cables to HVAC control panel terminal blocks and to the identified terminals of devices, starters and package equipment. The wiring diagrams shall show all necessary jumpers and ground connections. The wiring diagrams shall show the labels of all conductors. Sources of power required for HVAC control systems and for packaged-equipment control systems shall be identified back to the panel-board circuit breaker number, HVAC system control panel, magnetic starter, or packaged equipment control circuit. Each power supply and transformer not integral to a controller, starter, or packaged equipment shall be shown. The connected volt-ampere load and the power supply volt-ampere rating shall be shown.

SD-09 Reports

Commissioning Report; FIO

Six copies of the HVAC control system commissioning report, in indexed booklet form, within 30 days after completion of the system commissioning. The commissioning report shall include data collected during the HVAC control system commissioning and shall follow the format of the commissioning procedures. The commissioning report shall include all controller and time clock checksheets with final values listed for all parameters, setpoints, P, I, D setting constants, calibration data for all devices, and results of adjustments.

Performance Verification Test; FIO

Six copies of the HVAC control system performance verification test report, in indexed booklet form, within 30 days after completion of the test. The HVAC control system performance verification test report shall include data collected during the HVAC control system performance verification test. The original copies of data gathered during the performance verification test shall be turned over to the Government after Government approval of the test results.

SD-19 Operation and Maintenance Manuals

Operation Manual; GA
Maintenance and Repair Manual; FIO

Six copies of the HVAC control system operation manual and HVAC control system maintenance and repair manual for each HVAC control system 30 days before the date scheduled for the training course.

1.3 GENERAL REQUIREMENTS

1.3.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, shall verify all dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

1.3.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall investigate the mechanical, electrical, and finish conditions that could affect the work to be performed, shall arrange such work accordingly, and shall furnish all work necessary to meet such conditions.

1.4 DELIVERY AND STORAGE

Products shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage-condition limits published by the equipment manufacturer. Dampers shall be stored so that seal integrity, blade alignment and frame alignment are maintained.

1.5 OPERATION MANUAL

An HVAC control system operation manual for each HVAC control system, in

indexed booklet form, shall be provided. The operation manual shall include the HVAC control system sequence of operation, and procedures for the HVAC system start-up, operation and shut-down. The operation manual shall include as-built HVAC control system detail drawings. The operation manual shall include the as-built controller configuration checksheets, the as-built time clock configuration checksheet, the HVAC control system front panel description, the procedures for changing HVAC system controller setpoints, the procedures for gaining manual control of processes, the time clock manufacturer's manual control of processes, the time clock manufacturer's operation manual, and the controller manufacturer's operation manual.

- a. The HVAC control system front panel description shall explain the meaning and use of the lights, switches, gauges, and controller displays located in the front panel. Each light, switch, gauge, and display described shall be numbered and referenced to a drawing of the front panel.
- b. The procedures for changing HVAC system controller setpoints shall describe the step-by-step procedures required to change: the process variable setpoints of controllers, the alarm setpoints of controllers, the controller bias settings, and controller setpoint reset schedules.
- c. The procedures for gaining manual control of processes shall describe step-by-step procedures required to gain manual control of devices and manually adjust their positions.

1.6 MAINTENANCE AND REPAIR MANUAL

An HVAC control system maintenance and repair manual for each HVAC control system, in indexed booklet form in hardback binders, shall be provided. The maintenance and repair manual shall include the routine maintenance checklist, a recommended repair methods list, a list of recommended maintenance and repair tools, the qualified service organization list, the as-built commissioning procedures and report, the as-built performance verification test procedures and report, and the as-built equipment data booklet (EDB).

- a. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all devices listed in the equipment compliance booklet (ECB), the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional comments or reference.
- b. The recommended repair methods list shall be arranged in a columnar format and shall list all devices in the equipment compliance booklet (ECB) and state the guidance on recommended repair methods, either field repair, factory repair, or whole-item replacement.
- c. The as-built equipment data booklet (EDB) shall include the equipment compliance booklet (ECB) and all manufacturer supplied user manuals and information.
- d. If the operation manual and the maintenance and repair manual are provided in a common volume, they shall be clearly differentiated

and separately indexed.

PART 2 PRODUCTS

2.1 MATERIAL AND EQUIPMENT

Material and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 2 years experience must be satisfactorily completed by a product which has been sold or is offered for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation, for not less than 6000 hours exclusive of the manufacturer's factory tests, can be shown. The equipment items shall be supported by a service organization. The Contractor shall submit a certified list of qualified permanent service organizations and qualifications. These service organizations shall be reasonably convenient to the equipment on a regular and emergency basis during the warranty period.

2.2 GENERAL EQUIPMENT REQUIREMENTS

2.2.1 Electrical and Electronic Devices

All electrical, electronic, and electro-pneumatic devices not located within an HVAC control panel shall have a NEMA Type 12 enclosure in accordance with NEMA 250 unless otherwise shown.

2.2.2 Standard Signals

The output of all analog transmitters and the analog input and output of all single-loop controllers and function modules shall be 4-to-20 mA dc signals. The signal shall originate from current-sourcing devices and shall be received by current-sinking devices.

2.2.3 Ambient Temperature Limits

Ambient Temperature Actuators and positive positioners, and transmitters shall operate within temperature limit ratings of 40 to 140 degrees F. All panel-mounted instruments shall operate within limit ratings of 35 to 120 degrees F and 10 percent to 95 percent relative humidity, noncondensing. All devices installed outdoors shall operate within limit ratings of minus 40 to plus 150 degrees F.

2.2.4 Nameplates, Lens Caps, and Tag Nameplates

Nameplates, lens caps, and lens caps bearing legends as shown and tags bearing device-unique identifiers as shown shall have engraved or stamped characters. A plastic or metal tag shall be mechanically attached directly to each device or attached by a metal chain or wire. Each air flow measurement station shall have a tag showing flow rate range for signal output range, duct size, and identifier as shown.

2.2.5 Year 2000 Compliance

All equipment shall be Year 2000 compliant and shall be able to accurately process date/time data (including, but not limited to, calculating, comparing, and sequencing) from, into, and between the twentieth and twenty-first centuries, including leap year calculations, when used in accordance with the product documentation provided by the contractor, provided that all products (e.g. hardware, software, firmware) used in combination with other information technology, shall accurately process date/time data if other information technology properly exchanges date/time data with it.

2.3 MATERIALS

2.3.1 Wiring

2.3.1.1 Terminal Blocks

Terminal blocks shall be insulated, modular, feed-through, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or shall have enclosed sides.

2.3.1.2 Control Wiring for 24-Volt Circuits

Control wiring for 24-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 300-volt service.

2.3.1.3 Wiring for 120-Volt Circuits

Wiring for 120-volt circuits shall be 18 AWG minimum, stranded copper and shall be rated for 600-volt service.

2.3.1.4 Analog Signal Wiring Circuits

Analog signal wiring circuits within control panels shall not be less than 20 AWG and shall be rated for 300-volt service.

2.3.1.5 Instrumentation Cable

Instrumentation cable shall be 18 AWG, stranded copper, single or multiple-twisted, minimum 2 inch lay of twist, 100 percent shielded pairs, and shall have a 300-volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation. Cables shall have an overall aluminum-polyester or tinned-copper cable-shield tape, overall 20 AWG tinned-copper cable drain wire, and overall cable insulation.

2.3.1.6 Nonconducting Wiring Duct

Nonconducting wiring duct in control panels shall have wiring duct in control panels shall have slotted sides, snap-on duct covers, have slotted sides, snap-on duct covers, fittings for connecting ducts, mounting clips for securing ducts, and wire-retaining clips.

2.3.1.7 Transformers

Step-down transformers shall be utilized where control equipment operates at lower than line circuit voltage. Transformers, other than transformers in bridge circuits, shall have primaries wound for the voltage available and secondaries wound for the correct control circuit voltage.

Transformers shall be sized so that the connected load is 80 percent of the rated capacity or less. Transformers shall conform to UL 508.

2.4 ACTUATORS

Actuators shall be electric as shown and shall be provided with mounting and connecting hardware. Actuators shall fail to their spring-return positions on signal or power failure. The actuator stroke shall be limited in the direction of power stroke by an adjustable stop. Actuators shall have a visible position indicator. Actuators shall smoothly open or close the devices to which they are applied and shall have a full stroke response time of 90 seconds or less. Electric actuators shall have an oil-immersed gear train. Electric actuators operating in series shall have an auxiliary actuator driver. Electric actuators used in sequencing applications shall have an adjustable operating range and start point.

2.5 DAMPERS

2.5.1 Damper Assembly

Maximum damper blade width shall be 8 inches. Dampers shall be steel, or other materials where shown. Flat blades shall be made rigid by folding the edges. All blade-operating linkages shall be within the frame so that blade-connecting devices within the same damper section will not be located directly in the air stream. Damper axles shall be 0.5 inch (minimum) plated steel rods supported in the damper frame by stainless steel or bronze bearings. Blades mounted vertically shall be supported by thrust bearings.

Pressure drop through dampers shall not exceed 0.04 inch water gauge at 1,000 fpm in the wide-open position. Frames shall not be less than 2 inches in width. Dampers shall be tested in accordance with AMCA 500-D.

2.5.1.1 Operating Links

Operating links external to dampers (such as crankarms, connecting rods, and line shafting for transmitting motion from damper actuators to dampers) shall withstand a load equal to at least twice the maximum required damper-operating force. Rod lengths shall be adjustable. Links shall be brass, bronze, zinc-coated steel, or stainless steel. Working parts of joints and clevises shall be brass, bronze, or stainless steel. Adjustments of crankarms shall control the open and closed positions of dampers.

2.5.1.2 Damper Types

Dampers shall be parallel blade type.

2.5.2 Outside-Air and Exhaust-Air Dampers

The dampers shall be provided where shown. Blades shall have interlocking edges and shall be provided with compressible seals at points of contact. The channel frames of the dampers shall be provided with jamb seals to minimize air leakage. Dampers shall not leak in excess of 20 cfm per square foot at 4 inches water gaugestatic pressure when closed. Seals shall be suitable for an operating temperature range of minus 40 to plus 200 degrees F. Dampers shall be rated at not less than 2000 fpm air velocity. Dampers shall be sized according to damper schedule on drawings.

2.5.3 Mechanical Space Ventilation Dampers

The dampers shall be as shown. Dampers shall not leak in excess of 80 cfm per square foot at 4 inches water (gauge) static pressure when closed. Dampers shall be rated at not less than 1500 fpm air velocity.

2.6 THERMOSTATS

Thermostat ranges shall be selected so that the setpoint is adjustable without tools between plus or minus 10 degrees F of the setpoint shown. Thermostats shall be electronic or electric.

2.6.1 Nonmodulating Room Thermostats

Contacts shall be single-pole double-throw (SPDT), hermetically sealed, and wired to identified terminals. Maximum differential shall be 5 degrees F. Room thermostats shall be enclosed with separate locking covers (guards). Thermostats shall have manual switches as required by the application.

2.6.2 Modulating Room Thermostats

Modulating room thermostats shall have two output signals operating in unison, as required for the application. Each thermostat shall have an adjustable throttling range of 4 to 8 degrees F for each output. Room thermostats shall be enclosed with separate locking covers (guards).

2.7 CONTROL DEVICES AND ACCESSORIES

Control device and accessory input impedance shall not exceed 250 ohms.

2.7.1 Function Modules

Function modules shall accept mA_{dc} analog input signals to produce mA_{dc} analog output signals or contact output signals. Modules shall have zero and span adjustments for analog outputs, and setpoint adjustments for contact outputs. Module output span accuracy shall be plus or minus 1 percent of input span. Modules shall be rail-mounted as shown. Power consumption shall be not greater than 5 watts.

2.7.1.1 Minimum-Position Switch and Temperature-Setpoint Device

Minimum-position switch and temperature-setpoint device shall accept a 1000 ohms potentiometer input and shall produce a steady analog output. In temperature setpoint applications the potentiometer shall be single-turn, suitable for wall mounting, enclosed in a locking metal or heavy duty plastic enclosure and shall have a graduated dial corresponding to the range of the setpoint adjustment. In a minimum position switch application the potentiometer shall be mounted on or internal to the minimum position switch. The device shall have its input signal electrically or optically isolated from output. Mounting socket shall be an 8 pin base with pins 1, 2, 3 ac power input, 4, 5, 6 input signal, 7, 8, output signal.

2.7.2 Relays

Relays shall be 2-pole, double-throw (2PDT) with a 10-ampere resistive rating at 120 Vac, and shall have an enclosed 120-Vac coil with 8 pin blade connectors, and a matching rail-mounted socket. Power consumption shall not be greater than 3 watts.

2.7.3 Time-Delay Relays

Time delay relays shall be 2PDT with 8 pin connectors, dust cover, and a matching rail-mounted socket. Adjustable timing range shall be 0 to 5 minutes. Power consumption shall be not greater than 3 watts.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION CRITERIA

The HVAC control system shall be installed and ready for operation, as specified and shown. Dielectric isolation shall be provided where dissimilar metals are used for connection and support. Penetrations through and mounting holes in the building exterior shall be made watertight. The HVAC control system installation shall provide clearance for control system maintenance by maintaining access spacerequired to calibrate, remove, repair, or replace control system devices. The control system installation shall not interfere with the clearance requirements for mechanical installation shall not interfere with the clearance requirements for mechanical and electrical system maintenance.

3.1.1 Device Mounting Criteria

Devices mounted in or on piping or ductwork, on building surfaces, in mechanical/electrical spaces, or in occupied space ceilings shall be installed in accordance with manufacturer's recommendations and as shown. Control devices to be installed in piping and ductwork shall be provided with all required gaskets, flanges, thermal compounds, insulation, piping, fittings, and manual valves for shutoff, equalization, purging, and calibration. Strap-on temperature sensing elements shall not be used except as specified.

3.1.2 Wiring Criteria

Wiring external to control panels, including low-voltage wiring, shall be installed in metallic raceways. Wiring shall be installed without splices between control devices and HVAC control panels. Cables and conductors shall be tagged at both ends, with the identifier shown on the shop drawings, in accordance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Other electrical work shall be as specified in Section 16415 ELECTRICAL WORK, INTERIOR and as shown.

3.2 CONTROL SYSTEM INSTALLATION

3.2.1 Damper Actuators

Actuators shall not be mounted in the air stream. Multiple actuators operating a common damper shall be connected to a common drive shaft. Actuators shall be installed so that their action shall seal the damper to the extent required to maintain leakage at or below the specified rate and shall move the blades smoothly.

3.2.2 Room-Instrument Mounting

Room instruments, such as wall mounted thermostats, shall be mounted 5 feet above the floor unless otherwise noted.

3.3 CONTROL SEQUENCES OF OPERATION

3.3.1 System Requirements

These requirements shall apply to all primary HVAC systems unless modified herein. The sequences describe the actions of the control system for one direction of change in the HVAC process analog variable, such as temperature, humidity or pressure. The reverse sequence shall occur, with adequate dead band, when the direction of change is reversed.

3.3.2 Electric Unit-Heaters (EUH-1 and EUH-2)

A wall-mounted thermostat with an "AUTO-OFF" switch, shall cycle the fan to maintain a setpoint of 45 degrees F (adjustable) when the switch is in the "AUTO" position. When the switch is in the "OFF" position, the fan shall be stopped.

3.3.3 Exhaust Fan: EF-1 (Operating Floor)

EF-1 shall be interlocked with damper operator CD-2.

EF-1 shall be a 2-speed fan. At "High" speed, fan shall operate at 100 percent capacity. At "Low" speed, fan shall operate at approximately 50 percent capacity. EF-1 shall be controlled through an "Hand-Off-Auto" switch located near fan. In "Hand" position, EF-1 shall operate continuously at "Low" speed and Damper CD-2 shall be open. In "Off" position, EF-1 shall be de-energized and Damper CD-2 shall be closed. In "Auto" position, EF-1 shall be operated at "High" speed through a space mounted thermostat (see sequence below).

3.3.4 Exhaust Fan: EF-2 (Sump Floor)

EF-2 shall be interlocked with the submersible pump control panel and the pump room lights.

EF-2 shall be controlled through an "Hand-Off-Auto" switch located near the fan. In the "Hand" position, EF-2 shall operate continuously. In the "Off" position, EF-2 shall be de-energized. In the "Auto" position, EF-2 shall energize when any of the pumps energize (submersible storm water pumps or the sump pump) or when the pump room lights are "On." In the "Auto" position, EF-2 shall be de-energized when none of the pumps are running and the pump room lights are "Off."

3.3.5 Emergency Generator Damper Sequences

When the emergency generator is started, makeup air damper CD-2 and exhaust damper CD-1 shall open. Damper motors shall be connected to emergency power. The damper shall fail closed. Each motor-operated damper shall have a test button for testing the operation of the dampers. When the button is pushed, the damper shall open; when the button is released, the damper shall close. The test button shall be located in an oil tight enclosure next to associated operator.

Engine Generator Off: EUH-1 and EUH-2 cycle to maintain thermostat set point of 45 degrees F (adjustable). Radiator exhaust control damper CD-1 and makeup air damper CD-2 are closed.

Engine Generator On: EUH-1 and EUH-2 cycle to maintain thermostat set point of 45 degrees F. When engine generator is energized, exhaust damper CD-1 and makeup air damper CD-2 shall open and return air damper CD-3 shall be closed. When space temperature reaches 60 degrees F (adjustable), control dampers CD-1 and CD-3 shall modulate to maintain space temperature of 60 degrees F. When space temperature reaches 75 degrees F increasing

(adjustable), exhaust fan EF-1 shall energize. When space temperature reaches 70 degrees F decreasing (adjustable), EF-1 shall de-energize.

The Contractor shall test the operation of the engine generator set radiator fan and dampers to set minimum closed position for exhaust damper CD-1. When CD-1 is at minimum closed position, CD-3 shall be 100 percent open and the fan shall operate at full capacity at less than 0.5 inch total external static pressure.

3.4 COMMISSIONING PROCEDURES

3.4.1 General Procedures

3.4.1.1 Evaluations

The Contractor shall make the observations, adjustments, calibrations, measurements, and tests of the control systems, tune the controllers, set the time clock schedule, and make any necessary control-system corrections to ensure that the systems function as described in paragraph CONTROL SEQUENCES OF OPERATION. The Contractor shall permanently record, on system equipment schedule, the final setting of controller proportional, integral and derivative constant settings, setpoint, manual reset setting, maximum and minimum controller output, and ratio and bias settings, in units and terminology specific to the controller.

3.4.1.2 Item Check

An item-by-item check of the sequence of operation requirement shall be performed using Steps 1 through 4 in the specified control system commissioning procedures. Steps 1, 2, and 3 shall be performed with the HVAC system shutdown; Step 4 shall be performed after the HVAC systems have been started. Signals used to change the mode of operation shall originate from the actual HVAC control device intended for the purpose, such as the time clock. External input signals to the HVAC control panel (such as EMCS, starter auxiliary contacts, and external systems) may be simulated in Steps 1, 2, and 3. With each operational-mode change signal, pilot lights and HVAC-panel output-relay contacts shall be observed to ensure that they function. All terminals assigned to EMCS shall be checked and observed to ensure that the proper signals are available.

3.4.1.3 Configuration

The Contractor shall configure each controller for its specified service.

3.4.2 Unit Heater

The "OFF/AUTO" switch shall be placed in the "OFF" position. Each space-thermostat temperature setting shall be turned up so that it makes contact to turn on the unit-heater fans. The unit-heater fans shall not start. The "OFF/AUTO" switch shall be placed in the "AUTO" position. The unit-heater fans shall start. Each space-thermostat temperature setting shall be turned down, and the unit-heater fans shall stop. The thermostats shall be set at their temperature setpoints shown. The results of testing of one of each type of unit shall be logged.

3.5 BALANCING, COMMISSIONING, AND TESTING

3.5.1 Coordination with HVAC System Balancing

Commissioning of the control system, except for tuning of controllers, shall be performed prior to or simultaneous with HVAC system balancing. The Contractor shall tune the HVAC control system after all air-system and hydronic-system balancing has been completed, minimum damper positions set and a report has been issued.

3.5.2 Control System Calibration, Adjustments, and Commissioning

Control system commissioning shall be performed for each HVAC system, using test plans and procedures previously approved by the Government. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform commissioning and testing of the HVAC control system. All instrumentation and controls shall be calibrated and the specified accuracy shall be verified using test equipment with calibration traceable to NIST standards. Wiring shall be tested for continuity and for ground, open, and short circuits. Tubing systems shall be tested for leaks. Mechanical control devices shall be adjusted to operate as specified. HVAC control panels shall be pretested off-site as a functioning assembly ready for field connections, calibration, adjustment, and commissioning of the operational HVAC control system. Written notification of any planned commissioning or testing of the HVAC Control systems shall be given to the Government at least 14 calendar days in advance.

3.5.3 Performance Verification Test

The Contractor shall demonstrate compliance of the HVAC control system with the contract documents. Using test plans and procedures previously approved by the Government, the Contractor shall demonstrate all physical and functional requirements of the project. The performance verification test shall show, step-by-step, the actions and results demonstrating that the control systems perform in accordance with the sequences of operation. The performance verification test shall not be started until after receipt by the Contractor of written permission by the Government, based on Government approval of the commissioning report and completion of balancing. The tests shall not be conducted during scheduled seasonal off-periods of base heating and cooling systems.

3.5.4 Posted and Panel Instructions

Posted and panel instructions, showing the final installed conditions, shall be provided for each system. The posted instructions shall consist of half-size laminated drawings and shall include the control system schematic, equipment schedule, ladder diagram, sequence of operation, panel arrangement drawings, wiring diagram, and valve and damper schedules. The posted instructions shall be permanently affixed, by mechanical means, to a wall near the control panel. Panel instructions shall consist of laminated letter-size sheets and shall include a routine maintenance checklist and controller configuration check sheets with final configuration record for each controller. Panel instructions and one copy of the operation and maintenance manuals, previously described herein, shall be placed inside each control panel.

3.6 TRAINING

3.6.1 Training-Course Requirements

A training course shall be conducted for all operating staff members designated by the Contracting Officer. The training period, during normal

working time, shall be conducted within 30 days after successful completion of the performance verification test. The training course shall be conducted at the project site. Audiovisual equipment and sets of all other training materials and supplies shall be provided. A training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during the daytime shift in effect at the training facility.

3.6.2 Training-Course Content

For guidance in planning the required instruction, the Contractor shall assume that attendees will have a high school education or equivalent, and are familiar with HVAC systems. The training course shall cover all of the material contained in the operating and maintenance instructions, the layout and location of each HVAC control panel, the layout of one of each type of unitary equipment and the locations of each, the location of each system-control device external to the panels, the location of the compressed-air station, preventive maintenance, troubleshooting, diagnostics, calibration, adjustment, commissioning, tuning, and repair procedures. Typical systems and similar systems may be treated as a group, with instruction on the physical layout of one such system. The results of the performance verification test and the calibration, adjustment and commissioning report shall be presented as benchmarks of HVAC control-system performance by which to measure operation and maintenance effectiveness.

-- End of Section --

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SECTION 16120

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PART 3 EXECUTION (Not Applicable)

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SECTION 16120

INSULATED WIRE AND CABLE

PART 1 GENERAL

1.1 REFERENCES

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

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE Std 383 (1974; R 1992) Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC 7 (1988; Rev 3 1996)
Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

NEMA WC 8 (1988; Rev 3 1996)
Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Installation Instructions; FIO.

The Contractor shall submit cable manufacturing data as requested.

SD-09 Reports

Tests, Inspections, and Verifications; FIO.

Six certified copies of test reports shall be submitted by the Contractor.

1.3 DELIVERY, STORAGE, AND HANDLING

Reels shall remain the property of the Contractor.

1.4 PROJECT/SITE CONDITIONS

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Wire Table

Wire and cable shall be furnished in accordance with the requirements of the drawings and shall conform to the detailed requirements specified herein.

2.1.2 Rated Circuit Voltages

All wire and cable shall have minimum rated circuit voltages in accordance with Table 3-1 of NEMA WC 7 or NEMA WC 8.

2.1.3 Conductors

2.1.3.1 Material

Conductors shall conform to all the applicable requirements of Section 2 of NEMA WC 7 or Part 2 of NEMA WC 8 as applicable and shall be annealed copper. Copper conductors may be bare, or tin- or lead-alloy-coated, if required by the type of insulation used.

2.1.3.2 Size

Minimum wire size shall be No. 12 AWG for power and lighting circuits; No. 10 AWG for current transformer secondary circuits; No. 14 AWG for potential transformer, relaying, and control circuits; and No. 19 AWG for alarm circuits.

2.1.3.3 Stranding

Conductor stranding classes cited herein shall be as defined in Appendix L of NEMA WC 7 or NEMA WC 8, as applicable. Lighting conductors No. 10 AWG and smaller shall be solid or have Class B stranding. Any conductors used between stationary and moving devices, such as hinged doors or panels, shall have Class H or K stranding. All other conductors shall have Class B or C stranding, except that conductors shown on the drawings, or in the schedule, as No. 12 AWG may be 19 strands of No. 25 AWG, and conductors shown as No. 10 AWG may be 19 strands of No. 22 AWG.

2.1.3.4 Separator Tape

Where conductor shielding, strand filling, or other special conductor treatment is not required, a separator tape between conductor and insulation is permitted.

2.1.4 Insulation

2.1.4.1 Insulation Material

Insulation shall be cross-linked thermosetting polyethylene (XLPE) type, meeting the requirements of Section 3 or paragraph 7.7 of NEMA WC 7 as applicable, or an ethylene-propylene rubber (EPR) type meeting the requirements of Part 3 of NEMA WC 8.

2.1.4.2 Insulation Thickness

The insulation thickness for each conductor shall be based on its rated

circuit voltage.

2.1.5 Jackets

All cables shall have jackets meeting the requirements of Section 4 of NEMA WC 7, or Part 4 of NEMA WC 8, as applicable, and as specified herein. Individual conductors of multiple-conductor cables shall be required to have jackets only if they are necessary for the conductor to meet other specifications herein. Jackets of single-conductor cables and of individual conductors of multiple-conductor cables, shall be in direct contact and adhere or be vulcanized to the conductor insulation. Multiple-conductor cables and shielded single-conductor cables shall be provided with a common overall jacket, which shall be tightly and concentrically formed around the core. Repaired jacket defects found and corrected during manufacturing are permitted if the cable, including jacket, afterward fully meets these specifications and the requirements of the applicable standards.

2.1.5.1 Jacket Material

The jacket shall be one of the materials listed below.

a. General Use

- (1) Heavy-duty black neoprene (NEMA WC 8, paragraph 4.4.3).
- (2) Heavy-duty chlorosulfonated polyethylene (NEMA WC 8, paragraph 4.4.10).
- (3) Heavy-duty cross-linked (thermoset) chlorinated polyethylene (NEMA WC 8, paragraph 4.4.11).

2.1.5.2 Jacket Thickness

The minimum thickness of the jackets at any point shall be not less than 80 percent of the respective nominal thicknesses specified below.

a. Multiple-Conductor Cables - Thickness of the jackets of the individual conductors of multiple-conductor cables shall be as required by Section 4, Table 4-6 of NEMA WC 7 or Part 4, Table 4-4 of NEMA WC 8, and shall be in addition to the conductor insulation thickness required by Column B of Table 3-1 of the applicable NEMA publication for the insulation used. Thickness of the outer jackets or sheaths of the assembled multiple-conductor cables shall be as required by Section 4, Table 4-7, of NEMA WC 7 or Part 4, Table 4-5, of NEMA WC 8.

b. Single-Conductor Cables - Single-conductor cables, if nonshielded, shall have a jacket thickness as specified in Section 4, Table 4-4 of NEMA WC 7 or Part 4, Table 4-2 of NEMA WC 8.

2.1.6 Identification

2.1.6.1 Color-coding

Refer to Section 16415 ELECTRICAL WORK, INTERIOR for conductor identification and tagging.

2.1.7 Dimensional Tolerance

Grand Forks Phase 1 Levees

The outside diameters of single-conductor cables and of multiple-conductor cables shall not vary more than 5 percent and 10 percent, respectively, from the manufacturer's published catalog data.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Cable Data

Cable data shall be submitted for approval including dimensioned sketches showing cable construction, and sufficient additional data to show that these specifications will be satisfied.

2.2.2 Inspection and Tests

Inspection and tests of wire and cable furnished under these specifications shall be made by and at the plant of the manufacturer. The Government may perform further tests before or after installation. Testing in general shall comply with Section 6 of NEMA WC 7 or Part 6 of NEMA WC 8. Specific tests required for particular materials, components, and completed cables shall be as specified in the sections of the above standards applicable to those materials, components, and cable types. Tests shall also be performed in accordance with the additional requirements specified below.

2.2.2.1 Flame Tests

All multiple-conductor and single-conductor cable assemblies shall pass IEEE Std 383 flame tests, paragraph 2.5, using the ribbon gas burner. Single-conductor cables and individual conductors of multiple-conductor cables shall pass the flame test of NEMA WC 7, paragraph 7.7.3.1.3. If such tests, however, have previously been made on identical cables, these tests need not be repeated. Instead, certified reports of the original qualifying tests shall be submitted. In this case the reports furnished under paragraph REPORTS, shall verify that all of each cable's materials, construction, and dimensions are the same as those in the qualifying tests.

2.2.2.2 Independent Tests

The Government may at any time make visual inspections, continuity or resistance checks, insulation resistance readings, power factor tests, or dc high-potential tests at field test values. A cable's failure to pass these tests and inspections, or failure to produce readings consistent with acceptable values for the application, will be grounds for rejection of the cable.

2.2.2.3 Reports

Results of tests made shall be furnished. No wire or cable shall be shipped until authorized. Lot number and reel or coil number of wire and cable tested shall be indicated on the test reports.

PART 3 EXECUTION (Not Applicable)

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SECTION 16239

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SECTION 16239

ENGINE RADIATOR AIRFLOW-COOLED LOAD BANK

PART 1 GENERAL

1.1 REFERENCES

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

UNDERWRITERS LABORATORIES (UL)

UL 1030 (1994) Sheathed Heating Elements Sixth Edition

1.2 SYSTEM DESCRIPTION

Provide engine radiator airflow-cooled, resistive load bank for permanent, on-site installation as a component for each Government-furnished standby engine generator system. The load bank shall be designed for local control, with automatic and manual operation capability. The load bank shall bear the listing mark of Underwriters Laboratories (UL Listing).

1.3 WARRANTY

The load bank shall be supplied with a 2-year manufacturer's warranty, which covers all materials and service labor. The manufacturer shall demonstrate the availability of factory service technicians in support of the load bank.

1.4 MANUFACTURER'S QUALIFICATIONS

The load bank shall be a product of a firm regularly engaged in the design and manufacture of generator load banks. The load bank manufacturer shall demonstrate at least five years experience, with at least twenty-five successful installations of load banks, similar or equal to the load banks specified herein.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

Simplex LBD Series, or other approved equal.

2.2 ELECTRICAL CONNECTION

Power source to load bank connection shall be 3-phase, 3-wire plus ground. Additional control wire connections for remote control as required.

2.3 LOAD BANK RATING

Provide 4 separate load banks with the following capacities:

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- a. Capacity: 50 kW, 1.0 p.f.
- b. Capacity: 100 kW, 1.0 p.f.
- c. Capacity: 125 kW, 1.0 p.f.
- d. Capacity: 175 kW, 1.0 p.f.

Load banks shall be rated for 50 percent of total generator rating. Load steps shall be in manufacturer's suggested increments, in order to obtain specific rating. Voltage shall be 480 volts ac, three-phase, 3-wire. Frequency shall be 60 Hertz. Air intake temperature shall be 155 degrees F max (radiator air outflow). Provide radiator air outflow. Load bank shall have continuous duty cycle, air temperature rise of 100 degrees F, nominal, and an air back pressure of 0.25-0.50 inch water column.

2.4 LOAD BANK DESIGN

The load bank shall be a completely self-contained unit which includes all resistive load elements, load control devices, load element branch circuit fuse protection, main load bus and terminals, control terminals, system protection devices and NEMA enclosure of required type. The load bank shall be the manufacturer's standard product that has been investigated, tested and listed by Underwriters Laboratories, as a system for the purpose intended. Simple assemblies of listed parts that are not system UL listed shall not be acceptable.

2.4.1 Enclosure

NEMA Type 1, galvanized steel, unit construction, consisting of a power section, for installation and wiring of the load elements and a control section for installation and wiring of control components. The control section is to be physically and thermally isolated from both the hot load elements and the heated airflow. Load Bank shall be provided with adjustable height, floor mounting adaptors, for independent support of unit. Ductwork shall be supported separately. Load bank shall also be provided with a flexible isolating transition from the generator radiator, along with sheet metal duct on both sides of the load bank as shown on drawings.

2.4.2 Load Elements

Load elements shall be in accordance with UL 1030, labeled or recognized, totally enclosed, sealed and weather-proof with an electrically grounded outer sheath such that the element can not be electrically short-circuited by external foreign objects and personnel are protected against accidental electrical shock. Elements shall be individually replaceable. Open wire type elements in which the electrically live conductors are exposed and which can be short circuited to each other or to ground by foreign objects or by the breakage of an element or an element support shall not be permitted.

2.4.3 Load Element Short Circuit Protection

Branch circuit fuses, per each 50 kW load branch circuit. Fuses shall be 200,000 A.I.C current limiting type.

2.4.4 Load Control

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One magnetic contactor per each fused branch circuit.

2.4.5 Power Wiring

Load bank power wiring shall be 302 degrees F insulated.

2.4.6 Main Terminals

Barrier type power terminal block with compression type terminal to accept stranded building wire. Provide chassis ground stud with compression type terminal.

2.4.7 Control Wiring

Control wiring shall be 221 degrees F insulated.

2.4.8 Control Power

Control power shall be derived internally from the main load bus. Control and protective circuits shall operate at 120 volts via control power transformer or line-neutral circuit and shall be fused.

2.4.9 System Protection

The load bank shall include a comprehensive protection system to protect against overheating. The system shall function to disconnect the load elements from the power source and activate an alarm upon sensing an exhaust air temperature greater than 300 degrees F.

2.5 LOCAL CONTROL PANEL

Control panel shall be NEMA 1 for automatic and manual operation. The panel shall include:

- a. Control power on-off pushbuttons.
- b. Automatic and Manual operation switch.
- c. "Normal operation" indicator lamp.
- d. Master load control switch.
- e. Load step control switches.
- f. "Cooling failure" alarm indicator lamp.

2.6 AUTOMATIC LOAD BANK CONTROLLER

The load bank is to be equipped with an automatic controller, which will be activated when the load bank mode control selector switch is placed in the "automatic" position. In automatic mode, the load bank is to be on-line and continuously operative whenever the power source runs. The load bank shall provide a component of the total power source load and shall be automatically variable in response to dynamic total load demands upon the power source. The automatic controller shall include control logic, solid-state sensors and time delays, which shall act to apply or remove load bank component in multiple steps in response to dynamic output of the power source. The automatic controller shall function to maintain 50 percent total load upon the power source within a preset bandwidth by

adding load bank load component as external load component drops and removing load bank component as external load rises. The automatic controller shall sense load kilowatts. Full manual control of the load bank shall be restored when the mode selector switch is placed in the "manual" position. The automatic controller shall include a solid-state load sensor with level and time delay adjustment and output contacts for each load step. A current transformer for external installation shall be provided.

PART 3 EXECUTION

3.1 INSTALLATION

The load bank shall be installed within the air outflow of the engine unit mounted radiator and shall be cooled by the radiator airflow. Install load bank within radiator exhaust air duct. Provide flexible transition from radiator to duct and solid duct transition to load bank and outlet control dampers.

3.2 MANUFACTURER'S FIELD SERVICES

Provide manufacturer's field representative for one day start-up service, for each installation of the load bank, on site, after the load bank has been installed and connected.

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SECTION 16264

DIESEL-GENERATOR SET

PART 1 GENERAL

1.1 SCOPE

This section covers the furnishing and installing of the necessary ductwork, exhaust system, electrical connections, and any other power distribution equipment as shown and specified herein to complete the installation of Government-furnished generators for all four pump stations as indicated on the drawings. The handling, installing, connecting of these Government-furnished generators, connection to the electrical distribution system, the standby generator cooling removal system, engine exhaust and other associated equipment including connection to the automatic transfer switch, are also part of the Contractor's work under this section.

1.2 REFERENCES

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

ASME INTERNATIONAL (ASME)

ASME B31.1 (1998) Power Piping

ASME BPV IX (1998) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1997) National Electrical Safety Code

IEEE Std 81 (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

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

MSS SP-58 (1993) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (1996) Pipe Hangers and Supports - Selection and Application

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30 (1996; Errata TIA 96-2) Flammable and Combustible Liquids Code

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Materials and Equipment; FIO.

A complete list of accessory equipment and materials proposed (such as anchor bolts, exhaust components, etc), containing an adequate description of each separate item of equipment or materials recommended for approval, shall be furnished. The quantity of each item described shall be indicated.

Site Welding; FIO.

A letter listing the welder qualifying procedures for each welder, complete with supporting data such as test procedures used, what was tested to, and a list of the names of all welders and their qualifications symbols.

General Installation; FIO.

A complete copy of the manufacturer's installation procedures. A detailed description of the manufacturer's recommended break-in procedure.

SD-04 Drawings

Cooling; FIO.

Drawings shall be prepared that indicate sizes and physical configuration of the louvers, dampers, and ductwork required to connect the GFE generator and load bank into each pump station as shown on the drawings.

1.4 SYSTEM DESCRIPTION

Each engine-generator set shall be installed complete and totally functional, with all necessary ancillary equipment to include air filtration; starting system; generator controls, protection, and isolation; instrumentation; lubrication; fuel system; cooling system; and engine exhaust system. Each engine generator set shall satisfy the requirements specified in the Engine Generator Parameter Schedule.

1.5 GENERAL REQUIREMENTS

1.5.1 Verification of Dimensions

Before performing work, the premises shall be visited and details of the work verified. The Contracting Officer shall be advised in writing of any discrepancies before performing any work.

1.5.2 Conformance to Codes and Standards

Where equipment is specified to conform to requirements of any code or standard such as UL, the design, fabrication and installation shall conform to the code.

1.5.3 Site Welding

Structural members shall be welded in accordance with Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS. For all other welding, procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by a previously qualified employer may be accepted as permitted by ASME B31.1. Welder qualification tests shall be performed for each welder whose qualifications are not in compliance with the referenced standards. The Contracting Officer shall be notified 24 hours in advance of qualification tests. The qualification tests shall be performed at the work site if practical. The welder or welding operator shall apply the assigned personal symbol near each weld made as a permanent record

1.5.4 Field Engineer

The engine-generator set manufacturer or assembler shall furnish a qualified field engineer to supervise the complete installation of the engine-generator set, assist in the performance of the onsite tests, and instruct personnel as to the operational and maintenance features of the equipment. The field engineer shall have attended the engine-generator manufacturer's training courses on installation and operation and maintenance for engine generator sets.

1.6 STORAGE AND INSTALLATION

The Contractor shall properly protect material and equipment in accordance with the manufacturers recommended storage procedures, before, during, and after installation. Stored items shall be protected from the weather and contamination. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Workmanship

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

2.1.2 Materials and Equipment

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

2.1.3 Ductwork

All ductwork shall be made from galvanized steel sheets. All ductwork shall comply with SMACNA HVAC Duct Construction Standards. All ductwork shall be substantially airtight with no audible leaks, reinforced or crimped to

prevent "panning" at system start-up and good rigid connections to louvers and dampers.

2.1.4 Flexible Connector

The engine-generator shall be connected to the ductwork utilizing a flexible duct connector made of either fiberglass or neoprene strips bound to galvanized metal strips on each side. Duct connector shall be submitted for approval by the Contracting Officer's Representative.

2.2 COOLING

2.2.1 Ductwork

Ductwork shall be as specified in Section 15895 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM except that a flexible connection shall be used to connect the duct to the diesel engine radiator. Material for the connection shall be wire-reinforced glass. The connection shall be rendered practically airtight.

2.3 EXHAUST SYSTEM

2.3.1 Exhaust Piping

Horizontal sections of exhaust piping shall be sloped downward away from the engine to a condensate trap and drain valve. Changes in direction shall be long-radius. Exhaust piping, mufflers and silencers installed inside any building shall be insulated in accordance with Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS and covered to protect personnel. Vertical exhaust piping shall be provided with a hinged, gravity operated, self-closing, rain cover.

2.4 MANUAL ENGINE-GENERATOR SET SYSTEM OPERATION

Complete facilities shall be provided for manual starting and testing of each set without load, loading and unloading of each set.

2.5 THERMAL INSULATION

Thermal insulation shall be as specified in Section 15080 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

Installation shall provide clear space for operation and maintenance in accordance with NFPA 70 and IEEE C2. Installation of pipe, duct, conduit, and ancillary equipment shall be configured to facilitate easy removal and replacement of major components and parts of the engine-generator set.

3.2 PIPING INSTALLATION

3.2.1 General

Piping shall be welded. Connections at valves shall be flanged. Connections at equipment shall be flanged except that connections to the diesel engine may be threaded if the diesel-engine manufacturer's standard connection is threaded. Except as otherwise specified, flanged fittings

shall be utilized to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping. Connections to all equipment shall be made with flexible connectors. Pipes extending through the roof shall be properly flashed. Piping shall be installed clear of windows, doors, and openings to permit thermal expansion and contraction without damage to joints or hangers, and with a 1/2 inch drain valve at each low point.

3.2.2 Supports

Hangers, inserts, and supports shall be of sufficient size to accommodate any insulation and shall conform to MSS SP-58 and MSS SP-69. Supports shall be spaced not more than 7 feet on center for pipes 2 inches in diameter or less, not more than 12 feet on center for pipes larger than 2 inches but no larger than 4 inches, and not more than 17 feet on center for pipes larger than 4 inches in diameter. Supports shall be provided at pipe bends or change of direction.

3.2.2.1 Ceiling and Roof

Exhaust piping shall be supported with appropriately sized type 41 single pipe roll and threaded rods; all other piping shall be supported with appropriately sized type 1 clevis and threaded rods.

3.2.2.2 Wall

Wall supports for pipe shall be made by suspending the pipe from appropriately sized type 33 brackets with the appropriate ceiling and roof pipe supports.

3.2.3 Flanged Joints

Flanges shall be 125 pound type, drilled, and of the proper size and configuration to match equipment and diesel-engine connections. Gaskets shall be factory cut in one piece 1/16 inch thick.

3.2.4 Cleaning

After fabrication and before assembly, piping interiors shall be manually wiped clean of all debris.

3.2.5 Pipe Sleeves

Pipes passing through construction such as ceilings, floors, or walls shall be fitted with sleeves. Each sleeve shall extend through and be securely fastened in its respective structure and shall be cut flush with each surface. The structure shall be built tightly to the sleeve. The inside diameter of each sleeve shall be 1/2 inch, and where pipes pass through combustible materials, 1 inch larger than the outside diameter of the passing pipe or pipe covering.

3.3 ELECTRICAL INSTALLATION

Electrical installation shall comply with NFPA 70, IEEE C2, and Section 16415 ELECTRICAL WORK, INTERIOR.

3.3.1 Vibration Isolation

Flexible fittings shall be provided for all conduit and raceways attached to engine-generator sets. Metallic conductor cables installed on the engine generator set and from the engine generator set to equipment not mounted on the engine generator set shall be flexible stranded conductor. Terminations of conductors on the engine generator set shall be crimp-type terminals or lugs.

3.4 FIELD PAINTING

Field painting shall be as specified in Section 09900 PAINTING, GENERAL.

3.5 ONSITE INSPECTION AND TESTS

3.5.1 Test Conditions

3.5.1.1 Sequence

The sequence of testing shall be as specified in the approved testing plan unless variance is authorized by the Contracting Officer. Field testing shall be performed in the presence of the Contracting Officer. Tests may be scheduled and sequenced in order to optimize run-time periods; however the following general order of testing shall be followed: Construction Tests; Inspections; Safety run Tests; and Performance Tests and Final Inspection.

3.5.2 Construction Tests

Individual component and equipment functional tests for fuel piping, coolant piping, and lubricating-oil piping, electrical circuit continuity, insulation resistance, circuit protective devices, and equipment not provided by the engine-generator set manufacturer shall be performed prior to connection to the engine-generator set.

3.5.2.1 Piping Test

- a. Lube-oil and fuel-oil piping shall be flushed with the same type of fluid intended to flow through the piping, until the outflowing fluid has no obvious sediment or emulsion.
- b. Fuel piping which is external to the engine-generator set shall be tested in accordance with NFPA 30. All remaining piping which is external to the engine generator set shall be pressure tested with air pressure at 150% of the maximum anticipated working pressure, but in no case less than 150 psig, for a period of 2 hours to prove the piping has no leaks. If piping is to be insulated, the test shall be performed before the insulation is applied.

3.5.2.2 Electrical Equipment Tests

- a. Low-voltage cable insulation integrity tests shall be performed for cables connecting the generator breaker to the automatic transfer switch panelboard main disconnect switch distribution bus. Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench,

duct, or conduit. The minimum value of insulation shall be:

R in megohms = (rated voltage in kV + 1) x 304,800/(length of cable in meters).

(R in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet))

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

- b. Ground-Resistance Tests. The resistance of each grounding electrode each grounding electrode system the ground mat the ground ring shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
- 1) Single rod electrode - 25 ohms.
 - 2) Multiple rod electrodes - 10 ohms.
 - 3) Ground mat - 5 ohms.

3.6 ACCEPTANCE

Final acceptance of the engine-generator set will not be given until the Contractor has successfully completed all tests and after all defects in installation material or operation have been corrected.

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SECTION 16415

ELECTRICAL WORK, INTERIOR

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(1995) Code for Electricity Metering
ANSI C12.4	(1984; R 1996) Mechanical Demand Registers
ANSI C12.10	(1997) Electromechanical Watthour Meters
ANSI C12.11	(1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL Through 350 kV BIL (0.6 kV NSV through 69 kV NSV)
ANSI C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments
ANSI C78.1	(1991; C78.1a; R 1996) Fluorescent Lamps - Rapid-Start Types - Dimensional and Electrical Characteristics
ANSI C78.20	(1995) Electric Lamps - Characteristics of Incandescent Lamps A, G, PS, and Similar Shapes with E26 Medium Screw Bases
ANSI C78.21	(1995) Physical and Electrical Characteristics - Incandescent Lamps - PAR and R Shapes
ANSI C78.1350	(1990) Electric Lamps 400-Watt, 100-Volt, S51 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1351	(1989) Electric Lamps - 250-Watt, 100-Volt S50 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1352	(1990) Electric Lamps - 1000-Watt, 250-Volt, S52 Single-Ended High-Pressure Sodium Lamps
ANSI C78.1355	(1989) Electric Lamps - 150-Watt, 55-Volt S55 High-Pressure Sodium Lamps
ANSI C78.1375	(1996) 400-Watt, M59 Single-Ended Metal-Halide Lamps

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ANSI C78.1376	(1996) 1000-Watt, M47 Metal-Halide Lamps
ANSI C78.2A	(1991) 18 & 26- Watt, Compact Fluorescent Quad Tube Lamps
ANSI C78.2B	(1992) 9 & 13-Watt, Compact Fluorescent Quad Tube Lamps
ANSI C82.1	(1997) Specifications for Fluorescent Lamp Ballasts
ANSI C82.4	(1992) Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B 1	(1995) Hard-Drawn Copper Wire
ASTM B 8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D 709	(1992; R 1997) Laminated Thermosetting Materials

CODE OF FEDERAL REGULATIONS (CFR)

47 CFR 18	Industrial, Scientific, and Medical Equipment
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INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.13	(1993) Instrument Transformers
IEEE C62.41	(1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 1	(1993) Molded Case Circuit Breakers and Molded Case Switches
NEMA FU 1	(1986) Low Voltage Cartridge Fuses
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC

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NEMA ICS 3	(1993) Industrial Control and Systems Factory Built Assemblies
NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA LE 4	(1987) Recessed Luminaires, Ceiling Compatibility
NEMA MG 1	(1998) Motors and Generators
NEMA MG 10	(1994) Energy Management Guide for Selection and Use of Polyphase Motors
NEMA OS 1	(1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA PB 1	(1995) Panelboards
NEMA ST 20	(1992) Dry-Type Transformers for General Applications
NEMA TC 2	(1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)
NEMA WD 1	(1983; R 1989) General Requirements for Wiring Devices
NEMA WD 6	(1988) Wiring Devices - Dimensional Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1999) National Electrical Code
NFPA 101	(1997; Errata 97-1; TIA 97.1) Life Safety Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(1993; Rev thru Jan 1995) Flexible Metal Conduit
UL 6	(1997) Rigid Metal Conduit
UL 20	(1995; Rev thru Oct 1998) General-Use Snap Switches
UL 50	(1995; Rev thru Nov 1999) Enclosures for Electrical Equipment
UL 67	(1993; Rev thru Nov 1995) Panelboards
UL 83	(1998; Rev thru Sep 99) Thermoplastic-Insulated Wires and Cables
UL 98	(1994; Rev thru Jun 1998) Enclosed and

Dead-Front Switches

UL 198B	(1995) Class H Fuses
UL 198C	(1986; Rev thru Feb 1998) High-Interrupting-Capacity Fuses, Current-Limiting Types
UL 198D	(1995) Class K Fuses
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 198G	(1988; Rev May 1988) Fuses for Supplementary Overcurrent Protection
UL 198H	(1988; Rev thru Nov 1993) Class T Fuses
UL 360	(1996; Rev thru Oct 1997) Liquid-Tight Flexible Steel Conduit
UL 467	(1993; Rev thru Apr 1999) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	(1997; Rev thru Aug 1998) Splicing Wire Connectors
UL 486E	(1994; Rev thru Feb 1997) Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 489	(1996; Rev thru Dec 1998) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 506	(1994; Rev Oct 1997) Specialty Transformers
UL 508	(1999) Industrial Control Equipment
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
UL 512	(1993; R Dec 1995) Fuseholders
UL 514A	(1996; Rev Dec 1999) Metallic Outlet Boxes
UL 514B	(1997; Rev Oct 1998) Fittings for Cable and Conduit
UL 542	(1994; Rev thru Jul 1998) Lampholders, Starters, and Starter Holders for Fluorescent Lamps
UL 674	(1994; Rev thru Oct 1998) Electric Motors and Generators for Use in Division 1

Hazardous (Classified) Locations

UL 797	(1993; Rev thru Mar 1997) Electrical Metallic Tubing
UL 817	(1994; Rev thru Jul 1998) Cord Sets and Power-Supply Cords
UL 845	(1995; Rev Feb 1996) Motor Control Centers
UL 854	(1996; Rev Apr 1998) Service-Entrance Cables
UL 869A	(1998) Reference Standard for Service Equipment
UL 877	(1993; Rev thru May 1997) Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations
UL 924	(1995; Rev thru Oct 97) Emergency Lighting and Power Equipment
UL 935	(1995; Rev thru Oct 1998) Fluorescent-Lamp Ballasts
UL 943	(1993; Rev thru May 1998) Ground-Fault Circuit-Interrupters
UL 1004	(1994; Rev thru Dec 1997) Electric Motors
UL 1022	(1998) Line Isolation Monitors
UL 1029	(1994; Rev thru Dec 1997) High-Intensity-Discharge Lamp Ballasts
UL 1047	(1995; Rev Jul 1998) Isolated Power Systems Equipment
UL 1242	(1996; Rev Mar 1998) Intermediate Metal Conduit
UL 1449	(1996; Rev thru Dec 1999) Transient Voltage Surge Suppressors
UL 1569	(1995; Rev thru Sep 1998) Metal-Clad Cables
UL 1570	(1995; Rev thru Jun 1997) Fluorescent Lighting Fixtures
UL 1571	(1995; Rev thru Jun 1997) Incandescent Lighting Fixtures
UL 1572	(1995; Rev thru Jun 1997) High Intensity Discharge Lighting Fixtures
UL 1660	(1994; Rev Apr 1998) Liquid-Tight Flexible Nonmetallic Conduit

1.2 GENERAL

1.2.1 Rules

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

1.2.2 Coordination

The drawings indicate the extent and the general location and arrangement of equipment, conduit, and wiring. The Contractor shall become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment shall be properly located and readily accessible.

Lighting fixtures, outlets, and other equipment and materials shall be carefully coordinated with mechanical or structural features prior to installation and positioned according to architectural reflected ceiling plans; otherwise, lighting fixtures shall be symmetrically located according to the room arrangement when uniform illumination is required, or asymmetrically located to suit conditions fixed by design and shown. Raceways, junction and outlet boxes, and lighting fixtures shall not be supported from sheet metal roof decks. If any conflicts occur necessitating departures from the drawings, details of and reasons for departures shall be submitted and approved prior to implementing any change. The Contractor shall coordinate the electrical requirements of the mechanical work and provide all power related circuits, wiring, hardware and structural support, even if not shown on the drawings. The Contractor shall be responsible for installation, mounting, and connection of all Government-furnished equipment, as described in specifications and drawings.

1.2.3 Special Environments

1.2.3.1 Weatherproof Locations

Wiring, Fixtures, and equipment in designated locations shall conform to NFPA 70 requirements for installation in damp or wet locations.

1.2.3.2 Ducts, Plenums and Other Air-Handling Spaces

Wiring and equipment in ducts, plenums and other air-handling spaces shall be installed using materials and methods in conformance with NFPA 70 unless more stringent requirements are indicated in this specification or on the contract drawings.

1.2.4 Standard Products

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

1.2.5 Nameplates

1.2.5.1 Identification Nameplates

Major items of electrical equipment and major components shall be permanently marked with an identification name to identify the equipment by

type or function and specific unit number as indicated. Designation of motors shall coincide with their designation in the motor control center or panel. Unless otherwise specified, identification nameplates shall be made of laminated plastic in accordance with ASTM D 709 with black outer layers and a white core. Edges shall be chamfered. Plates shall be fastened with black-finished round-head drive screws, except motors, or approved nonadhesive metal fasteners. When the nameplate is to be installed on an irregular-shaped object, the Contractor shall devise an approved support suitable for the application and ensure the proper installation of the supports and nameplates. In all instances, the nameplate shall be installed in a conspicuous location. At the option of the Contractor, the equipment manufacturer's standard embossed nameplate material with black paint-filled letters may be furnished in lieu of laminated plastic. The front of each panelboard, motor control center, switchgear, and switchboard shall have a nameplate to indicate the phase letter, corresponding color and arrangement of the phase conductors. The following equipment, as a minimum, shall be provided with identification nameplates:

Minimum 1/4 inch
High Letters

Minimum 1/8 inch
High Letters

Panelboards
Starters
Safety Switches
Motor Control Centers
Transformers
Equipment Enclosures
Switchgear
Switchboards
Motors

Control Power Transformers
Control Devices
Instrument Transformers

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

1.2.6 As-Built Drawings

Following the project completion or turnover, within 30 days the Contractor shall furnish 2 sets of as-built drawings to the Contracting Officer.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Manufacturer's Catalog; GA

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

Material, Equipment, and Fixture Lists; GA

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A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each item.

As-Built Drawings; GA

The as-built drawings shall be a record of the construction as installed. The drawings shall include all the information shown on the contract drawings, deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be kept at the job site and updated daily. The as-built drawings shall be a full-sized set of prints marked to reflect all deviations, changes, and modifications. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall submit three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction.

The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within ten calendar days from the time the drawings are returned to the Contractor.

Onsite Tests; GA

A detailed description of the Contractor's proposed procedures for on-site tests.

SD-04 Drawings

Interior Electrical Equipment; GA

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams, and other information necessary to define the installation. Detail drawings shall show the rating of items and systems and how the components of an item and system are assembled, function together, and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission.

Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall show physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. Optional items shall be clearly identified as included or excluded. Detail drawings shall as a minimum include:

- a. Transformers.

- b. Switchgear.
- c. Battery system including calculations for the battery and charger.
- d. Motors and rotating machinery.
- e. Motor control centers.
- f. Panels and panelboards.
- g. Single line electrical diagrams including primary, metering, sensing and relaying, control wiring, and control logic.
- h. Sway bracing for suspended luminaires.

Structural drawings showing the structural or physical features of major equipment items, components, assemblies, and structures, including foundations or other types of supports for equipment and conductors. These drawings shall include accurately scaled or dimensioned outline and arrangement or layout drawings to show the physical size of equipment and components and the relative arrangement and physical connection of related components. Weights of equipment, components and assemblies shall be provided when required to verify the adequacy of design and proposed construction of foundations or other types of supports. Dynamic forces shall be stated for switching devices when such forces must be considered in the design of support structures. The appropriate detail drawings shall show the provisions for leveling, anchoring, and connecting all items during installation, and shall include any recommendations made by the manufacturer.

Electrical drawings including single-line and three-line diagrams, and schematics or elementary diagrams of each electrical system; internal wiring and field connection diagrams of each electrical device when published by the manufacturer; wiring diagrams of cabinets, panels, units, or separate mountings; interconnection diagrams that show the wiring between separate components of assemblies; field connection diagrams that show the termination of wiring routed between separate items of equipment; internal wiring diagrams of equipment showing wiring as actually provided for this project. Field wiring connections shall be clearly identified.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons why, shall be submitted with the detail drawings. Approved departures shall be made at no additional cost to the Government.

SD-09 Reports

Factory Test Reports; GA

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers

with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

Field Test Plan; GA

A detailed description of the Contractor's proposed procedures for onsite test submitted 30 days prior to testing the installed system. No field test will be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Field Test Reports; GA

Six copies of the information described below in 8 1/2 x 11 inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The conditions specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.
- h. Final position of controls and device settings.

SD-13 Certificates

Materials and Equipment; GA

The label or listing of the Underwriters Laboratories, Inc., will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this label or listing, a statement from a nationally recognized, adequately equipped testing agency indicating that the items have been tested in accordance with required procedures and that the

materials and equipment comply with all contract requirements will be accepted. However, materials and equipment installed in hazardous locations must bear the UL label unless the data submitted from other testing agency is specifically approved in writing by the Contracting Officer. Items which are required to be listed and labeled in accordance with Underwriters Laboratories must be affixed with a UL label that states that it is UL listed. No exceptions or waivers will be granted to this requirement. Materials and equipment will be approved based on the manufacturer's published data.

For other than equipment and materials specified to conform to UL publications, a manufacturer's statement indicating complete compliance with the applicable standard of the American Society for Testing and Materials, National Electrical Manufacturers Association, or other commercial standard, is acceptable.

1.4 WORKMANSHIP

Materials and equipment shall be installed in accordance with NFPA 70, recommendations of the manufacturer, and as shown.

PART 2 PRODUCTS

Products shall conform to the respective publications and other requirements specified below. Materials and equipment not listed below shall be as specified elsewhere in this section. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.1 CABLES AND WIRES

Conductors No. 8 AWG and larger diameter shall be stranded. Conductors No. 10 AWG and smaller diameter shall be solid, except that conductors for remote control, alarm, and signal circuits, classes 1, 2, and 3, shall be stranded unless specifically indicated otherwise. Conductor sizes and ampacities shown are based on copper, unless indicated otherwise. All conductors shall be copper.

2.1.1 Equipment Manufacturer Requirements

When manufacturer's equipment requires copper conductors at the terminations or requires copper conductors to be provided between components of equipment, provide copper conductors or splices, splice boxes, and other work required to meet manufacturer's requirements.

2.1.2 Aluminum Conductors

Aluminum conductors shall not be used.

2.1.3 Insulation

Unless indicated otherwise, or required by NFPA 70, power and lighting wires shall be 600-volt, Type XHHW or XHHW-2 conforming to UL 83, except that grounding wire may be type THWN conforming to UL 83; remote-control and signal circuits shall be Type XHHW or THWN, conforming to UL 83. Where lighting fixtures require 90-degree Centigrade (C) conductors, provide only conductors with 90-degree C insulation or better.

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2.1.4 Bonding Conductors

ASTM B 1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B 8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter.

2.1.5 Service Entrance Cables

Service entrance (SE) and underground service entrance (USE) cables, UL 854.

2.1.6 Metal-Clad Cable

UL 1569; NFPA 70, Type MC cable.

2.1.7 Cord Sets and Power-Supply Cords

UL 817.

2.2 TRANSIENT VOLTAGE SURGE PROTECTION

Transient voltage surge suppressors shall be provided as indicated. Surge suppressors shall meet the requirements of IEEE C62.41 and be UL-listed and labeled as having been tested in accordance with UL 1449. Surge suppressor ratings shall be 480 volts rms, 60 Hz, 3-phase, 4-wire with ground, transient suppression voltage (peak let through voltage) of 500 volts. Fuses shall not be used as surge suppression.

2.3 CIRCUIT BREAKERS

2.3.1 MOLDED-CASE CIRCUIT BREAKERS

Molded-case circuit breakers shall conform to NEMA AB 1 and UL 489 and UL 877 for circuit breakers and circuit breaker enclosures located in hazardous (classified) locations. Circuit breakers may be installed in panelboards, switchboards, enclosures, motor control centers, or combination motor controllers.

2.3.1.1 Construction

Circuit breakers shall be suitable for mounting and operating in any position. Lug shall be listed for copper conductors only in accordance with UL 486E. Single-pole circuit breakers shall be full module size with not more than one pole per module. Multi-pole circuit breakers shall be of the common-trip type having a single operating handle such that an overload or short circuit on any one pole will result in all poles opening simultaneously. Sizes of 100 amperes or less may consist of single-pole breakers permanently factory assembled into a multi-pole unit having an internal, mechanical, nontamperable common-trip mechanism and external handle ties. All circuit breakers shall have a quick-make, quick-break overcenter toggle-type mechanism, and the handle mechanism shall be trip-free to prevent holding the contacts closed against a short-circuit or sustained overload. All circuit breaker handles shall assume a position between "ON" and "OFF" when tripped automatically. All ratings shall be clearly visible.

2.3.1.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. The interrupting rating of the circuit breakers shall be at least equal to the

available short-circuit current at the line terminals of the circuit breaker and correspond to the UL listed integrated short-circuit current rating specified for the panelboards and switchboards. Molded-case circuit breakers shall have nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings in accordance with NEMA AB 1. Ratings shall be coordinated with system X/R ratio.

2.3.1.3 Thermal-Magnetic Trip Elements

Thermal magnetic circuit breakers shall be provided as shown. Automatic operation shall be obtained by means of thermal-magnetic tripping devices located in each pole providing inverse time delay and instantaneous circuit protection. The instantaneous magnetic trip shall be adjustable and accessible from the front of all circuit breakers on frame sizes above 150 amperes.

2.3.2 SWD Circuit Breakers

Circuit breakers rated 15 amperes and intended to switch 277 volts or less fluorescent lighting loads shall be marked "SWD."

2.3.3 HACR Circuit Breakers

Circuit breakers 60 amperes or below, 240 volts, 1-pole or 2-pole, intended to protect multi-motor and combination-load installations involved in heating, air conditioning, and refrigerating equipment shall be marked "Listed HACR Type."

2.3.4 Ground Fault Circuit Interrupters

UL 943. Breakers equipped with ground fault circuit interrupters shall have ground fault class, interrupting capacity, and voltage and current ratings as indicated.

2.4 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

Motor short-circuit protectors shall conform to UL 508 and shall be provided as shown. Protectors shall be used only as part of a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection, and shall be rated in accordance with the requirements of NFPA 70.

2.4.1 Construction

Motor short-circuit protector bodies shall be constructed of high temperature, dimensionally stable, long life, nonhygroscopic materials. Protectors shall fit special MSCP mounting clips and shall not be interchangeable with any commercially available fuses. Protectors shall have 100 percent one-way interchangeability within the A-Y letter designations. All ratings shall be clearly visible.

2.4.2 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Letter designations shall be A through Y for motor controller Sizes 0, 1, 2, 3, 4, and 5, with 100,000 amperes interrupting capacity rating. Letter designations shall correspond to controller sizes as follows:

CONTROLLER SIZE	MSCP DESIGNATION
NEMA 0	A-N
NEMA 1	A-P
NEMA 2	A-S
NEMA 3	A-U
NEMA 4	A-W
NEMA 5	A-Y

2.5 CONDUIT AND TUBING

2.5.1 Electrical, Zinc-Coated Steel Metallic Tubing (EMT)
UL 797.

2.5.2 Electrical Plastic Tubing and Conduit
NEMA TC 2.

2.5.3 Flexible Conduit, Steel and Plastic
General-purpose type, UL 1; liquid tight, UL 360, and UL 1660.

2.5.4 Intermediate Metal Conduit
UL 1242.

2.5.5 Rigid Metal Conduit
UL 6.

2.6 CONDUIT AND DEVICE BOXES AND FITTINGS

2.6.1 Boxes, Metallic Outlet
NEMA OS 1 and UL 514A.

2.6.2 Boxes, Switch (Enclosed), Surface-Mounted
UL 98.

2.6.3 Fittings for Conduit and Outlet Boxes
UL 514B.

2.6.4 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing
UL 514B.

2.7 CONNECTORS, WIRE PRESSURE

2.7.1 For Use With Copper Conductors

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UL 486A.

2.8 ELECTRICAL GROUNDING AND BONDING EQUIPMENT

UL 467.

2.8.1 Ground Rods

Ground rods shall be of copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length of the sectional type driven full length into the earth.

2.8.2 Ground Bus

The ground bus shall be bare conductor or flat copper in one piece, if practicable.

2.9 ENCLOSURES

NEMA ICS 6 or NEMA 250, unless otherwise specified. All equipment enclosures shall be NEMA 12 for indoor use, and NEMA 4X for outdoor use.

2.9.1 Cabinets and Boxes

Cabinets and boxes with volume greater than 100 cubic inches shall be in accordance with UL 50, hot-dip, zinc-coated, if sheet steel.

2.9.2 Circuit Breaker Enclosures

UL 489.

2.10 LIGHTING FIXTURES, LAMPS, BALLASTS, EMERGENCY EQUIPMENT, CONTROLS AND ACCESSORIES

The following specifications are supported and supplemented by information and details on the drawings. Additional fixtures, if shown, shall conform to this specification. Lamps, lampholders, ballasts, transformers, electronic circuitry and other lighting system components shall be constructed according to industry standards. Equipment shall be tested and listed by a recognized independent testing laboratory for the expected installation conditions. Equipment shall conform to the standards listed below. General descriptions of required fixtures can be found at: <http://cadlib.wes.army.mil/html/detlib/gif/d502gif/D502262E.gif> . Fixture sheets are also attached at the end of this section.

2.10.1 Lamps

Lamps shall be constructed to operate in the specified fixture, and shall function without derating life or output as listed in published data. Lamps shall meet the requirements of the Energy Policy Act of 1992.

- a. Incandescent and tungsten halogen lamps shall be designed for 125 volt operation (except for low voltage lamps), shall be rated for minimum life of 2,000 hours, and shall have color temperature between 2,800 and 3,200 degrees Kelvin. Tungsten halogen lamps shall incorporate quartz capsule construction. Lamps shall comply with ANSI C78.20 and sections 238 and 270 of ANSI C78.21.
- b. Fluorescent lamps shall have color temperature of 3,000 degrees

Kelvin. They shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used. Fluorescent lamps, including spares, shall be manufactured by one manufacturer to provide for color and performance consistency. Fluorescent lamps shall comply with ANSI C78.1. Fluorescent tube lamp efficiencies shall meet or exceed the following requirements.

T8, 32 watts	(4' lamp)	2800 lumens
T12,34 watts	(4' lamp)	2800 lumens
T8,59 watts	(8' lamp)	5700 lumens
T12,60 watts	(8' lamp)	5600 lumens
T8/U,31-32 watts	(U-tube)	2600 lumens
T12/U,34 watts	(U-tube)	2700 lumens

(1) Linear fluorescent lamps, unless otherwise indicated, shall be 4 feet long 32 watt T8, 265 mA, with minimum CRI of 75. Lamps of other lengths or types shall be used only where specified or shown. Lamps shall deliver rated life when operated on rapid start ballasts.

(2) Small compact fluorescent lamps shall be twin, double, or triple tube configuration as shown with bi-pin or four-pin snap-in base and shall have minimum CRI of 85. They shall deliver rated life when operated on ballasts as shown. 9 and 13 watt double tube lamps shall comply with ANSI C78.2B. 18 and 26 watt double tube lamps shall comply with ANSI C78.2A. Minimum starting temperature shall be 32 degrees F for twin tube lamps and for double and triple twin tube lamps without internal starter; and 15 degrees F for double and triple twin tube lamps with internal starter.

- c. High intensity discharge lamps, including spares, shall be manufactured by one manufacturer in order to provide color and performance consistency. High intensity discharge lamps shall be designed to operate with the ballasts and circuitry of the fixtures in which they will be used and shall have wattage, shape and base as shown. High intensity discharge lamps, unless otherwise shown, shall have medium or mogul screw base and minimum starting temperature of -20 degrees F. Metal halide lamps, unless otherwise shown, shall have minimum CRI of 65; color temperature of 4,300 degrees Kelvin; shall be -BU configuration if used in base-up position; and shall be -H or high output configuration if used in horizontal position. Lamps shall comply with all applicable ANSI C78.1350, ANSI C78.1351, ANSI C78.1352, ANSI C78.1355, ANSI C78.1375, and ANSI C78.1376.

2.10.2 Ballasts and Transformers

Ballasts or transformers shall be designed to operate the designated lamps within their optimum specifications, without derating the lamps. Lamp and ballast combinations shall be certified as acceptable by the lamp manufacturer.

- a. Fluorescent ballasts shall comply with ANSI C82.1 and shall be mounted integrally within fluorescent fixture housing unless otherwise shown. Ballasts shall have maximum current crest factor

of 1.7; high power factor; Class A sound rating; maximum operating case temperature of 77 degrees F above ambient; and shall be rated Class P. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture. A single ballast may be used to serve multiple fixtures if they are continuously mounted, identically controlled and factory manufactured for that installation with an integral wireway.

(1) Compact fluorescent ballasts shall comply with IEEE C62.41 Category A transient voltage variation requirements and shall be mounted integrally within compact fluorescent fixture housing unless otherwise shown. Ballasts shall have minimum ballast factor of 0.95; maximum current crest factor of 1.6; high power factor; maximum operating case temperature of 77 degrees F above ambient; shall be rated Class P; and shall have a sound rating of Class A. Ballasts shall meet FCC Class A specifications for EMI/RFI emissions. Ballasts shall operate from nominal line voltage of 120 volts at 60 Hz and maintain constant light output over a line voltage variation of 10%. Ballasts shall have an end-of-lamp-life detection and shut-down circuit. Ballasts shall be UL listed and shall contain no PCBs. Ballasts shall contain potting to secure PC board, provide lead strain relief, and provide a moisture barrier.

(2) Electronic fluorescent ballasts shall comply with 47 CFR 18 for electromagnetic interference. Ballasts shall withstand line transients per IEEE C62.41, Category A. Ballasts shall have total harmonic distortion between 10 and 20%; minimum frequency of 20,000Hz; filament voltage between 2.5 and 4.5 volts; maximum starting inrush current of 20 amperes; and shall comply with the minimum Ballast Efficacy Factors shown in the table below. Minimum starting temperature shall be 32 degrees F. Ballasts shall carry a manufacturer's full warranty of three years, including a minimum \$10 labor allowance per ballast.

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS

LAMP TYPE	TYPE OF STARTER & LAMP	NOMINAL OPERATIONAL VOLTAGE	NUMBER OF LAMPS	MINIMUM BALLAST EFFICACY FACTOR
32W T8	rapid start	120 or 277 V	1	2.54
	linear & U-tubes		2	1.44
			3	0.93
			4	0.73
34W T12	rapid start	120 or 277 V	1	2.64
	linear & U-tubes		2	1.41
			3	0.93
59W T8	rapid start linear	120 or 277 V	2	0.80

ELECTRONIC FLUORESCENT BALLAST EFFICACY FACTORS

60W T12	rapid start linear	120 or 277 V	2	0.80
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(3) Magnetic fluorescent ballasts shall be energy-saving, automatic resetting type, approved for the application by the Certified Ballast Manufacturers and complying with ANSI C82.1 and UL 935. Minimum ballast starting temperature shall be 40 degrees F for normal service and 0 degrees F where cold temperature service is required. Magnetic fluorescent ballasts shall have a ballast factor not less than shown in the following table:

MAGNETIC FLUORESCENT BALLAST FACTORS*

Design starting temperature above 40 degrees F with 60 Hz input frequency

LAMP TYPE	NUMBER OF LAMPS	NOMINAL OPERATIONAL INPUT VOLTAGE	TYPE OF STARTER & LAMP	MIN. BALLAST FACTOR
25W F25T8	1	120v	rapid start	.96
	1	277v		.96
	2	120v		.95
	2	277v		.94
32W F32T8	1	120v	rapid start	.96
	1	277v		.95
	2	120v		.85
	2	277v		.96
96W F96T8	1	120 or 277v	instant start	1.10
	2			.85

* For ballasts not specifically designed for use with dimming controls.

b. High intensity discharge ballasts shall comply with UL 1029 and, if multiple supply types, with ANSI C82.4. Ballasts shall have minimum ballast factor of 0.9; high power factor; Class A sound rating; and maximum operating case temperature of 77 degrees F above ambient.

(1) Electronic high intensity discharge ballasts shall be constant wattage autotransformer type; shall have less than 10% ballast loss; shall have total harmonic distortion between 10 and 20%; and shall have a minimum starting temperature of 0 degrees F.

(2) Magnetic high intensity discharge ballasts shall have a minimum starting temperature of -20 degrees F.

2.10.3 Fixtures

Fixtures shall be in accordance with the size, shape, appearance, finish, and performance shown on drawings. Unless otherwise indicated, lighting fixtures shall be provided with housings, junction boxes, wiring, lampholders, mounting supports, trim, hardware and accessories for a complete and operable installation. Recessed housings shall be minimum 20 gauge cold rolled or galvanized steel as shown. Extruded aluminum fixtures

shall have minimum wall thickness of 0.125 inches. Plastic lenses shall be 100% virgin acrylic or as shown. Glass lenses shall be tempered. Heat resistant glass shall be borosilicate type. Conoid recessed reflector cones shall be Alzak with clear specular low iridescent finish.

- a. Incandescent fixtures shall comply with UL 1571. Incandescent fixture specular reflector cone trims shall be integral to the cone and shall be finished to match. Painted trim finishes shall be white with minimum reflectance of 88%. Low voltage incandescent fixtures shall have integral step-down transformers.
- b. Fluorescent fixtures shall comply with UL 1570. Recessed ceiling fixtures shall comply with NEMA LE 4. Fixtures shall be plainly marked for proper lamp and ballast type to identify lamp diameter, wattage, color and start type. Marking shall be readily visible to service personnel, but not visible from normal viewing angles. Fluorescent fixture lens frames on recessed and surface mounted troffers shall be one assembly with mitered corners. Parabolic louvers shall have a low iridescent finish and 45 degree cut-off. Louver intersection joints shall be hairline type and shall conceal mounting tabs or other assembly methods. Louvers shall be free from blemishes, lines or defects which distort the visual surface. Integral ballast and wireway compartments shall be easily accessible without the use of special tools. Housings shall be constructed to include grounding necessary to start the lamps. Open fixtures shall be equipped with a sleeve, wire guard, or other positive means to prevent lamps from falling. Medium bi-pin lampholders shall be twist-in type with positive locking position. Long compact fluorescent fixtures and fixtures utilizing U-bend lamps shall have clamps or secondary lampholders to support the free ends of the lamps.
- c. High intensity discharge fixture shall comply with UL 1572. Recessed ceiling fixtures shall comply with NEMA LE 4. Reflectors shall be anodized aluminum. Fixtures for horizontal lamps shall have position oriented lampholders. Lampholders shall be pulse-rated to 5,000 volts. Fixtures indicated as classified or rated for hazardous locations or special service shall be designed and independently tested for the environment in which they are installed. Recessed lens fixtures shall have extruded aluminum lens frames. Ballasts shall be integral to fixtures and shall be accessible without the use of special tools. Remote ballasts shall be encased and potted. Lamps shall be shielded from direct view with a UV absorbing material such as tempered glass, and shall be circuited through a cut-off switch which will shut off the lamp circuit if the lens is not in place.
- d. Emergency lighting fixtures and accessories shall be constructed and independently tested to meet the requirements of applicable codes. Batteries shall be Nicad or equal with no required maintenance, and shall have a minimum life expectancy of five years and warranty period of three years.
- e. Exit Signs

Exit signs shall be ENERGY STAR compliant, thereby meeting the following requirements. Input power shall be less than 5 watts per face. Letter size and spacing shall adhere to NFPA 101. Luminance contrast shall be greater than 0.8. Average luminance shall be greater than 15 cd/ft²

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measured at normal (0 degree) and 45 degree viewing angles. Minimum luminance shall be greater than 8.6 cd/u² measured at normal and 45 degree viewing angles. Maximum to minimum luminance shall be less than 20:1 measured at normal and 45 degree viewing angles. The manufacturer warranty for defective parts shall be at least 5 years.

2.10.4 Lampholders, Starters, and Starter Holders

UL 542

2.11 LOW-VOLTAGE FUSES AND FUSEHOLDERS

2.11.1 Fuses, Low Voltage Cartridge Type

NEMA FU 1.

2.11.2 Fuses, High-Interrupting-Capacity, Current-Limiting Type

Fuses, Class G, J, L and CC shall be in accordance with UL 198C.

2.11.3 Fuses, Class K, High-Interrupting-Capacity Type

UL 198D.

2.11.4 Fuses, Class H

UL 198B.

2.11.5 Fuses, Class R

UL 198E.

2.11.6 Fuses, Class T

UL 198H.

2.11.7 Fuses for Supplementary Overcurrent Protection

UL 198G.

2.11.8 Fuseholders

UL 512.

2.12 INSTRUMENTS, ELECTRICAL INDICATING

ANSI C39.1.

2.13 MOTORS, AC, FRACTIONAL AND INTEGRAL

Motors, ac, fractional and integral horsepower, 500 hp and smaller shall conform to NEMA MG 1 and UL 1004 for motors; NEMA MG 10 for energy management selection of polyphase motors; and UL 674 for use of motors in hazardous (classified) locations. In addition to the standards listed above, motors shall be provided with efficiencies as specified in the table "MINIMUM NOMINAL EFFICIENCIES" below.

2.13.1 Rating

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The horsepower rating of motors should be limited to no more than 125 percent of the maximum load being served unless a NEMA standard size does not fall within this range. In this case, the next larger NEMA standard motor size should be used.

2.13.2 Motor Efficiencies

All permanently wired polyphase motors of 1 hp or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 1 hp or more with open, drip proof or totally enclosed fan cooled enclosures shall be high efficiency type, unless otherwise indicated. Motor efficiencies indicated in the tables apply to general-purpose, single-speed, polyphase induction motors. Applications which require definite purpose, special purpose, special frame, or special mounted polyphase induction motors are excluded from these efficiency requirements. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

MINIMUM NOMINAL MOTOR EFFICIENCIES
OPEN DRIP PROOF MOTORS

<u>k</u>	<u>1200 RP</u>	<u>1800 RP</u>	<u>3600 RPM</u>
0.746	82.5	85.5	80.0
1.12	86.5	86.5	85.5
1.49	87.5	86.5	86.5
2.24	89.5	89.5	86.5
3.73	89.5	89.5	89.5
5.60	91.7	91.0	89.5
7.46	91.7	91.7	90.2
11.2	92.4	93.0	91.0
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	93.6
44.8	95.0	95.0	94.1
56.9	95.0	95.0	94.5
74.6	95.0	95.4	94.5
93.3	95.4	95.4	95.0
112.0	95.8	95.8	95.4
149.0	95.4	95.8	95.4
187.0	95.4	96.2	95.8
224.0	95.4	95.0	95.4
261.0	94.5	95.4	95.0
298.0	94.1	95.8	95.0
336.0	94.5	95.4	95.4
373.0	94.5	94.5	94.5

TOTALLY ENCLOSED FAN-COOLED MOTORS

<u>k</u>	<u>1200 RP</u>	<u>1800 RP</u>	<u>3600 RPM</u>
0.746	82.5	85.5	78.5
1.12	87.5	86.5	85.5
1.49	88.5	86.5	86.5
2.24	89.5	89.5	88.5

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TOTALLY ENCLOSED FAN-COOLED MOTORS

3.73	89.5	89.5	89.5
5.60	91.7	91.7	91.0
7.46	91.7	91.7	91.7
11.2	92.4	92.4	91.7
14.9	92.4	93.0	92.4
18.7	93.0	93.6	93.0
22.4	93.6	93.6	93.0
29.8	94.1	94.1	93.6
37.3	94.1	94.5	94.1
44.8	94.5	95.0	94.1
56.9	95.0	95.4	94.5
74.6	95.4	95.4	95.0
93.3	95.4	95.4	95.4
112.0	95.8	95.8	95.4
149.0	95.8	96.2	95.8
187.0	95.6	96.2	95.9
224.0	95.4	96.1	95.8
261.0	94.5	96.2	94.8
298.0	94.5	95.8	94.5
336.0	94.5	94.5	94.5
373.0	94.5	94.5	94.5

MINIMUM NOMINAL MOTOR EFFICIENCIES
OPEN DRIP PROOF MOTORS

<u>H</u>	<u>1200 RP</u>	<u>1800 RP</u>	<u>3600 RPM</u>
1	82.5	85.5	80.0
1.5	86.5	86.5	85.5
2	87.5	86.5	86.5
3	89.5	89.5	86.5
5	89.5	89.5	89.5
7.5	91.7	91.0	89.5
10	91.7	91.7	90.2
15	92.4	93.0	91.0
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	93.6
60	95.0	95.0	94.1
75	95.0	95.0	94.5
100	95.0	95.4	94.5
125	95.4	95.4	95.0
150	95.8	95.8	95.4
200	95.4	95.8	95.4
250	95.4	96.2	95.8
300	95.4	95.0	95.4
350	94.5	95.4	95.0
400	94.1	95.8	95.0
450	94.5	95.4	95.4
500	94.5	94.5	94.5

TOTALLY ENCLOSED FAN-COOLED MOTORS

<u>H</u>	<u>1200 RP</u>	<u>1800 RP</u>	<u>3600 RPM</u>
1	82.5	85.5	78.5

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TOTALLY ENCLOSED FAN-COOLED MOTORS			
1.5	87.5	86.5	85.5
2	88.5	86.5	86.5
3	89.5	89.5	88.5
5	89.5	89.5	89.5
7.5	91.7	91.7	91.0
10	91.7	91.7	91.7
15	92.4	92.4	91.7
20	92.4	93.0	92.4
25	93.0	93.6	93.0
30	93.6	93.6	93.0
40	94.1	94.1	93.6
50	94.1	94.5	94.1
60	94.5	95.0	94.1
75	95.0	95.4	94.5
100	95.4	95.4	95.0
125	95.4	95.4	95.4
150	95.8	95.8	95.4
200	95.8	96.2	95.8
250	95.6	96.2	95.9
300	95.4	96.1	95.8
350	94.5	96.2	94.8
400	94.5	95.8	94.5
450	94.5	94.5	94.5
500	94.5	94.5	94.5

2.14 MOTOR CONTROLS AND MOTOR CONTROL CENTERS

2.14.1 General

NEMA ICS 1, NEMA ICS 2, NEMA ICS 3 and NEMA ICS 6, and UL 508 and UL 845. Panelboards supplying non-linear loads shall have neutrals sized for 200 percent of rated current.

2.14.2 Motor Starters

Combination starters shall be provided with fusible switches.

2.14.3 Thermal-Overload Protection

Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating.

2.14.4 Low-Voltage Motor Overload Relays

2.14.4.1 General

Thermal overload relays shall conform to NEMA ICS 2 and UL 508. Overload protection shall be provided either integral with the motor or motor controller, and shall be rated in accordance with the requirements of NFPA 70. Standard units shall be used for motor starting times up to 7 seconds. Quick trip units shall be used on hermetically sealed, submersible pumps,

and similar motors.

2.14.4.2 Construction

Manual reset type thermal relay shall be melting alloy construction. Automatic reset type thermal relays shall be bimetallic construction. Magnetic current relays shall consist of a contact mechanism and a dash pot mounted on a common frame.

2.14.4.3 Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Trip current ratings shall be established by selection of the replaceable overload device and shall not be adjustable. Where the controller is remotely-located or difficult to reach, an automatic reset, non-compensated overload relay shall be provided. Manual reset overload relays shall be provided otherwise, and at all locations where automatic starting is provided. Where the motor is located in a constant ambient temperature, and the thermal device is located in an ambient temperature that regularly varies by more than minus 18 degrees F, an ambient temperature-compensated overload relay shall be provided.

2.14.5 Automatic Control Devices

2.14.5.1 Direct Control

Automatic control devices (such as thermostats, float or pressure switches) which control the starting and stopping of motors directly shall be designed for that purpose and have an adequate horsepower rating.

2.14.5.2 Pilot-Relay Control

Where the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit.

2.14.5.3 Manual/Automatic Selection

- a. Where combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-position tumbler or rotary switch (marked MANUAL-OFF-AUTOMATIC) shall be provided for the manual control.
- b. Where combination manual and automatic control is specified and the automatic-control device actuates the pilot control circuit of a magnetic starter, the magnetic starter shall be provided with a three-position selector switch marked MANUAL-OFF-AUTOMATIC.
- c. 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 Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less

unless otherwise indicated.

2.15 PANELBOARDS

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

2.16 RECEPTACLES

2.16.1 Heavy Duty Grade

NEMA WD 1. Devices shall conform to all requirements for heavy duty receptacles.

2.16.2 Ground Fault Interrupters

UL 943, Class A or B.

2.16.3 NEMA Standard Receptacle Configurations

NEMA WD 6.

a. Single and Duplex, 15-Ampere and 20-Ampere, 125 Volt

15-ampere, non-locking: NEMA type 5-15R, locking: NEMA type L5-15R,
20-ampere, non-locking: NEMA type 5-20R, locking: NEMA type L5-20R.

2.17 Service Entrance Equipment

UL 869A.

2.18 SPLICE, CONDUCTOR

UL 486C.

2.19 SNAP SWITCHES

UL 20.

2.20 TAPES

2.20.1 Plastic Tape

UL 510.

2.20.2 Rubber Tape

UL 510.

2.21 TRANSFORMERS

Single- and three-phase transformers shall have two windings per phase. Full-capacity standard NEMA taps shall be provided in the primary windings of transformers unless otherwise indicated. Three-phase transformers shall be configured with delta-wye windings, except as indicated. "T" connections may be used for transformers rated 15 kVA or below. Transformers supplying non-linear loads shall be UL listed as suitable for supplying such loads with a total K-factor not to exceed K-13 and have neutrals sized for 200 percent of rated current.

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2.21.1 Transformers, Dry-Type

Transformers shall have 220 degrees C insulation system for transformers 15 kVA and greater, and shall have 180 degrees C insulation system for transformers rated 10 kVA and less, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient temperature of 40 degrees C. Transformer of 150 degrees C temperature rise shall be capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.

a. 600 Volt or Less Primary:

NEMA ST 20, UL 506, general purpose, dry-type, self-cooled, ventilated. Transformers shall be provided in NEMA 1 enclosure. Transformers shall be quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

2.21.2 Average Sound Level

The average sound level in decibels (dB) of transformers shall not exceed the following dB level at 12 inches for the applicable kVA rating range listed unless otherwise indicated:

kVA Range	dB Sound Level
1-50	50
51-150	55
151-300	58
301-500	60
501-700	62
701-1000	64
1001-1500	65
1501 & above	70

2.22 ISOLATED POWER SYSTEM EQUIPMENT

UL 1047, with monitor UL 1022.

2.23 WATTHOUR METERS, UTILITY REVENUE

Watthour meters shall conform to ANSI C12.1 and ANSI C12.10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the socket-mounted outdoor type having a 15-minute, cumulative form, demand register meeting ANSI C12.4 and provided with not less than two and one-half stators. Watthour demand meters shall have factory-installed electronic pulse initiators meeting the requirements of ANSI C12.1. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, phototransistors, and power transistors, except that mercury-wetted output contacts are acceptable. Initiators shall be totally contained within watthour demand meter enclosures, shall be capable of operating up to speeds of 500 pulses per minute with no false pulses, and shall require no field adjustments. Initiators shall be calibrated for a pulse rate output of one pulse per 1/4 disc revolution of the associated meter and shall be compatible with the indicated equipment.

2.24 INSTRUMENT TRANSFORMERS

2.24.1 General

Instrument transformers shall comply with ANSI C12.11 and IEEE C57.13. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on drawings.

2.24.2 Current Transformers

Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal-current rating factor shall be not less than 2.0. Other thermal and mechanical ratings of current transformer and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accidental open-circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short-circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.

2.24.2.1 Current Transformers for kWh and Demand Metering (Low Voltage)

Current transformers shall conform to IEEE C57.13. Provide current transformers with a metering accuracy Class of 0.3 through B-0.1, with a minimum RF of 4.0 for 200 ampere services, and a Class 0.3 through B-0.2, with a minimum RF of 4.0 for 400 ampere services, at 30 degrees C, with 600-volt insulation, and 10 kV BIL. Provide butyl-molded, window-type current transformers mounted in the current transformer cabinet.

2.25 WIRING DEVICES

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

PART 3 EXECUTION

3.1 GROUNDING

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

3.1.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, 2 additional rods not less than 6 feet on centers, or if sectional type rods are used, 2 additional sections may be coupled and driven with the first rod. In high-ground-resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

3.1.2 Ground Bus

Ground bus shall be provided in the electrical equipment rooms as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical equipment shall be effectively grounded by bonding to the ground bus. The ground bus shall be bonded to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Connections and splices shall be of the brazed, welded, bolted, or pressure-connector type, except that pressure connectors or bolted connections shall be used for connections to removable equipment.

3.1.3 Grounding Conductors

A green equipment grounding conductor, sized in accordance with NFPA 70 shall be provided, regardless of the type of conduit. Equipment grounding bars shall be provided in all panelboards. The equipment grounding conductor shall be carried back to the service entrance grounding connection or separately derived grounding connection. All equipment grounding conductors, including metallic raceway systems used as such, shall be bonded or joined together in each wiring box or equipment enclosure. Metallic raceways and grounding conductors shall be checked to assure that they are wired or bonded into a common junction. Metallic boxes and enclosures, if used, shall also be bonded to these grounding conductors by an approved means per NFPA 70. When switches, or other utilization devices are installed, any designated grounding terminal on these devices shall also be bonded to the equipment grounding conductor junction with a short jumper.

3.2 WIRING METHODS

Wiring shall conform to NFPA 70, the contract drawings, and the following specifications. Unless otherwise indicated, wiring shall consist of insulated conductors installed in rigid zinc-coated steel conduit. Where cables and wires are installed in cable trays, they shall be of the type permitted by NFPA 70 for use in such applications. Metallic-armored cables may be installed in areas permitted by NFPA 70. Wire fill in conduits shall be based on NFPA 70 for the type of conduit and wire insulations specified.

3.2.1 Conduit and Tubing Systems

Conduit and tubing systems shall be installed as indicated. Conduit sizes shown are based on use of copper conductors with insulation types as described in paragraph WIRING METHODS. Minimum size of raceways shall be 3/4 inch. Electrical Metallic Tubing (EMT) shall be permitted for use in sizes 1-1/4 inches and smaller for concealed power systems and for telecommunications systems. All exposed conduit shall be rigid metal conduit. Only metal conduits will be permitted when conduits are required for shielding or other special purposes indicated, or when required by conformance to NFPA 70. Nonmetallic conduit and tubing may be used in damp, wet or corrosive locations when permitted by NFPA 70 and the conduit or tubing system is provided with appropriate boxes, covers, clamps, screws or other appropriate type of fittings. Bushings, manufactured fittings or boxes providing equivalent means of protection shall be installed on the ends of all conduits and shall be of the insulating type, where required by NFPA 70. Connectors and couplings for EMT conduit shall be all steel compression ring type. Connectors shall have insulated throats. Rigid metal conduit fittings shall be threaded. Only UL listed adapters shall be

used to connect EMT to rigid metal conduit, cast boxes, and conduit bodies.

Penetrations of above grade floor slabs, time-rated partitions and fire walls shall be firestopped. Except as otherwise specified, IMC may be used as an option for rigid steel conduit in areas as permitted by NFPA 70. All conduit shall be concealed in finished areas. Raceways shall not be installed under the firepits of boilers and furnaces and shall be kept 6 inches away from parallel runs of flues, steam pipes and hot-water pipes. Raceways crossing structural expansion joints or seismic joints shall be provided with suitable expansion fittings or other suitable means to compensate for the building expansion and contraction and to provide for continuity of grounding. Wiring installed in underfloor raceway system shall be suitable for installation in wet locations.

3.2.1.1 Pull Wires

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

3.2.1.2 Conduit Stub-Ups

Where conduits are to be stubbed up through concrete floors, a short elbow shall be installed below grade to transition from the horizontal run of conduit to a vertical run. A conduit coupling fitting, threaded on the inside shall be installed, to allow terminating the conduit flush with the finished floor. Wiring shall be extended in rigid threaded conduit to equipment, except that where required, flexible conduit may be used 6 inches above the floor. Empty or spare conduit stub-ups shall be plugged flush with the finished floor with a threaded, recessed plug.

3.2.1.3 Below Slab-on-Grade or in the Ground

Electrical wiring below slab-on-grade shall be protected by a conduit system. Conduit passing vertically through slabs-on-grade shall be rigid steel or IMC. Rigid steel or IMC conduits installed below slab-on-grade or in the earth shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory-applied polyvinyl chloride, plastic resin, or epoxy coating system.

3.2.1.4 Installing in Slabs Including Slabs on Grade

Conduit installed in slabs-on-grade shall be rigid steel or IMC. Conduits shall be installed as close to the middle of concrete slabs as practicable without disturbing the reinforcement. Outside diameter shall not exceed 1/3 of the slab thickness and conduits shall be spaced not closer than 3 diameters on centers except at cabinet locations where the slab thickness shall be increased as approved by the Contracting Officer. Where conduit is run parallel to reinforcing steel, the conduit shall be spaced a minimum of one conduit diameter away but not less than one inch from the reinforcing steel.

3.2.1.5 Changes in Direction of Runs

Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an

approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Trapped raceways in damp and wet locations shall be avoided where possible. Lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment shall be prevented during the course of construction. Clogged raceways shall be cleared of obstructions or shall be replaced.

3.2.1.6 Supports

Metallic conduits and tubing, and the support system to which they are attached, shall be securely and rigidly fastened in place to prevent vertical and horizontal movement at intervals of not more than 10 feet and within 3 feet of boxes, cabinets, and fittings, with approved pipe straps, wall brackets, conduit clamps, conduit hangers, threaded C-clamps, beam clamps, or ceiling trapeze. Loads and supports shall be coordinated with supporting structure to prevent damage or deformation to the structure. Loads shall not be applied to joist bridging. Attachment shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring-steel-tension clamps on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine screws. Raceways or pipe straps shall not be welded to steel structures. Cutting the main reinforcing bars in reinforced concrete beams or joists shall be avoided when drilling holes for support anchors. Holes drilled for support anchors, but not used, shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported using wire or nylon ties. Raceways shall be independently supported from the structure. Upper raceways shall not be used as a means of support for lower raceways. Supporting means shall not be shared between electrical raceways and mechanical piping or ducts. Cables and raceways shall not be supported by ceiling grids. Except where permitted by NFPA 70, wiring shall not be supported by ceiling support systems. Conduits shall be fastened to sheet-metal boxes and cabinets with two locknuts where required by NFPA 70, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used. Threadless fittings for electrical metallic tubing shall be of a type approved for the conditions encountered.

3.2.1.7 Exposed Raceways

Exposed raceways shall be installed parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. Raceways under raised floors and above accessible ceilings shall be considered as exposed installations in accordance with NFPA 70 definitions.

3.2.1.8 Exposed Risers

Exposed risers in wire shafts of multistory buildings shall be supported by U-clamp hangers at each floor level, and at intervals not to exceed 10 feet.

3.2.1.9 Communications Raceways

Communications raceways indicated shall be installed in accordance with the previous requirements for conduit and tubing and with the additional requirement that no length of run shall exceed 50 feet for 1/2 inch and 3/4 inch sizes, and 100 feet for 1 inch or larger sizes, and shall not contain more than two 90-degree bends or the equivalent. Additional pull or

junction boxes shall be installed to comply with these limitations whether or not indicated. Inside radii of bends in conduits of 1 inch size or larger shall not be less than ten times the nominal diameter.

3.2.2 Cables and Conductors

Installation shall conform to the requirements of NFPA 70. Covered, bare or insulated conductors of circuits rated over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 600 volts or less.

3.2.2.1 Sizing

Unless otherwise noted, all sizes are based on copper conductors and the insulation types indicated. Sizes shall be not less than indicated. Branch-circuit conductors shall be not smaller than No. 12 AWG. Conductors for branch circuits of 120 volts more than 100 feet long and of 277 volts more than 230 feet long, from panel to load center, shall be no smaller than No. 10 AWG. Class 1 remote control and signal circuit conductors shall be not less than No. 14 AWG. Class 2 remote control and signal circuit conductors shall be not less than No. 16 AWG. Class 3 low-energy, remote-control and signal circuits shall be not less than No. 22 AWG.

3.2.2.2 Use of Aluminum Conductors in Lieu of Copper

Aluminum conductors shall not be used.

3.2.2.3 Cable Splicing

Splices shall be made in an accessible location. Crimping tools and dies shall be approved by the connector manufacturer for use with the type of connector and conductor.

- a. Copper Conductors, 600 Volt and Under: Splices in conductors No. 10 AWG and smaller diameter shall be made with an insulated, pressure-type connector. Splices in conductors No. 8 AWG and larger diameter shall be made with a solderless connector and insulated with tape or heat-shrink type insulating material equivalent to the conductor insulation.

3.2.2.4 Conductor Identification and Tagging

Power, control, and signal circuit conductor identification shall be provided within each enclosure where a tap, splice, or termination is made.

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. Phase conductors of low voltage power circuits shall be identified by color coding. Phase identification by a particular color shall be maintained continuously for the length of a circuit, including junctions.

- a. Color coding shall be provided for service, feeder, branch, and ground conductors. Color shall be green for grounding conductors and white for neutrals; except where neutrals of more than one system are installed in the same raceway or box, other neutral shall be white with colored (not green) stripe. The color coding for 3-phase and single-phase low voltage systems shall be as follows:

120/208-volt, 3-phase: Black(A), red(B), and blue(C).
277/480-volt, 3-phase: Brown(A), orange(B), and yellow(C).
120/240-volt, 1-phase: Black and red.

- b. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by the use of half-lapped bands of colored electrical tape wrapped around the insulation for a minimum of 3 inches of length near the end, or other method as submitted by the Contractor and approved by the Contracting Officer.
- c. Control and signal circuit 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. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved detail drawings. Hand lettering or marking is not acceptable.

3.3 BOXES AND SUPPORTS

Boxes shall be provided in the wiring or raceway systems where required by NFPA 70 for pulling of wires, making connections, and mounting of devices or fixtures. Pull boxes shall be furnished with screw-fastened covers. Indicated elevations are approximate, except where minimum mounting heights for hazardous areas are required by NFPA 70. Unless otherwise indicated, boxes for wall switches shall be mounted 48 inches above finished floors. Switch and outlet boxes located on opposite sides of fire rated walls shall be separated by a minimum horizontal distance of 24 inches. The total combined area of all box openings in fire rated walls shall not exceed 100 square inches per 100 square feet. Maximum box areas for individual boxes in fire rated walls vary with the manufacturer and shall not exceed the maximum specified for that box in UL Elec Const Dir. Only boxes listed in UL Elec Const Dir shall be used in fire rated walls.

3.3.1 Box Applications

Each box shall have not less than the volume required by NFPA 70 for number of conductors enclosed in box. Boxes for metallic raceways shall be listed for the intended use when located in normally wet locations, when flush or surface mounted on outside of exterior surfaces, or when located in hazardous areas. Boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed. Boxes for mounting lighting fixtures shall be not less than 4 inches square, or octagonal, except smaller boxes may be installed as required by fixture configuration, as approved. Unless otherwise indicated, all boxes for switches and receptacles that are mounted in exposed interior and exterior locations shall be cast metal type with threaded hubs. Cast-metal boxes with 3/32 inch wall thickness are acceptable. Large size boxes shall be NEMA 12 or as shown. Boxes in other locations shall be sheet steel when permitted by NFPA 70. Boxes for use in masonry-block or tile walls shall be square-cornered, tile-type, or standard boxes having square-cornered, tile-type covers.

3.3.2 Brackets and Fasteners

Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and metal expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screw or welded studs on steel work. Threaded studs driven in by powder charge and provided with lockwashers and nuts, or nail-type nylon anchors may be used in lieu of expansion shields, or machine screws. Penetration of more than 1-1/2 inches into reinforced-concrete beams or more than 3/4 inch into reinforced-concrete joists shall avoid cutting any main reinforcing steel. The use of brackets which depend on gypsum wallboard or plasterboard for primary support will not be permitted. In partitions of light steel construction, bar hangers with 1 inch long studs, mounted between metal wall studs or metal box mounting brackets shall be used to secure boxes to the building structure. When metal box mounting brackets are used, additional box support shall be provided on the side of the box opposite the brackets. This additional box support shall consist of a minimum 12 inch long section of wall stud, bracketed to the opposite side of the box and secured by two screws through the wallboard on each side of the stud. Metal screws may be used in lieu of the metal box mounting brackets.

3.3.3 Mounting in Walls, Ceilings, or Recessed Locations

In walls or ceilings of concrete, tile, or other non-combustible material, boxes shall be installed so that the edge of the box is not recessed more than 1/4 inch from the finished surface. Boxes mounted in combustible walls or ceiling material shall be mounted flush with the finished surface. The use of gypsum or plasterboard as a means of supporting boxes will not be permitted. Boxes installed for concealed wiring shall be provided with suitable extension rings or plaster covers, as required. The bottom of boxes installed in masonry-block walls for concealed wiring shall be mounted flush with the top of a block to minimize cutting of the blocks, and boxes shall be located horizontally to avoid cutting webs of block. 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.

3.3.4 Installation in Overhead Spaces

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 bar hangers. Hangers shall not be fastened to or supported from joist bridging. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved type fastener not more than 24 inches from the box.

3.4 DEVICE PLATES

One-piece type device plates shall be provided for all outlets and fittings. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast-metal. 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 shall be gasketed and

provided with a hinged, gasketed cover, unless otherwise specified. All devices installed in exposed cast metal boxes shall have compatible cast metal device plates installed.

3.5 RECEPTACLES

3.5.1 Single and Duplex, 15 or 20-ampere, 125 volt

Single and duplex receptacles shall be extra hard use specification grade, rated 20 amperes, 125 volts, two-pole, three-wire, grounding type with polarized parallel slots. Bodies shall be of gray to match color of switch handles in the same room and supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke. Switched receptacles shall be the same as other receptacles specified except that the ungrounded pole of each suitable receptacle shall be provided with a separate terminal. Only the top receptacle of a duplex receptacle shall be wired for switching application. Receptacles with ground fault circuit interrupters shall have the current rating as indicated, and shall be UL Class A type unless otherwise shown. Ground fault circuit protection shall be provided as required by NFPA 70 and as indicated on the drawings.

3.5.2 Weatherproof Applications

Weatherproof receptacles shall be suitable for the environment, damp or wet as applicable, and the housings shall be labeled to identify the allowable use. Receptacles shall be marked in accordance with UL 514A for the type of use indicated; "Damp locations", "Wet Locations", "Wet Location Only When Cover Closed". Assemblies shall be installed in accordance with the manufacturer's recommendations.

3.5.2.1 Damp Locations

Receptacles in damp locations shall be mounted in an outlet box with a gasketed, weatherproof, cast-metal cover plate (device plate, box cover) and a gasketed cap (hood, receptacle cover) over each receptacle opening. The cap shall be either a screw-on type permanently attached to the cover plate by a short length of bead chain or shall be a flap type attached to the cover with a spring loaded hinge.

3.5.2.2 Wet Locations

Receptacles in wet locations shall be installed in an assembly rated for such use whether the plug is inserted or withdrawn, unless otherwise indicated. In a duplex installation, the receptacle cover shall be configured to shield the connections whether one or both receptacles are in use.

3.5.3 Special-Purpose or Heavy-Duty Receptacles

Special-purpose or heavy-duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking type receptacles, rated 30 amperes or less, shall be locked by rotating the plug. Locking type receptacles, rated more than 50 amperes, shall utilize a locking ring.

3.6 WALL SWITCHES

Wall switches shall be specification grade, fast make, positive break, snap switches with grounding terminal. The wall switch handle and switch plate color shall be gray. Wiring terminals shall be of the screw type or of the solderless pressure type having suitable conductor-release arrangement. Not more than two switches shall be installed in a single-gang position. Switches shall be rated 20-ampere 120-volt for use on alternating current only. Pilot lights indicated shall consist of yoke-mounted candelabra-base sockets rated at 75 watts, 125 volts, and fitted with glass or plastic jewels. A clear 6-watt lamp shall be furnished and installed in each pilot switch. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be red.

3.7 SERVICE EQUIPMENT

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

3.8 DISTRIBUTION PANELS AND POWER PANELS

Circuit breakers and switches used as a motor disconnecting means shall be capable of being locked in the open position. Door locks shall be keyed alike. Nameplates shall be as approved. Directories shall be typed to indicate loads served by each circuit and mounted in a holder behind a clear protective covering. Busses shall be copper.

3.8.1 Distribution Panels

Quantity and identification shall be as shown on drawings. Distribution panels shall be in accordance with UL 67 and NEMA PB 1. Panels will be of a Dead-front construction, with molded case circuit breakers, and be surface mounted. Distribution panels will be rated for 480Y/277 volts ac, 3-phase, 4-wire, with a main bus capacity of 600 amperes, and a neutral bus capacity of 150 percent of the main bus. Busses will be of copper construction. Distribution panels will be equipped with bolt-on, enclosed thermal-magnetic protective, quick make, quick break, trip indicating, circuit breakers, with a rating of 14,000 symmetrical amperes at 277 volts.

3.8.2 Power Panels

Quantity and identification shall be as shown on drawings. Power panels shall be in accordance with UL 67 and NEMA PB 1. Panels will be of a Dead-front construction, with molded case circuit breakers, and be surface mounted. Power panels will be rated for 208Y/120 volts ac, 3-phase, 4-wire, with a main bus capacity of 100 amperes, and a neutral bus capacity of 150 percent of the main bus or with a voltage and current rating as shown on drawings. Busses will be of copper construction. Power panels will be equipped with bolt-on, enclosed thermal-magnetic protective, quick make, quick break, trip indicating, circuit breakers, with a rating of 10,000 symmetrical amperes at 240 volts.

3.9 FUSES

Equipment provided under this contract shall be provided with a complete

set of properly rated fuses when the equipment manufacturer utilize fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination. Time-delay and non-time-delay options shall be as specified.

3.9.1 Cartridge Fuses; Current-Limiting Type

Cartridge fuses, current-limiting type, Class RK1 shall have tested interrupting capacity not less than 200,000 amperes. Fuse holders shall be the type that will reject all Class H fuses.

3.9.2 Continuous Current Ratings (600 Amperes and Smaller)

Service entrance and feeder circuit fuses (600 amperes and smaller) shall be Class RK1, current-limiting, time-delay with 200,000 amperes interrupting capacity.

3.9.3 Motor and Transformer Circuit Fuses

Motor, motor controller, transformer, and inductive circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

3.10 UNDERGROUND SERVICE

Unless otherwise indicated, interior conduit systems shall be stubbed out 5 feet beyond the building wall and 2 feet below finished grade, for interface with the exterior service lateral conduits. Outside conduit ends shall be bushed when used for direct burial service lateral conductors. Outside conduit ends shall be capped or plugged until connected to exterior conduit systems. Contractor shall provide and install exterior, underground, conduit and cable system, from building service disconnect to Utility provided transformer. All service cable and conduit will be installed and terminated in accordance with the requirements of NFPA 70. Contractor shall be responsible for all costs associated with establishing required services. Contractor shall be responsible for all costs associated with relocation or termination of existing services, for construction of the new levee system.

3.11 MOTORS

Each motor shall conform to the hp and voltage ratings indicated, and shall have a service factor and other characteristics that are essential to the proper application and performance of the motors under conditions shown or specified. Three-phase motors for use on 3-phase 208-volt systems shall have a nameplate rating of 200 volts. Unless otherwise specified, all motors shall have open frames, and continuous-duty classification based on a 40 degree C ambient temperature reference. Polyphase motors shall be squirrel-cage type, having normal-starting-torque and low-starting-current characteristics, unless other characteristics are specified in other sections of these specifications or shown on contract drawings. The Contractor shall be responsible for selecting the actual horsepower ratings and other motor requirements necessary for the applications indicated. When electrically driven equipment furnished under other sections of these

specifications materially differs from the design, the Contractor shall make the necessary adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed.

3.12 MOTOR CONTROL

Each motor or group of motors requiring a single control shall be provided under other sections of these specifications with a suitable controller and devices that will perform the functions as specified for the respective motors. Each motor of 1/8 hp or larger shall be provided with thermal-overload protection. Polyphase motors shall have overload protection in each ungrounded conductor. The overload-protection device shall be provided either integral with the motor or controller, or shall be mounted in a separate enclosure. Unless otherwise specified, the protective device shall be of the manually reset type. Single or double pole tumbler switches specifically designed for alternating-current operation only may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats, float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic-control device does not have such a rating, a magnetic starter shall be used, with the automatic-control device actuating the pilot-control circuit. When combination manual and automatic control is specified and the automatic-control device operates the motor directly, a double-throw, three-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 three-position selector switch marked MANUAL-OFF-AUTOMATIC. 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 Manual and the Automatic positions of the selector switch. Control circuit connections to any MANUAL-OFF-AUTOMATIC switch or to more than one automatic regulatory control device shall be made in accordance with wiring diagram approved by the Contracting Officer unless such diagram is included on the drawings. All controls shall be 120 volts or less unless otherwise indicated.

3.12.1 Contacts

Unless otherwise indicated, contacts in miscellaneous control devices such as float switches, pressure switches, and auxiliary relays shall have current and voltage ratings in accordance with NEMA ICS 2 for rating designation B300.

3.12.2 Safety Controls

Safety controls for boilers shall be connected to a 2-wire, 120 volt grounded circuit supplied from the associated boiler-equipment circuit. Where the boiler circuit is more than 120 volts to ground, safety controls shall be energized through a two-winding transformer having its 120 volt secondary winding grounded. Overcurrent protection shall be provided in the ungrounded secondary conductor and shall be sized for the load encountered.

3.13 MOTOR-DISCONNECT MEANS

Each motor shall be provided with a disconnecting means when required by NFPA 70 even though not indicated. For single-phase motors, a single or double pole toggle switch, rated only for alternating current, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating. Switches shall disconnect all ungrounded conductors.

3.14 TRANSFORMER INSTALLATION

Three-phase transformers shall be connected only in a delta-wye configuration as indicated. "T" connections may be used for transformers rated at 15 kVA or below. Dry-type transformers shown located within 5 feet of the exterior wall shall be provided in a weatherproof enclosure. Transformers to be located within the building may be provided in the manufacturer's standard, ventilated indoor enclosure designed for use in 40 degrees C ambient temperature, unless otherwise indicated.

3.15 LIGHTING FIXTURES, LAMPS AND BALLASTS

This paragraph shall cover the installation of lamps, lighting fixtures and ballasts in interior or building mounted applications.

3.15.1 Lamps

Lamps of the type, wattage, and voltage rating indicated shall be delivered to the project in the original cartons and installed just prior to project completion. Lamps installed and used for working light during construction shall be replaced prior to turnover to the Government if more than 15% of their rated life has been used. Lamps shall be tested for proper operation prior to turn-over and shall be replaced if necessary with new lamps from the original manufacturer. 10% spare lamps of each type, from the original manufacturer, shall be provided.

3.15.2 Lighting Fixtures

Fixtures shall be as shown and shall conform to the following specifications and shall be as detailed on the drawings. Illustrations attached at the end of this section are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar designs and equivalent energy efficiency, light distribution and brightness characteristics, and of equal finish and quality will be acceptable if approved. In suspended acoustical ceilings with fluorescent fixtures, the fluorescent emergency light fixtures shall be furnished with self-contained battery packs.

3.15.2.1 Accessories

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

3.15.2.2 Ceiling Fixtures

Ceiling fixtures shall be coordinated with and suitable for installation in, on or from the ceiling as shown. Installation and support of fixtures shall be in accordance with NFPA 70 and manufacturer's recommendations. Where seismic requirements are specified herein, fixtures shall be supported as shown or specified. Recessed fixtures shall have adjustable fittings to permit alignment with ceiling panels. Recessed fixtures

installed in fire-resistive ceiling construction shall have the same fire rating as the ceiling or shall be provided with fireproofing boxes having materials of the same fire rating as the ceiling, in conformance with UL Elec Const Dir. Surface-mounted fixtures shall be suitable for fastening to the ceiling panel structural supports.

3.15.2.3 Suspended Fixtures

Suspended fixtures shall be provided with swivel hangers or hand-straightens so that they hang plumb. Pendants, rods, or chains 4 feet or longer excluding fixture shall be braced to prevent swaying using three cables at 120 degrees of separation. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints. Steel fixtures shall be supported to prevent "oil-canning" effects. Fixture finishes shall be free of scratches, nicks, dents, and warps, and shall match the color and gloss specified. Pendants shall be finished to match fixtures. Aircraft cable shall be stainless steel. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown. Maximum distance between suspension points shall be 10 feet or as recommended by the manufacturer, whichever is less.

Suspended fixtures installed in seismic areas shall have 45% swivel hangers and shall be located with no obstructions within the 45% range in all directions. The stem, canopy and fixture shall be capable of 45% swing.

3.15.3 Emergency Light Sets

Emergency light sets shall conform to UL 924 with the number of heads as indicated. Sets shall be permanently connected to the wiring system by conductors installed in short lengths of flexible conduit.

3.16 BATTERY CHARGERS

Battery chargers shall be installed in conformance with NFPA 70.

3.17 EQUIPMENT CONNECTIONS

Wiring not furnished and installed under other sections of the specifications for the connection of electrical equipment as indicated on the drawings shall be furnished and installed under this section of the specifications. Connections shall comply with the applicable requirements of paragraph WIRING METHODS. Flexible conduits 6 feet or less in length shall be provided to all electrical equipment subject to periodic removal, vibration, or movement and for all motors. All motors shall be provided with separate grounding conductors. Liquid-tight conduits shall be used in damp or wet locations.

3.17.1 Motors and Motor Control

Motors, motor controls, and motor control centers shall be installed in accordance with NFPA 70, the manufacturer's recommendations, and as indicated. Wiring shall be extended to motors, motor controls, and motor control centers and terminated.

3.17.2 Installation of Government-Furnished Equipment

Contractor shall be responsible for installation and connection of all Government-furnished equipment. This includes installation and mounting, connection of power and control wiring, and all required interconnections. Government-furnished equipment shall include, but not be limited to the following:

- a. Electrical generator.
- b. Automatic transfer switch.
- c. Pump motor controller.
- d. Pump motor starters.
- e. Pump motors.
- f. Level indicators.
- g. SCADA system.

3.18 CIRCUIT PROTECTIVE DEVICES

The Contractor shall calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system under actual operating conditions.

3.19 PAINTING AND FINISHING

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

3.20 REPAIR OF EXISTING WORK

The work shall be carefully laid out in advance, and where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceiling, 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, and any damage to building, piping, or equipment shall be repaired by skilled mechanics of the trades involved at no additional cost to the Government.

3.21 FIELD TESTING OF NON-GOVERNMENT-FURNISHED EQUIPMENT

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 30 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspection recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. All field test reports will be signed and dated by the Contractor.

3.21.1 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the

test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.21.2 Ground-Resistance Tests

The resistance of the grounding grid shall be measured using the fall-of-potential method defined in IEEE Std 81. Soil resistivity in the area of the grid shall be measured concurrently with the grid measurements.

Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.
- b. Grid electrode - 5 ohms.

3.21.3 Ground-Grid Connection Inspection

All below-grade ground-grid connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer 96 hours before the site is ready for inspection.

3.21.4 Cable Tests

The Contractor shall be responsible for identifying all equipment and devices that could be damaged by application of the test voltage and ensuring that they have been properly disconnected prior to performing insulation resistance testing. An insulation resistance test shall be performed on all low and medium voltage cables after the cables are installed in their final configuration and prior to energization. The test voltage shall be 500 volts DC applied for one minute between each conductor and ground and between all possible combinations of conductors. The minimum value of resistance shall be:

$$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 1000 / (\text{length of cable in feet})$$

Each cable failing this test shall be repaired or replaced. The repaired cable system shall then be retested until failures have been eliminated.

3.21.4.1 Low Voltage Cable Tests

- a. Continuity test.
- b. Insulation resistance test.

3.21.5 Motor Tests

- a. Phase rotation test to ensure proper directions.
- b. High potential test on each winding to ground.
- c. Insulation resistance of each winding to ground.

3.21.6 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers.

3.21.6.1 Circuit Breakers, Molded Case

- a. Insulation resistance test phase-to-phase, all combinations.
- b. Insulation resistance test phase-to-ground, each phase.
- c. Closed breaker contact resistance test.
- d. Manual operation of the breaker.

3.21.7 Protective Relays

Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. These tests shall include pick-up, timing, contact action, restraint, and other aspects necessary to insure proper calibration and operation. Relay settings shall be implemented in accordance with the coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.

3.22 OPERATING TESTS

After the installation is completed, and at such time as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the specified requirements. An operating test report shall be submitted in accordance with paragraph FIELD TEST REPORTS.

3.23 ACCEPTANCE

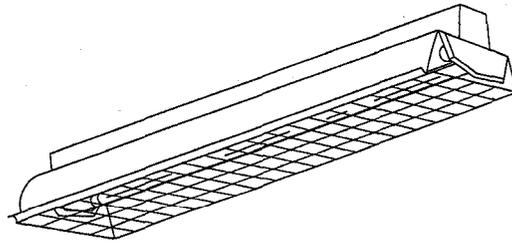
Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --

TYPE: PF6

FEATURES

LAMP TYPE: F32T8/75 CRI
PROFILE: 2 LAMP
SHIELDING: WIRE GUARD
BALLAST: ELECTRONIC



OPTIONS

PROFILE: 3 LAMP
MOUNTING: SURFACE
BALLAST: HIGH POWER FACTOR
MAGNETIC, EMERGENCY

NOM. DIMENSIONS 178 mm X 356 mm X 1219 mm
(7" H X 14" W X 4' L)

GENERAL DESCRIPTION

HOUSING: DIE-FORMED CRS HOUSING WITH ROLLED SYMMETRIC
REFLECTOR/BALLAST COVER

REFLECTORS: COLD ROLLED STEEL, PAINTED WHITE, 10% UPLIGHT APERTURES

ELECTRICAL: 120 OR 277 VOLT BALLAST

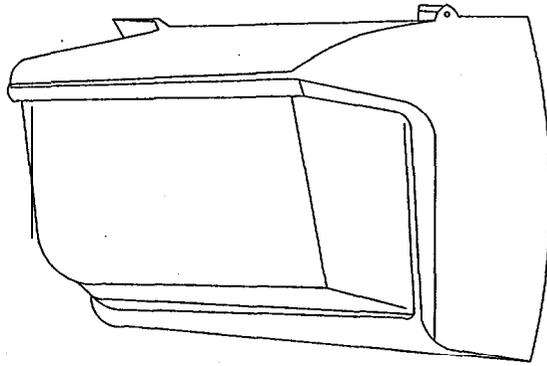
FINISH: WHITE ENAMEL POLYESTER POWDER COAT

CHAIN HUNG 4' TURRET INDUSTRIAL
FLUORESCENT

TYPE: EH5

FEATURES

LAMP TYPE: 70W METAL HALIDE
PROFILE: 1 LAMP
SHIELDING: PRISMATIC BOROSILICATE
GLASS
BALLAST: HIGH POWER FACTOR,
CORE & COIL, CWA



OPT-IONS

LAMP TYPE: MH: 100W, 175W
HPS: 70W, 100W, 150W
SHIELDING: POLYCARBONATE
OTHER: PHOTOCCELL CONTROL

NOM. DIMENSIONS 311 mm X 241 mm X 184 mm
(12¹/₄" L X 9¹/₂" H X 7¹/₄" D)

GENERAL DESCRIPTION

HOUSING: DIE CAST ALUMINUM HOUSING, DOOR ASSEMBLY AND BACKPLATE

MOUNTING: DIE CAST ALUMINUM BACKPLATE WITH CAST-IN KNOCKOUTS FOR
MOUNTING HOLE ALIGNMENT.

REFLECTORS: SPECULAR ANODIZED ALUMINUM

ELECTRICAL: 120, 277, 208, 240, 347 & 480 VOLT MULTI TAP BALLAST

FINISH: BAKED-ON POLYURETHANE POWDER COAT PAINT

METAL HALIDE WALL PAK

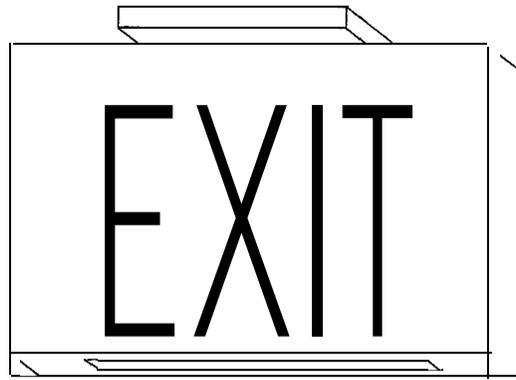
TYPE: XL1

FEATURES

LAMP TYPE: LED
MOUNTING: UNIVERSAL
SHIELDING: FLAT SHEET ACRYLIC
LETTERS: GREEN

OPTIONS

LETTERS: RED
OTHER: BRUSHED ALUMINUM,
WHITE AND BRONZE



NOM. DIMENSIONS 289 mm X 200 mm X 44 mm
(11³/₈" W X 7⁷/₈" H X 1³/₄" D)

GENERAL DESCRIPTION

HOUSING: DIE-CAST ALUMINUM OR 20 GA. COLD ROLLED STEEL, HARDWARE FINISH TO MATCH HOUSING FINISH. 152 mm (6") H LETTERS WITH 19 mm (3/4") STROKE. DIRECTIONAL ARROWS AS REQUIRED

ELECTRICAL: 120 OR 277 VOLT

FINISH: BLACK

OTHER: MINIMUM BRIGHTNESS. 20 CD/SQ METER ON FACE OF SIGN.

LED STENCIL FACE EXIT SIGN

CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY

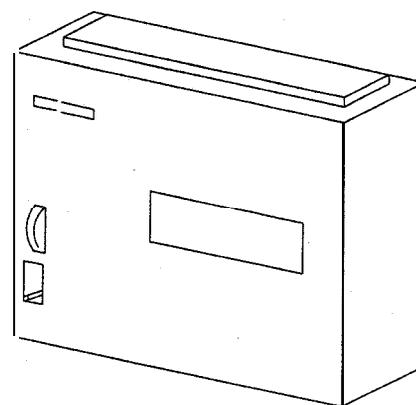
TYPE: XII

FEATURES

BATTERY: SEALED LEAD CALCIUM, 3
YEAR

OPTIONS

BATTERY: SEALED LONG LIFE, 5
YEAR
SEALED NICKEL CADMIUM



NOM. DIMENSIONS 267 mm X 140 mm X 73 mm
(10¹/₂" L X 5¹/₂" H X 2⁷/₈" W)

GENERAL DESCRIPTION

HOUSING: COMPACT FIRE-RETARDANT THERMOPLASTIC

MOUNTING: LIGHTING HEADS MOUNTED TOP OR SIDE, WALL-MOUNTED UNIT.

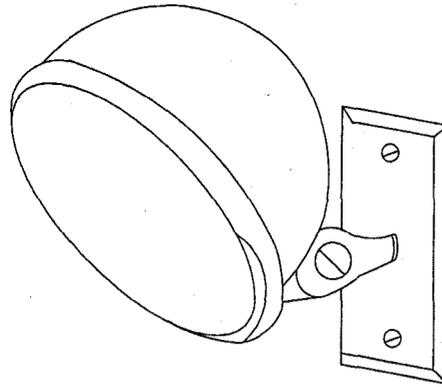
ELECTRICAL: 120 OR 277 VOLT PRIMARY, 6 OR 12 VOLT SECONDARY

FINISH: OFF WHITE

EMERGENCY LIGHTING BATTERY UNIT

16415 - A4

TYPE: X12



FEATURES

LAMP TYPE: 18W PAR36
PROFILE: 1 LAMP

OPTIONS

LAMP TYPE: 8W, 12W PAR36
PROFILE: 2 LAMP

NOM. DIMENSIONS 76 mm X 197 mm X 168 mm
(3" D X 7³/₄" H X 6⁵/₈" W)

SPECIFICATIONS

HOUSING: IMPACT RESISTANT, FLAME RETARDANT THERMOPLASTIC

MOUNTING: TOP MOUNTING OR SIDE MOUNTING TO X11 EMERGENCY UNIT

ELECTRICAL: 6 OR 12 VOLT SUPPLY FROM EMERGENCY UNIT

FINISH: OFF WHITE

EMERGENCY REMOTE-MOUNTED FLOODLIGHT
FOR USE WITH TYPE X11 EMERGENCY
UNIT

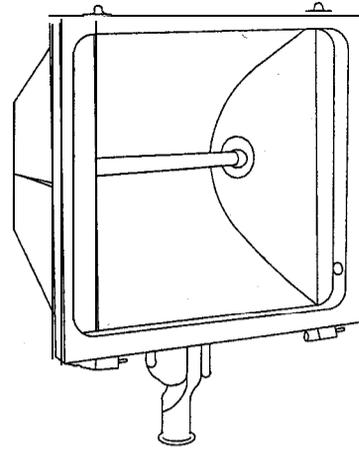
TYPE: E12

FEATURES

LAMP TYPE: 500W T3 HALOGEN

PROFILE: 1 LAMP

SHIELDING: CLEAR TEMPERED GLASS



OPTIONS

LAMP TYPE: 300W, 425W, 1500W T3

NOM. DIMENSIONS 241 mm L X 197 mm H X 98 mm
(9 1/2" L X 7 3/4" H X 3 7/8" W)

GENERAL DESCRIPTION

HOUSING: CAST ALUMINUM

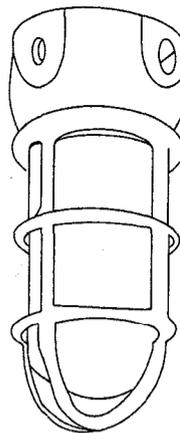
REFLECTORS: SPECULAR ALUMINUM

ELECTRICAL: 120 VOLT

FINISH: PAINTED DARK BRONZE FINISH

TUNGSTEN HALOGEN FLOODLIGHT

TYPE: SF11



FEATURES

LAMP TYPE: F18DTT/RS
PROFILE: 1 LAMP
SHIELDING: CLEAR GLASS GLOBE
BALLAST: ELECTRONIC

OPTIONS

LAMP TYPE: 90W TB/IF
MOUNTING: PENDANT, ARM MOUNT
ADAPTER
SHIELDING: HEAT RESISTANT
BALLAST: HIGH POWER FACTOR
MAGNETIC

NOM. DIMENSIONS 111 mm X 251 mm
(4³/₈" DIA. X 9⁷/₈" H)

GENERAL DESCRIPTION

HOUSING: 30 PERCENT GLASS-FILLED THERMOPLASTIC POLYESTER

ELECTRICAL: 120 OR 277 VOLT BALLAST

FINISH: MOLDED IN NON-GRAYING FINISH

SURFACE MOUNTED COMPACT FLUORESCENT
VAPOR TIGHT JELLY JAR WITH WIRE
GUARD

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SECTION 16528

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SECTION 16528

EXTERIOR LIGHTING INCLUDING SECURITY AND CCTV APPLICATIONS

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO LTS-3 (1994) Standard Specifications for
Structural Supports for Highway Signs,
Luminaires and Traffic Signals

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C78.1 (1991; C78.1a; R 1996) Fluorescent Lamps -
Rapid-Start Types - Dimensional and
Electrical Characteristics

ANSI C78.40 (1992) Specifications for Mercury Lamps

ANSI C78.1350 (1990) Electric Lamps 400-Watt, 100-Volt,
S51 Single-Ended High-Pressure Sodium Lamps

ANSI C78.1351 (1989) Electric Lamps - 250-Watt, 100-Volt
S50 Single-Ended High-Pressure Sodium Lamps

ANSI C78.1352 (1990) Electric Lamps - 1000-Watt,
250-Volt, S52 Single-Ended High-Pressure
Sodium Lamps

ANSI C78.1355 (1989) Electric Lamps - 150-Watt, 55-Volt
S55 High-Pressure Sodium Lamps

ANSI C78.1375 (1996) 400-Watt, M59 Single-Ended
Metal-Halide Lamps

ANSI C78.1376 (1996) 1000-Watt, M47 Metal-Halide Lamps

ANSI C80.1 (1995) Rigid Steel Conduit - Zinc Coated

ANSI C82.4 (1992) Ballasts for
High-Intensity-Discharge and Low-Pressure
Sodium Lamps (Multiple-Supply Type)

ANSI C119.1 (1986; R 1997) Sealed Insulated
Underground Connector Systems Rated 600
Volts

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ANSI C135.1	(1979) Galvanized Steel Bolts and Nuts for Overhead Line Construction
ANSI C135.14	(1979) Staples with Rolled or Slash Points for Overhead Line Construction
ANSI C136.2	(1996) Luminaires, Voltage Classification Roadway Lighting Equipment
ANSI C136.3	(1995) Roadway Lighting Equipment-Luminaire Attachments
ANSI C136.6	(1997) Roadway Lighting Equipment - Metal Heads and Reflector Assemblies - Mechanical and Optical Interchangeability
ANSI C136.9	(1990) Roadway Lighting - Socket Support Assemblies for Use in Metal Heads - Mechanical Interchangeability
ANSI C136.10	(1996) Roadway Lighting- Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing
ANSI C136.11	(1995) Multiple Sockets for Roadway Lighting Equipment
ANSI C136.15	(1986) Roadway Lighting, High-Intensity-Discharge and Low-Pressure Sodium Lamps in Luminaires -

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123/A 123M	(1997a ^{el}) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(1998) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 575	(1996) Steel Bars, Carbon, Merchant Quality, M-Grades
ASTM A 576	(1990b; R 1995) Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM B 2	(1994) Medium-Hard-Drawn Copper Wire
ASTM B 8	(1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B 117	(1997) Operating Salt Spray (Fog) Apparatus
ASTM D 1654	(1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

Grand Forks Phase 1 Levees

IESNA RP-8	(1983; R 1993) Roadway Lighting
INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)	
IEEE C2	(1997) National Electrical Safety Code
IEEE C136.13	(1987; R 1997) Metal Brackets for Wood Poles
IEEE Std 81	(1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA 250	(1997) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2,000 Volts AC or 750 Volts DC
NEMA ICS 6	(1993) Industrial Control and Systems, Enclosures
NEMA OS 1	(1996) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA OS 2	(1986; Errata Aug 1986; R 1991) Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
NEMA RN 1	(1989) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 6	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA TC 9	(1990) Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(1999) National Electrical Code
UNDERWRITERS LABORATORIES (UL)	
UL 6	(1997) Rigid Metal Conduit
UL 44	(1997; Rev Mar 1999) Rubber-Insulated Wires and Cables
UL 50	(1995; Rev thru Nov 1999) Enclosures for Electrical Equipment

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UL 83	(1998; Rev thru Sep 99) Thermoplastic-Insulated Wires and Cables
UL 98	(1994; Rev thru Jun 1998) Enclosed and Dead-Front Switches
UL 467	(1993; Rev thru Apr 1999) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997; Rev Jun 1997) Wire Connections for Use with Aluminum Conductors
UL 493	(1995) Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables
UL 514A	(1996; Rev Dec 1999) Metallic Outlet Boxes
UL 514B	(1997; Rev Oct 1998) Fittings for Cable and Conduit
UL 514C	(1996; R Sep 1998) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 651	(1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit
UL 651A	(1995; Rev thru Apr 1998) Type EB and A Rigid PVC Conduit and HDPE Conduit
UL 854	(1996; Rev Apr 1998) Service-Entrance Cables
UL 1029	(1994; Rev thru Dec 1997) High-Intensity-Discharge Lamp Ballasts
UL 1571	(1995; Rev thru Jun 1997) Incandescent Lighting Fixtures
UL 1572	(1995; Rev thru Jun 1997) High Intensity Discharge Lighting Fixtures

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment and Materials; FIO

Data published by the manufacturer of each item on the list of equipment and material, to permit verification that the item proposed is of the correct size, properly rated or applied, or is

otherwise suitable for the application and fully conforms to the requirements specified.

SD-04 Drawings

Lighting System; GA
Detail Drawings; GA

Detail drawings for the complete system and for poles, lighting fixtures, banner arms, handholes, controllers, and streetlight control center.

As-Built Drawings; FIO

Final as-built drawings shall be finished drawings on mylar or vellum and shall be delivered with the final test report.

SD-09 Reports

Operating Test; GA

Test procedures and reports for the Operating Test. After receipt by the Contractor of written approval of the test procedures, the Contractor shall schedule the tests. The final test procedures report shall be delivered after completion of the tests.

Ground Resistance Measurements; FIO

The measured resistance to ground of each separate grounding installation, indicating the location of the rods, the resistance of the soil in ohms per millimeter and the soil conditions at the time the measurements were made. The information shall be in writing.

SD-19 Operation and Maintenance Manuals

Lighting System; FIO

A draft copy of the operation and maintenance manuals, prior to beginning the tests for use during site testing. Final copies of the manuals as specified bound in hardback, loose-leaf binders, within 30 days after completing the field test. The draft copy used during site testing shall be updated with any changes required, prior to final delivery of the manuals. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of each subcontractor installing equipment and systems, and nearest service representatives for each item of equipment for each system. The manuals shall have a table of contents and tab sheets. Tab sheets shall be placed at the beginning of each chapter or section and at the beginning of each appendix. The final copies delivered after completion of the field test shall include modifications made during installation checkout and acceptance.

1.3 SYSTEM DESCRIPTION

1.3.1 Lighting System

The lighting system shall be configured as specified and shown. The system shall include all fixtures, hardware, poles, cables, connectors, adapters and appurtenances needed to provide a fully functional lighting system.

1.3.2 Design Requirements for Lighting

The lighting system shall be configured as specified and shown. Equipment shall conform to NFPA 70 and IEEE C2. The lighting configuration shall provide sufficient light for each area. The system shall include all fixtures, hardware, poles, cables, connectors, adapters, and appurtenances needed to provide a fully functional lighting system.

1.3.3 Electrical Requirements

The equipment shall operate from a voltage source as shown, plus or minus 10 percent, and 60 Hz, plus or minus 2 percent.

1.3.4 Interface Between Lighting System and Power Distribution

Conductors shall be as indicated.

1.3.5 Nameplates

Each major component of equipment shall have a nonferrous metal or engraved plastic nameplate which shall show, as a minimum, the manufacturer's name and address, the catalog or style number, the electrical rating in volts, and the capacity in amperes or watts.

1.3.6 Standard Products

Materials and equipment shall be standard products of manufacturer regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening.

1.3.7 Unusual Service Conditions

Equipment and materials furnished under this section shall be suitable for the following unusual service conditions: ambient temperature -40 degrees F.

1.4 CORROSION PROTECTION

1.4.1 Aluminum Materials

Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

1.4.2 Ferrous Metal Materials

1.4.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

1.4.2.2 Equipment

Equipment and component items, including but not limited to metal poles and ferrous metal luminaires not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 480 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall have a rating of not less than 7 in accordance with TABLE 1, (procedure A) of ASTM D 1654. Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

1.4.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory, shall be as specified in Section 09900 PAINTING, GENERAL.

PART 2 PRODUCTS

2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.2 BANNER ARMS

2.2.1 On Aluminum, Steel, Fiberglass, and Concrete Poles

Poles shall be provided with banner arms of the style and of the length indicated on drawings. Banner arms shall conform to the design of the pole provided. The banner arms shall be capable of supporting the equipment to be mounted on it with the maximum wind and ice loading encountered at the site. Strength of banner arms shall be in accordance with IEEE C136.13. Steel banner arms shall be galvanized. Wood banner arms shall not be used.

2.2.2 Floodlight Brackets

Floodlight brackets shall be coordinated with the floodlight support provided.

2.3 CABLE

The Contractor shall provide all wire and cable not indicated as government furnished equipment. Wire and cable components shall be able to withstand the jobsite environment for a minimum of 20 years.

2.3.1 Insulated Cable

Cable shall be type USE conforming to UL 854, with copper conductors and type RHW or XHHW insulation conforming to UL 44, and shall include green ground conductor. Cable shall be Type UF-B conforming to UL 83 and UL 493, with copper conductors. Cable shall be provided with insulation of a thickness not less than that given in column A B of TABLE 15.1 of UL 854. Cable shall be rated 600 volts. Parts of the cable system such as splices and terminations shall be rated not less than 600 volts. The size and

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number of conductors and the number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded.

2.3.2 Bare Copper Conductors

Medium-hard-drawn copper conductors shall conform to ASTM B 2 and ASTM B 8.

2.4 CABLE SPLICES AND CONNECTORS

Cable splices and connectors shall conform to UL 486A. Underground splices and connectors shall also conform to the requirements of ANSI C119.1.

2.4.1 Twist-On Sealed Waterproof Connectors

Provide twist-on sealed waterproof connectors where indicated on the drawing schedule. Connectors shall meet NEC Article 100-11 for use in all NEMA enclosures and shall be UL 50 tested and raintight/watertight. Connectors shall come prefilled with custom sealant which shall act to lock out moisture and air. Connectors shall have an infinite shelf life and include color coding to indicate acceptable wire sizes. Connectors shall have a voltage rating of 600 volts ac, a temperature rating of 221 degrees F, a sealant temperature rating range of -45 degrees F to 400 degrees F, and suitable for copper-to-copper wire combinations. Connectors shall be taped with electrical tape.

2.4.2 Low Voltage Waterproof Mechanical Connector Kit

Provide mechanical bolted connectors where indicated on the drawing schedule. Connectors shall be comprised of a connector and an outer closure, prefilled with a waterproofing gel material. Connectors shall accept up to 4 properly sized conductors per connector. Connectors shall be rated for 600 volts ac and suitable for copper-to-copper and copper-to-aluminum conductor combinations. Outer hinged closure shall contain a prefilled waterproofing gel and 2 locking snaps to secure closure when fully closed.

2.5 HANDHOLES

Handholes shall be as indicated. Handholes for low voltage cables shall be of molded high density polyethylene, UV stabilized or polymer concrete. Box and cover shall withstand a minimum vertical load test of 5000 psi. Base shall be flanged to prevent frost heaving. Cover shall be of similar material and shall be secured with 2 captive penta-head bolts. Cover will have logo "ELECTRIC" molded into it.

2.6 CONDUIT, DUCTS AND FITTINGS

2.6.1 Conduit, Rigid Steel

Rigid steel conduit shall conform to ANSI C80.1 and UL 6.

2.6.2 Conduit Coatings

Underground metallic conduit and fittings shall be coated with a plastic resin system conforming to NEMA RN 1, Type 40. Epoxy systems may also be used.

2.6.3 Conduit Fittings and Outlets

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2.6.3.1 Boxes, Metallic Outlets

NEMA OS 1 and UL 514A.

2.6.3.2 Boxes, Nonmetallic, Outlet and Flush-Device Boxes and Covers

NEMA OS 2 and UL 514C.

2.6.3.3 Boxes, Switch (Enclosed), Surface Mounted

UL 98.

2.6.3.4 Fittings for Conduit and Outlet Boxes

UL 514B.

2.6.3.5 Fittings, PVC, for Use with Rigid PVC Conduit and Tubing

UL 514B.

2.6.4 Non-Metallic Duct

Non-metallic duct lines and fittings utilized for underground installation shall be suitable for the application. Duct shall be thick-wall, single, round-bore type. Material of one type shall be used.

Acrylonitrile-butadiene-styrene (ABS) duct shall conform to NEMA TC 6 and NEMA TC 9. High-density conduit shall conform to UL 651A. Schedule 40 polyvinyl chloride (PVC) shall conform to UL 651. Plastic utility duct and fittings manufactured without a UL label or listing shall be provided with a certification as follows: "The materials are suitable for use with 167 degree F wiring. No reduction of properties in excess of that specified for materials with a UL label or listing will be experienced if samples of the finished product are operated continuously under the normal conditions that produce the highest temperature in the duct."

2.7 GROUND RODS

Ground rods shall be of copper clad steel conforming to UL 467 not less than 5/8 inch in diameter by 8 feet in length of the sectional type driven full length into earth.

2.8 POLES

Metal and concrete poles shall be the pole manufacturer's standard design for supporting the number of fixtures indicated. Poles shall be designed for a wind velocity of 80 mph at the base of the pole, for a wind gust factor of 1.3, and for the height and drag factors recommended by AASHTO LTS-3. The effective projected area of luminaires and other pole-mounted devices shall be taken into account in pole design. Poles shall have grounding provisions. The type of pole shaft material provided shall not be mixed on any project. Grounding connection shall be provided near the bottom of each metal pole and at each concrete pole anchor base. Scratched, stained, chipped, or dented poles shall not be installed.

2.8.1 Decorative Street Light Pole for Double Decorative Luminaires

The lighting pole shall consist of a decorative fluted base, a 5 inch diameter fluted shaft with a tenon for luminaire mounting. Accessories include a duplex GFCI receptacle with weatherproof cover for festoon

lighting and 2 banner arms with breakaway couplings designed to fail at 85 mph wind speeds. The pole base material shall be heavy-wall cast aluminum (356.1 alloy) formed true to pattern. The shaft material shall be fluted aluminum extrusion (6061-T6). Banner arms shall be aluminum pipe construction. All hardware shall be tamper resistant, stainless steel. The post shall be 16 feet in height with a 44 inch tall x 16 inch diameter base. The fluted shaft shall have a 5 inch outside diameter and a 0.228 inch nominal wall thickness, with a 3 inch diameter x 2-5/8 inch tall tenon for luminaire mounting. Banner arms shall be 1 inch pipe (1-5/16 inch diameter) and measure 24 inches in length. Poles shall be provided with four 3/4 inch diameter x 24 inch L-type anchor bolts. A door shall be located in the base for anchorage and wiring access. A grounding screw shall be provided inside the base, opposite the door, for easy access. The pole shall be finish with a black powder coat finish. The pole shall match existing downtown street light poles for make and model.

Existing downtown street light pole is Holophane Charleson Series Cast Aluminum, Catalog #CH14F5/16-CA/BK-RS/GFI/WPC-BBA242/1/BO/CA/BK-NP28-CA/BK. Contact Holophane Representative, John Wethern, Holophane 3403 South 12th Street, Moorhead, MN 56560, Telephone 218-291-9499 to confirm catalog # of existing pole.

2.8.2 Decorative Street Light Pole for Single Residential Area Luminaire

The lighting pole shall consist of a decorative fluted base, a 5 inch diameter fluted shaft with a tenon for luminaire mounting. The pole base material shall be heavy-wall cast aluminum (356.1 alloy) formed true to pattern. The shaft material shall be fluted aluminum extrusion (6061-T6). All hardware shall be tamper resistant, stainless steel. The post shall be 14 feet in height with a 44 inch tall x 16 inch diameter base. The fluted shaft shall have a 5 inch outside diameter and a 0.228 inch nominal wall thickness, with a 3 inch diameter x 2-5/8 inch tall tenon for luminaire mounting. Poles shall be provided with four 3/4 inch diameter x 24 inch L-type anchor bolts. A door shall be located in the base for anchorage and wiring access. A grounding screw shall be provided inside the base, opposite the door, for easy access. The pole shall be finish with a black powder coat finish. The pole shall match existing downtown street light poles for make and model with the exception they shall have no banner arms or festoon outlet receptacle.

Existing downtown street light pole without banner arms and gestoon outlet receptacle is Holophane Charleson Series Cast Aluminum, Catalog #CH14F5/16-CA/BK. Contact Holophane Representative, John Wethern, Holophane 3403 South 12th Street, Moorhead, MN 56560, Telephone 218-291-9499 to confirm catalog # of existing pole without banner arms and festoon outlet receptacle.

2.8.3 Parking Lot Street Light Pole for Single Shoebox Luminaire

The lighting pole shall consist of a square steel straight tubing 30 feet in height rated for 80 mph wind with a 1.3 time gust factor. The pole shall have a handhole type access cover located 1 foot above the base. The base shall be 12.63 inches square with an 11.5 inch bolt circle. The pole shall be provided with four 1 inch diameter x 36 inch L-type anchor bolts to meet manufacturers loading requirements. A grounding screw shall be provided inside the base. A 2-piece plastic base cover shall be provided to shield the anchor bolts and base plate. The pole shall be finish with a black powder coat finish. The pole shall have no festoon outlet receptacle.

2.8.4 Steel Poles

Steel poles shall be hot-dip galvanized in accordance with ASTM A 123/A 123M and shall not be painted. Poles shall have tapered tubular members, either round in cross-section or polygonal. Pole shafts shall be one piece. Poles shall be welded construction with no bolts, rivets, or other means of fastening except as specifically approved. Pole markings shall be approximately 3 to 4 feet above grade and shall include manufacturer, year of manufacture, top and bottom diameters, length, and a loading tree. Attachment requirements shall be provided as indicated, including grounding provisions. Climbing facilities are not required. Bases shall be of the anchor bolt-mounted type.

2.8.5 Anchor Bolts

Anchor bolts shall be the pole manufacturer's standard, but not less than necessary to meet the pole wind and ice loading, herein and other specified design requirements.

2.9 POLE LINE HARDWARE

Zinc coated hardware shall conform to ANSI C135.1 and ANSI C135.14, and steel hardware material shall conform to ASTM A 575 and ASTM A 576. Hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M.

2.10 ELECTRICAL ENCLOSURES

The Contractor shall provide metallic enclosures as needed to house the lighting equipment. Enclosures shall conform to NEMA ICS 6 and NEMA 250. Enclosures shall be provided with lockable or padlock handles. Keys for lockable enclosures shall be delivered to the Contracting Officer. The enclosures shall be as specified or as shown on the drawings.

2.10.1 Interior Enclosures

Enclosures to house lighting equipment in an interior environment shall meet the requirements of a NEMA 12 enclosure as defined in NEMA 250.

2.10.2 Exposed-to-Weather Enclosures

Enclosures to house lighting equipment in an outdoor environment shall meet the requirements of a NEMA 4 enclosure as defined in NEMA 250.

2.10.3 Corrosion Resistant Enclosures

Enclosures to house lighting equipment in a corrosive environment shall meet the requirements of a NEMA 4X enclosure as defined in NEMA 250.

2.10.4 Street Light Control Center

Provide lighting service cabinet(s) for the purpose of distributing electrical power, providing overcurrent protection and providing a means to disconnect and control power to all or part of lighting system.

2.10.4.1 Cabinet Enclosure

Lighting service cabinet enclosure shall be constructed of a minimum of 3/32 inch thick steel and shall be deadfront type with a hinged door for access to the contactor(s). The cabinet shall have a weathertight door capable of being securely latched at 3 points and released by an easy

turning handle. The handle and three point locking mechanism shall lock with a standard Owner-furnished padlock. Hinges shall be fabricated from stainless steel. Hinges may be welded on or fastened with stainless steel tamperproof bolts.

All surfaces of the cabinet shall be thoroughly cleaned and painted with at least one coat of rust resistant primer and two coats of high grade oil resistant enamel. Cabinet exterior finish color shall be industrial green and interior finish color shall be gloss white including interior deadfront hinged panel.

2.10.4.2 Circuit Breakers

Circuit breakers shall be thermo-magnetic type. Main circuit breakers shall be located on the line side of the lighting contactor(s). The lighting contactor(s) shall be located on the line side of the branch circuit breakers. Each branch circuit breaker shall be bolted onto a copper bus and shall be labeled indicating the lighting load(s) that it serves. Labels shall be pressure sensitive vinyl embossed label-maker tape 3/8 inch high with 5/32 inch high letters. Spacers shall cover empty circuit breaker spaces for circuits that are not used.

2.10.4.3 Lighting Contactors

Lighting contactor(s) shall be the amperage rating and number of poles as required, normally open, electrically held, open type, and shall be rated for tungsten filament and ballast lighting loads. The control coil shall be actuated by photocell or timeclock or both and shall be protected by a properly sized circuit breaker on the line side of the photocell/timeclock and test switch.

2.10.4.4 Test Switches

Test switch(es) shall be a heavy duty, 2-position, rotary switch. One switch position shall be labeled "AUTOMATIC" and the other switch position shall be labeled "TEST". In the "AUTOMATIC" position, the test switch(es) shall connect the coil of the lighting contactor to the AC+ (switched) from the photocell or timeclock control, providing control of the lighting circuit. In the "TEST" position, the test switch(es) shall connect the coil of the lighting contactor to the AC+ (unswitched) from the photocell or timeclock control, providing power to the circuit regardless of the state of the lighting control(s).

2.10.4.5 Terminal Blocks

Provide terminal blocks in cabinets for termination and connection of power and control wiring. Terminal blocks shall be strap screw type rated 600 volts and have white marking strips.

2.10.4.6 Electronic Time Switches

Provide 24-hour programmable electronic time switch(es) where indicated on the drawings. Time switch(es) shall include a 1/4 inch high LCD display which shall show the current time of day with A.M. or P.M. indication and "ON" or "OFF" during programming or the current status of the load control contacts in the automatic mode. Switch(es) shall include a minimum of 8 points or events (4 "ON" / 4 "OFF") which can be preset to automatically repeat on a daily basis. It shall be possible to override the programming at any time by placing a selector switch into a manual position.

Switch(es) shall be equipped with large teeter type terminal screws and saddle clamps to securely fasten a range of No. 18 AWG to No. 10 AWG wire for both input power and output switching.

Switch(es) shall be furnished with a SPST contact configuration and shall be sized for loads up to 30 amps at 120 or 240 volts ac. Clock voltage shall be 120 VAC, 60 Hertz. Maximum switch power consumption shall be approximately 3 watts.

Switch(es) shall be furnished with factory-installed industrial-grade standard alkaline batteries to provide automatic carryover for a minimum of 3 years.

Switch(es) shall be housed in a grey finished lockable steel enclosure to protect components from vandalism and unauthorized tampering. Switch shall be capable of operating in a temperature range of -40 degrees F to 122 degrees F and a humidity range of 0 percent to 95 percent noncondensing.

2.10.4.7 Photocell Controls

Photocell control for control of exterior lighting circuits shall be fixed mounting thermal type unit with inherent delay action to prevent false switching due to momentary flashes of light. Control shall be weatherproof, mounted on stainless steel cover plate, and mounted on the side of the control cabinet. The photocell shall be rated at 1000 watts (tungsten), 120 volts ac.

2.10.4.8 Electrical Equipment and Wiring

Lighting control cabinet(s) components shall be arranged and wired as indicated on the Drawings. The lighting control cabinet shall be a pad-mounted cabinet properly sized to accommodate the components required. The cabinet shall have provisions for being secured to a fiberglass ground sleeve by means of 4 properly sized bolts. The cabinet shall be provided with one 2-pole main circuit breaker (service entrance rated); with the number and size lighting contactors noted on the drawings; with the number and size single-pole branch circuit breakers for street lighting and festoon circuits noted on the drawings; one 15 ampere single-pole branch circuit breaker for the control circuit; 2 heavy-duty, 2-position rotary test switches; one 24-hour timeclock with adjustable settings, and 1 photocell control mounted in the side of the cabinet. Properly sized termination lugs shall be provided for 1 incoming single-phase 120/240 volts ac 3-wire circuit (No. 4/0 AWG Str. CU), the number and size of outgoing single-phase 120 volts ac 2-wire street light circuits (No. 2 AWG Str. CU) and outgoing single-phase 120 volts ac 2-wire festoon circuits (No. 2 AWG Str. CU) as noted on the drawings.

Light control cabinet shall be furnished with 31 inches wide x 19 inches long x 18 inches high, preformed fiberglass ground sleeve. Ground sleeve shall have an appropriately sized opening in the top to allow cable entrance to the cabinet. The specified ground sleeve width and length dimensions are to be considered minimums and the ground sleeve provided shall fit the design of the cabinet.

All cabinet neutral/ground bonding bars and bus bars shall be copper. All connectors shall be UL listed for copper conductors. All wiring inside the cabinet shall be of sufficient length to allow for contraction.

2.11 ILLUMINATION

2.11.1 General Lighting

Luminaires, ballasts, lamps, and control devices required for general area, parking lot, and streetlighting, including floodlighting shall be in accordance with the drawings.

2.11.1.1 Downtown Double Decorative Street Light Luminaire

Luminaire shall be one-piece, heat resistant, borosilicate glass prismatic refractor, acorn style with cast aluminum decorative finial, fluted cast aluminum tenon fitting, and double fixture with cast aluminum bracket style as shown on the drawings and shall match the existing luminaires in the downtown area. Lamps shall be 150 watt HPS with mogul base. Ballast shall be HPF CWA Type, 120 volt. Fixture shall be Type III light distribution.

Existing downtown street light luminaires and crossarms are Holophane Granville Series luminaire fixture, Catalog #GV415AHPXX-B3NFG and crossarms Catalog #NP28-CA/BK. Contact Holophane Representative, John Wethern, Holophane 3403 South 12th Street, Moorhead, MN 56560, Telephone 218-291-9499 to confirm catalog # of existing fixtures and crossarms.

2.11.1.2 Single Residential Area Street Light Luminaire

Luminaire shall be an 18 foot high Century English colonial lantern style. The optical assembly shall be enclosed by 4 tempered glass panels mechanically held to a cast aluminum window frame housing topped with a decorative gasketed cover, hinged and latched to the window frame housing. The optical assembly shall be a molded thermal resistant borosilicate glass refractor mechanically attached to the socket assembly. Light distribution shall be Type V. The ballast shall be a high power factor autotransformer type, 120 volt. Lamp shall be 150 Watt HPS. The cast aluminum fitter assembly shall be designed to mount on 3 inches high by 3 inches diameter tenon secured by 8 stainless steel allen head set screws. The fixture shall include decorative ladder rests. Luminaire shall be finished with a polyester powder paint in a black color.

2.11.1.3 Single Parking Lot Street Light Luminaire

Luminaire shall be a rectangular shoe box style fixture measuring 15 inches x 21-1/2 inches x 8 inches. Lamp shall be 250 Watt HPS, 120 volt. Optical refractor shall be flat prismatic borosilicate glass. Luminaire shall be finished with a polyester powder paint in a black color. Luminaire shall be single close mount on a square pole.

2.11.1.4 Flood Wall Mount Type FLW Flood Light Luminaire

Luminaire shall be a 9 inch x 16 inch x 6-1/2 inches deep one-piece, D-shaped, extruded aluminum alloy with integrally extruded heat dissipating fins. End caps shall be aluminum plate, fastened to the housing with stainless steel screws and sealed with EPDM gasket and assembly. The lamp shall be 175 Watt 120 Volt Metal Halide. The lens assembly shall be clear tempered glass with a type RW beam pattern. Fixture mount shall be a 2 inch IPS slipfitter. Fixture shall be black. Provide a wall arm mount for mounting fixture on the flood wall as show on the drawings. Wall mount shall include a square 12 inch steel arm with a 3-1/2 inches x 1-1/2 inches pipe mounted perpendicular to the arm. See drawings: Provide a barndoor style shield for adjusting the light pattern.

2.11.1.5 Surface Mount Type FLS Flood Light Luminaire

Luminaire shall be a 9 inch x 16 inch x 6-1/2 inches deep one-piece, D-shaped, extruded aluminum alloy with integrally extruded heat dissipating fins. End caps shall be aluminum plate, fastened to the housing with stainless steel screws and sealed with EPDM gasket and assembly. The lamp shall be 150 Watt 120 Volt HPS. The lens assembly shall be clear tempered glass with a type HPW beam pattern. Fixture mount shall be a 2 inch IPS slipfitter. Fixture shall be black. Provide a surface mount bracket for mounting fixture on a concrete surface as shown on the drawings. Surface mount bracket shall include a 3-1/2 inch x 1-1/2 inch pipe mounted on a 6 inch square steel plate. See drawings: Provide a top shield for the fixture.

2.12 LAMPS AND BALLASTS, HIGH INTENSITY DISCHARGE (HID) SOURCES

2.12.1 High-Pressure Sodium

Lamps shall conform to ANSI C78.1350 or ANSI C78.1351 or ANSI C78.1352 or ANSI C78.1355. Ballasts shall conform to ANSI C82.4, or UL 1029. High-pressure sodium lamps shall be clear.

2.12.2 Mercury Vapor

Lamps shall conform to ANSI C78.40. Ballasts shall conform to ANSI C82.4.

2.12.3 Metal-Halide

Lamps shall be made by a manufacturer with not less than 5 years experience in making metal-halide lamps. Metal-halide lamps shall conform to ANSI C78.1375 or ANSI C78.1376. Ballasts shall conform to ANSI C82.4 or UL 1029.

2.13 LAMPS, FLUORESCENT

Fluorescent lamps shall have standard cool-white color characteristics and shall not require starter switches. The lamps shall be of the rapid-start type.

2.14 LUMINAIRE COMPONENTS

Luminaire components shall conform to the following: attachments, ANSI C136.3; voltage classification, ANSI C136.2; field identification marking, ANSI C136.15; interchangeability, ANSI C136.6 and ANSI C136.9; and sockets, ANSI C136.11.

2.15 LIGHTING CONTROL EQUIPMENT

2.15.1 Photo-Control Devices

Photo-control devices shall conform to ANSI C136.10. Each photo-control element shall be a replaceable, weatherproof, plug-in or twist-lock assembly adjustable operation range of approximately 0.5 to 5.0 foot-candles. luminaires shall be equipped with weatherproof plug-in or twist-lock receptacle to receive the photo-control element.

2.15.2 Timer Control Switches

Astronomic dial type arranged to turn "ON" at sunset, and turn "OFF" at a pre-determined time between 2030 hours hours and 2400 hours, automatically

changing the settings each day in accordance with seasonal changes of sunset and sunrise shall be provided. A switch rated 240 volts, having automatically wound spring mechanism to maintain accurate time for a minimum of 7 hours following a power failure shall be provided. A time switch with a manual on-off bypass switch shall be provided. Housing for the time switch shall be a surface mounted, NEMA 1 (indoor) enclosure conforming to NEMA ICS 6.

2.15.3 Safety Switches

Switches shall be the heavy-duty type with NEMA ICS 6 Type 1 enclosures and shall be suitable for operation on a 240 volt, 60 Hz, single-phase system. Switch construction shall be such that a screwdriver will be required to open the switch door when the switch is on. Blades shall be visible with door open and shall be of the quick-make, quick-break type. Terminal lugs shall be coordinated with the wire size. Switches shall conform to UL 98.

2.15.4 Magnetic Contactor

Magnetic contactors shall be mechanically held, electrically operated, and shall conform to NEMA ICS 1 and NEMA ICS 2. The contactor shall be suitable for 240 volts, single-phase, 60 Hz. Coil voltage shall be 120 volts. Maximum continuous ampere rating and number of poles shall be as indicated on drawings. Enclosures for contactors mounted indoors shall be NEMA ICS 6, Type 1. Each contactor shall be provided with a spare, normally open auxiliary contact. Terminal lugs shall be coordinated with the wire size.

2.16 PHOTOMETRIC DISTRIBUTION CLASSIFICATION

Photometrics shall conform to IESNA RP-8.

2.17 LUMINAIRES, FLOODLIGHTING

2.17.1 HID and Incandescent

HID lighting fixtures shall conform to UL 1572. Incandescent lighting fixtures shall conform to UL 1571.

2.17.2 Fluorescent

Fluorescent lamps shall conform to ANSI C78.1.

2.18 FIXTURES

Standard fixtures shall be as detailed on drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection to fixtures of any particular manufacturer. Fixtures of similar design, equivalent light distribution and brightness characteristics, equal finish and quality will be acceptable as approved. However, fixtures so noted to match existing must match exact make, model, and manufacturer in order to provide for interchangeable parts and materials for maintenance purposes, inventory control, and uniformity in application.

2.18.1 Accessories

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

2.18.2 Special Fixtures

The types of special fixtures are designated by letters and numbers. For example, SP-1 denotes special Type 1.

2.18.3 In-Line Fuse

An in-line fuse shall be provided for each fixture, and shall consist of a fuse and a UL approved waterproof breakaway fuse holder rated at 30 amperes, 600 volts, with insulated boots. Fuse rating shall be 600 volts.

Fuseholders shall be single-pole, in-line, watertight breakaway type designed to be attached to solid or stranded copper or aluminum wire. Fuseholders shall accommodate 1-1/2 inches x 13/32 inch midget and Class CC fuses. Fuseholders shall incorporate a built-in breakaway feature which shall isolate the load should the connecting wire come under tension. Fuseholders shall use internal O-rings to provide a water-resistant compartment for the fuse. Fuseholders shall have a 600 volt ac; 30 ampere minimum rating, be UL-listed and meet National Electric Code requirements for branch circuit protection.

Provide fuses of the type, class, and rating as stated below for the type of lamp specified or indicated on the drawing schedule. Fuses shall be manufacturer's premium grade.

Lamp Wattage	Fuse Size
150	6 ampere
250	8 ampere
400	8 ampere

Provide 15 ampere fuses for all festoon circuit fuseholders.

Fuses for lighting loads shall be fast-acting, nondelay, current limiting type fuses sized as required for the fuseholders being supplied. Fuses shall be rated for 600 volts ac or less and shall have an interrupting rating of 100,000 amperes rms symmetrical.

PART 3 EXECUTION

3.1 GENERAL

The Contractor shall install all system components, including government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, IEEE C2, and contract documents, and shall furnish necessary hardware, fixtures, cables, wire, connectors, interconnections, services, and adjustments required for a complete and operable system.

3.1.1 Current Site Conditions

The Contractor shall verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Government. The Contractor shall not take any corrective action without written permission from the Government.

3.1.2 Existing Equipment

The Contractor shall connect to and utilize existing lighting equipment and devices as shown. Lighting equipment that is usable in their original configuration without modification may be reused with Government approval. The Contractor shall perform a field survey, including testing and inspection of existing lighting equipment and control lines intended to be incorporated into the lighting system, and furnish a report to the Government. For those items considered nonfunctioning, specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency shall be provided with the report.

As part of the report, the Contractor shall include the scheduled need date for connection to all existing equipment. The Contractor shall make written requests and obtain approval prior to disconnecting any control lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Government approval of these requests. If any device fails after the Contractor has commenced work on that device, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment. The Government is responsible for maintenance and repair of Government equipment. The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of Government equipment.

3.2 ENCLOSURE PENETRATIONS

Enclosure penetrations shall be from the bottom unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer, and in such a manner that the cable is not damaged.

3.3 PREVENTION OF CORROSION

3.3.1 Aluminum

Aluminum shall not be used in contact with earth or concrete, and where connected to dissimilar metal, shall be protected by approved fittings and treatment.

3.3.2 Steel Conduits

Steel conduits shall not be installed within concrete slabs-on-grade. Steel conduits installed underground or under slabs-on-grade, or penetrating slabs-on-grade, shall be field wrapped with 0.010 inch thick pipe-wrapping plastic tape applied with a 50 percent overlap, or shall have a factory-applied plastic resin, epoxy coating. Zinc coating may be omitted from steel conduit which has a factory-applied epoxy coating.

3.3.3 Cold Galvanizing

Field welds and/or brazing on factory galvanized boxes, enclosures, conduits, etc. shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

3.4 CABLE INSTALLATION

Cable and all parts of the cable system such as splices and terminations shall be rated not less than 600 volts. The size and number of conductors

and the number of cables shall be as indicated. Conductors larger than No. 8 AWG shall be stranded. Each circuit shall be identified by means of fiber or nonferrous metal tags, or approved equal, in each handhole, and at each terminal.

3.4.1 Splices

Splices below grade shall be made with nonpressure-filled resin systems using transparent, interlocking, self-venting, longitudinally split plastic molds. Splices above grade shall be made with sealed insulated pressure connectors and shall provide insulation and jacket equal to that of the cable. In order to prevent moisture from entering the splice, jackets shall be cut back to expose the required length of insulation between the jacket and the tapered end of the insulation.

3.4.2 Direct Burial

Minimum cover from top of cable to finished grade shall be 30 inches for direct buried cable.

3.4.2.1 Trenching

Trenches shall be excavated to the depths required to provide the minimum cable cover. The bottom of the trench shall be smooth and free of stones and sharp objects. Where the bottom of the trench consists of material other than sand or earth, an additional 3 inch layer shall be removed and replaced by a 3 inch layer of sand or stone-free earth compacted to the approximate density of the surrounding firm soil. The cables shall be unreeled in place along the side of or in the trench and carefully placed on the sand or earth bottom. Pulling cables into a direct-burial trench from a fixed reel position will not be permitted. Where cables cross, a separation of at least 3 inches shall be provided, unless the cables are protected by nonmetallic conduit sleeves at the crossing. The radius of bends in cables shall be not less than 12 times the diameter of the cable. Cables shall not be left under longitudinal tension. The first layer of backfill shall be 6 inches thick and shall consist of sand or stone-free earth. A 5 mil, bright red colored plastic tape not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers, or other approved dig-in warning indication, shall be placed approximately 12 inches below finished grade levels of trenches. Selected backfill of sand or stone-free earth shall be provided to a minimum depth of 3 inches above cables.

3.4.2.2 Boring

All boring depths shall match connecting trench or plowing depths as measured from the finished grade to the top surface of the cable. The routing shall be as indicated on the drawings, unless conditions encountered are such that changes are necessary to accomplish the work. If obstructions or difficulties in boring are encountered, the Contractor shall determine the nature and extent of the difficulty and the Contracting Officer will determine if rerouting or other changes are necessary. Boring hole dimensions specified are minimum and may be increased as required to complete the work.

Where bores require conduit, the boring excavation shall not exceed the outside diameter of the pipe. Furnish and install conduit of the type and size as specified or as indicated on the drawings.

Boring pits shall be as required for the number of and dimensional size of the bore. Bore pits shall be braced and protected as necessary to provide for a safe working environment. Construction shall be arranged so that bore pits will be left open for the shortest practicable time to avoid creating a hazard to the public and to minimize the likelihood of collapse due to other construction activity, rain, accumulation of water in the pit, etc.

3.4.2.3 Requirements for Installation in Duct

Where indicated on drawing, cable shall be installed in duct lines. Ground and neutral conductors shall be installed in duct with the associated phase conductors. The segments of direct-burial cable that cross under new railroad tracks, roads, or paving exceeding 5 feet in width, shall be installed in plastic, or rubber duct encased in concrete in accordance with paragraph DUCT LINES. Pulling of cable into conduit from a fixed reel position will be permitted. At interfaces with direct-burial cable, the direct-burial cable shall be centered in the entrance to the duct, using an approved waterproof, nonhardening mastic compound to facilitate the centering.

3.4.2.4 Location of Cable Splices

Splices in direct-burial cable will not be permitted in runs of 500 feet or less or at intervals of less than 500 feet in longer runs except as required for taps. Where cable splices in shorter intervals are required to avoid obstructions or damage to the cable, the location shall be as approved. Cable splices shall be installed in cable boxes or concrete handholes.

3.4.2.5 Warning Tape

Direct burial cable shall be placed below a plastic warning tape buried in the same trench or slot. A 5 mil bright red colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the buried cable, shall be placed approximately 12 inches below finished grade.

3.5 CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated and shall be properly connected to the indicated equipment. Empty conduits to the indicated equipment from a point 5 feet outside the building wall and 2 feet below finished grade are specified in Section 16415 ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed to prevent moisture or gases from entering the building.

3.6 DUCT LINES

3.6.1 Requirements

Numbers and size of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short radius manufactured 90 degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inches in diameter, and 36

inches for duct 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells when duct lines terminate.

3.6.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and shall match factory tapers. A coupling recommended by the duct manufacturer shall be used when an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.6.3 Nonencased Direct-Burial

Top of duct lines shall be not less than 30 inches below finished grade and shall be installed with a minimum of 3 inches of earth around each duct, except that between adjacent electric power and communication ducts, 12 inches of earth is required. Bottom of trenches shall be graded toward manholes or handholes and shall be smooth and free of stones, soft spots, and sharp objects. Where bottoms of trenches comprise materials other than sand, a 3 inch layer of sand shall be laid first and compacted to approximate densities of surrounding firm soil before installing ducts. Joints in adjacent tiers of duct shall be vertically staggered at least 6 inches. The first 6 inch layer of backfill cover shall be sand compacted as previously specified. The rest of the excavation shall be backfilled and compacted in 3 to 6 inch layers. Duct banks may be held in alignment with earth. However, high tiered banks shall use a wooden frame or equivalent form to hold ducts in alignment prior to backfilling.

3.6.4 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendation for the particular type of duct and coupling selected and as approved.

3.6.4.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4 turn to set the joint tightly.

3.6.5 Concrete

Concrete work shall be as specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete shall be plain, 2500 psi at 28 days, except that reinforced concrete shall be 3000 psi at 28 days.

3.6.6 Duct Line Markers

A 5 mil red colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous

metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of buried lines.

3.7 HANDHOLES

The exact locations shall be determined after carefully considering the locations of other utilities, grading, and paving. Exact locations shall be approved before construction is started.

3.7.1 Construction

Handholes shall be constructed as indicated on drawings, including appurtenances. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic construction. Concrete shall be 3000 psi at 28 days. Precast concrete handholes having the same strength and inside dimensions as cast-in-place concrete handholes may be used. In paved areas, the top of entrance covers shall be flush with the finished surface of the paving. In unpaved areas, the top of entrance covers shall be approximately 1/2 inch above the finished grade. Where finished grades are in cut areas, unmortared brick shall be installed between the top of handhole and entrance frame to temporarily elevate the entrance cover to existing grade level. Where duct lines enter walls, the sections of duct may be cast in the concrete or may enter the wall through a suitable opening. The openings around entering duct lines shall be caulked tight with lead wool or other approved material.

3.7.2 Appurtenances

The following appurtenances shall be provided for each handhole.

3.7.3 Ground Rods

In each handhole, at a convenient point close to the wall, a ground rod conforming to paragraph GROUNDING shall be driven into the earth before the floor is poured; approximately 4 inches of the ground rod shall extend above the floor after pouring. When precast concrete units are used, the top of the ground rod may be below the floor; a No. 1/0 AWG copper ground conductor shall be brought inside through a watertight sleeve in the wall.

3.8 POLE INSTALLATION

Pole lengths shall provide a luminaire mounting height as indicated on the drawings. Electrical cabling shall be provided to the light pole as specified in Section 16120 INSULATED WIRE AND CABLE. The mount interfaces shall have ac power connected, and the pole wiring harness shall be connected to the luminaire. Light poles shall not be installed outside the site or inside the perimeter zone. Pole installation shall conform to the manufacturer's recommendations, NFPA 70, and IEEE C2. Poles shall be set straight and plumb.

3.8.1 Pole Brackets

Brackets shall be installed as specified by the manufacturer and as shown on drawings. Mounting hardware shall be sized appropriately to secure the mount, luminaire, and housing with wind and ice loading normally encountered at the site. Pole brackets for floodlights shall have the number of tenons indicated, arranged to provide the indicated spread between each tenon. Where indicated on drawings, adjustable heads shall be

installed on the brackets to position the luminaires. Identical brackets shall be used with one type of luminaire.

3.8.2 Concrete Foundations

Concrete foundations shall have anchor bolts accurately set in the foundation using a template supplied by the pole manufacturer. Once the concrete has cured, the pole shall be set on the foundation, leveled on the foundation bolts, and secured with the holding nuts. The space between the foundation and the pole base shall be grouted. Concrete and grout work shall conform to Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete shall be 3000 psi at 28 days, or as indicated on the drawings, whichever is greater.

3.8.3 Rigid Conduit Ells

Rigid conduit ells shall be provided where specified or indicated on drawings.

3.8.4 Aluminum and Steel Pole Installation

Poles shall be mounted on cast-in-place foundations. Conduit elbows shall be provided for cable entrances into pole interiors.

3.8.4.1 Cast-In-Place Foundations

Concrete foundations, sized as indicated, shall have anchor bolts accurately set in foundations using templates supplied by the pole manufacturer. Concrete work and grouting is specified in Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. After the concrete has cured, pole anchor bases shall be set on foundations and leveled by shimming between anchor bases and foundations or by setting anchor bases on leveling nuts and grouting. Poles shall be set plumb. Anchor bolts shall be the manufactures standard, and not less than necessary to meet the pole wind loading and other specified design requirements.

3.9 LIGHTING

3.9.1 Lamps

Lamps of the proper type, wattage, and voltage rating shall be delivered to the project in the original containers and installed in the fixtures just before completion of the project.

3.9.2 Fixture Installation

Standard fixtures shall be installed as detailed on drawings. Illustrations shown on these sheets or on the drawings are indicative of the general type desired and are not intended to restrict selection of fixtures to any particular manufacturer. Fixtures of similar design, equivalent light-distribution and brightness characteristics, and equal finish and quality will be acceptable as approved. However, fixtures so noted to match existing must match exact make, model, and manufacturer in order to provide for interchangeable parts and materials for maintenance purposes, inventory control, and uniformity in application.

3.9.2.1 Accessories

Accessories such as straps, mounting plates, nipples, or brackets shall be

installed as required for proper installation.

3.9.2.2 In-Line Fuses

An in-line fuse shall be provided for each luminaire and outlet.

3.9.2.3 Special Fixtures

The types of special fixtures are designated by letters and numbers. For example, SP-1 denotes special type 1.

3.10 LIGHTING CONTROL SYSTEM

3.10.1 Photo-Control

Lighting luminaires shall be controlled in banks by a single photo-control element mounted within each bank or individually controlled by photo-control elements mounted on the heads of the luminaires.

3.10.2 Time Control Switches

Switches shall be installed with not less than four 1/4 inch bolts. The use of sheet metal screws will not be allowed.

3.10.3 Magnetic Contactors

Terminal lugs shall be coordinated with the wire size. Switches shall be securely fastened to the supporting structure or wall using not less than four 1/4 inch bolts. The use of sheet metal screws will not be allowed.

3.11 GROUNDING

Grounding shall be in conformance with NFPA 70, the contract drawings, and the following. Grounding conductors shall be soft-drawn, stranded copper. Ground rods shall be driven into the earth so that after the installation is complete, the top of the ground rod will be approximately 1 foot below finished grade, except in handholes.

3.11.1 Ground Rods

The resistance to ground shall be measured using the fall-of-potential method described in IEEE Std 81. The maximum resistance of a driven ground rod shall not exceed 25 ohms under normally dry conditions. Whenever the required ground resistance is not met, additional electrodes shall be provided interconnected with grounding conductors, to achieve the specified ground resistance. The additional electrodes shall be 8 feet long rods spaced a minimum of 10 feet apart, 5/8 inch in diameter, up to 30 feet long, driven perpendicular to grade. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately. Connections below grade shall be fusion welded. Connections above grade shall be fusion welded or shall use UL 467 approved connectors.

3.11.2 Items to be Grounded

Ground conductors, metallic conduits, junction boxes, and noncurrent-carrying metallic parts of equipment shall be grounded. Connections above grade shall be made with solderless connectors, and those

below grade shall be made by a fusion-welding process.

3.11.3 Lighting Pole

One ground rod shall be provided at each pole. Bases of metal or concrete lighting poles shall be connected to ground rods by means of a minimum No. 8 AWG bare copper wire.

3.12 TESTS

3.12.1 Operating Test

After the installation is completed and at such time as the Contracting Officer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements specified. The test shall be performed in the presence of the Contracting Officer. The Contractor shall furnish instruments and personnel required for the test, and the Government will furnish the necessary electric power.

3.12.2 Ground Resistance Measurements

The resistance to ground shall be measured by the fall-of-potential method described in IEEE Std 81.

The contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the lighting to be used for "as-built" drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the lighting system. In addition to being complete and accurate, this set of drawings shall be kept neat and shall not be used for installation purposes. Upon completion of the as-built drawings, a representative of the Government will review the as-built work with the Contractor. If the as-built work is not complete, the Contractor will be so advised and shall complete the work as required.

-- End of Section --

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DIVISION 16 - ELECTRICAL

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SECTION 16600

ELECTRIC DRYERS

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Electric Hand Dryer; GA

Manufacturer's descriptive data and catalog cuts indicating materials of construction, fasteners proposed for use for each type of wall construction, mounting instructions, operation instructions, and cleaning instructions.

PART 2 PRODUCTS

2.1 ELECTRIC DRYER

Electric hand dryers shall be Model "A". Units as manufactured by World Dryer Corporation or approved equal shall be used. The entire hand dryer shall be listed under re-examination service of Underwriter's Laboratories, Inc.

2.1.1 Cover

Cover of dryer shall consist of a one-piece gray iron casting fitted with isolated pushbutton, revolving nozzle and recessed instruction plate. All exposed portions of iron casting shall be finished with acid resisting porcelain enamel; color as selected by Contracting Officer. Cover shall be fastened by two recessed allen head specially constructed tamper-resistant bolts to aluminum base which in turn shall be fastened to the wall by 4 concealed 1/4 inch mounting bolts. The cover shall be equipped with an air inlet opening on the bottom side of the casting covered with an expanded metal grille having vanes with a minimum depth of 1/4 inch and a maximum spacing between vanes of 1/4 inch. The cover shall also be equipped with an air outlet opening on the front side of the casting covered with a metal grille having vanes with a minimum depth of 5/8 inch and a spacing between vanes of 1/4 inch.

2.1.2 Metal Parts Other Than Castings

All metal parts other than castings are to be plated with either cadmium (minimum thickness 0.003 inch) or with brightly polished chrome (minimum copper 0.0003 inch, minimum nickel 0.0005 inch, minimum combined copper and nickel 0.001 inch, minimum chrome 0.0001 inch).

2.1.3 Motor

The motor shall be of universal type, 1/10 horsepower, 7,500 rpm at rated load, with resilient mounting and sealed, lubricated ball bearings. The motor shall be protected by a fuse. A dynamically balanced fan shall be mounted directly on the motor shaft. The fan and motor unit shall be insulated from balance of dryer with rubber resilient mounting, the rubber being stressed in shear to eliminate transmission of sound to the wall. The fan shall be a double inlet centrifugal type and shall deliver a minimum of 152 cfm at the discharge end of the nozzle.

2.1.4 Heating Element

The heating element shall be protected by an automatically resetting circuit breaker mounted directly on the heating element frame within the convolutions of the coil which shall open whenever the airflow is cut off and which shall close automatically as soon as the airflow is resumed.

2.1.5 Timer

The timer shall be designed to operate the hand dryer for a period of 30 seconds after actuation by the pushbutton.

PART 3 EXECUTION

3.1 INSTALLATION

Install all electric hand dryers as shown on the drawings.

-- End of Section --