SECTION 13085

SOUND AND VIBRATION ISOLATION PADS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing pads for sound and vibration isolation.

B. Isolation pads for floating slabs are specified in Section 03305.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. ASTM: B29, D395, D412, D573, D624, D1149, D2240, D3182, D3190.

B. Allowable Tolerances:
   1. Pads:
      a. Total thickness: Minus zero inch or plus 1/8 inch.
      b. Length and width variation not more than 1/8 inch from dimensions shown.

C. Testing of Pads:
   1. Have samples tested by an independent testing facility.
   2. Prepare test specimens in accordance with ASTM D3182 and ASTM D3190 and wipe with solvent before tests to remove any traces of surface impurities.
   3. Perform tests in accordance with the following requirements:

Original Physical Properties	ASTM Designation	Grade (Durometer)	
		60	70
Hardness, Durometer A	D2240	60 + 5	70 + 5
Tensile strength, minimum psi	D412	2,500	2,500
Elongation at break minimum percent	D412	350	350

Accelerated Test to Determine Longteristics Oven-Aged 70 Hours at 212F	ASTM Designation	Grade (Durometer)	
		60	70
Hardness, points change, maximum	D573	0 to + 15	0 to + 15
Tensile strength, percent change, maximum	D573	+ 15	+ 15
Elongation at break, percent change, maximum	D573	- 40	- 40

Ozone	ASTM Designation	Grade (Durometer)	
		60	70
One part per million (ppm) in air by volume; 20-Percent Strain, 100 Plus-or-Minus 2F, 100 Hours	D1149	No cracks	No cracks

Compression Set	ASTM Designation	Grade (Durometer)	
		60	70
22 hours at 158F; percent, maximum	D395 Method B	25	25

Low-Temperature Stiffness	ASTM Designation	Grade (Durometer)	
		60	70
At -40F, Young's Modulus, maximum psi	-	10,000	10,000
Tear test, pounds per linear inch, minimum	D624 Die C	250	250

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

A. Samples:
   1. Elastomer from each batch used, six by nine inches: Four.
   2. Each type of pad to be incorporated in the work, six inches by nine inches: Four.

B. Certification.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to the jobsite in original unopened containers clearly labeled with manufacturer's name and brand designation, type, and class as applicable.

B. Store products in an approved dry area, protect from contact with soil and from exposure to the elements. Keep products dry.

C. Handle products so as to prevent breakage of containers and damage to products.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Pads: Plain elastomeric pads consisting of solid sheet of neoprene without laminations, molded individually to specified dimensions, cut from previously molded strips or slabs or extruded and cut to length.

B. Adhesive: Epoxy, solvent-free, specifically compounded and recommended by the manufacturer as a high-quality, resilient adhesive compound, containing mildew-inhibiting agents and completely suitable for effective and permanent bonding of pads to supporting surfaces.

C. Lead for Shims: ASTM B29, corroding-type.

2.02 FABRICATION:

A. Fabrication includes adaptation or assembly of components into complete pads of the type specified.

B. Exterior surfaces, corners and edges of pads finished so as to present a smooth workmanlike appearance, as approved.

C. Corners and edges may be rounded in accordance with the following:
   1. Corner radius: 3/8-inch maximum.
   2. Edge radius: 1/8-inch maximum.

D. Pads fabricated to shapes shown.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Examine locations where pads are to be placed and correct unsatisfactory supporting areas as approved.

B. Do not place upon areas which are improperly finished, deformed, irregular or soiled by paint, oil, grease or other substances that might induce sliding or otherwise prevent full, firm and stable adhesion to supporting areas. Thoroughly clean supporting areas immediately before placing pads.

3.02 INSTALLATION:

A. Place pads to conform to lines, grades and other requirements of construction as shown.

B. Where necessary, construct concrete surfaces intended as supporting areas slightly higher than specified elevation and grind surface down to exact elevation.

C. Provide shims where directed and where necessary to secure even support.

D. Use shims of necessary thickness, same size as pads, made of lead or manufactured from same material as specified pads.

E. Where necessary, provide shims as follows:
1. 1/4 inch or more in thickness: Same material as pads.
2. 1/16-inch to 3/16-inch thick: Lead.

F. Coat contact surfaces of shims, except top surface under bearing member, with epoxy resin before installing pads. Eliminate air bubbles.

G. When supporting areas have been prepared in an approved manner, install pads in designated locations and hold securely in place as shown.

3.03 CLEAN-UP:

A. Remove rubbish and debris caused by this work from site.

B. Leave areas surrounding sound and vibration-isolation work in broom-clean condition.

END OF SECTION

SECTION 13110

STRAY CURRENT AND CATHODIC PROTECTION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing and connecting stray-current and cathodic-protection equipment.

B. Related Work Specified Elsewhere:
1. Grading, excavation and backfilling: Section 02320.
2. Corrosion control system testing: Section 13115.
3. Grounding and bonding: Section 16060.
4. Wire, cable and busways: Section 16120.
5. Wire connection accessories: Section 16125.
6. Raceways, boxes and cabinets: Section 16130.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of jurisdictional authorities.
2. ICEA: S-61-402.
3. ASTM: B418, D256, D570, D638, D693, D1248, E11.
4. MS: MIL-A-18001.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

1. Shop Drawings.

2. Certification:
a. Certified test reports of field quality-control testing.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Mark each item with manufacturer's name, brand designation, referenced standard, type, class and rating, as applicable.

B. Ship each unit securely packaged and labeled for safe handling in shipment and to avoid damage or distortion.

C. Store equipment in secure and dry storage facility.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MATERIALS:

A. Cast-Iron Anodes:
1. Size and type: As shown.
2. Chemical composition:

Element	Percent
Silicon	14.33
Chromium	4.5
Carbon	0.85
Manganese	0.65
Iron	Remainder

3. Physical properties:
   a. Tensile strength: 15,000 psi.
   b. Compressive strength: 100,000 psi.
   c. Brinell hardness: 520.
   d. Density: 7.0 grams per cubic centimeter.
   e. Melting point: 2,300F.
   f. Specific resistance: 72 microhms per centimeter cube at 20C.
   g. Coefficient of expansion: 7.33×10^{-6} per degree F from 32F to 212F.
4. Lead wire: Single-conductor insulated cable, 8AWG minimum, factory-connected to anode with connection sealed with cast epoxy-resin encapsulation.
5. Anode packaged as follows:
   a. Stove pipe: Galvanized steel, 30-gauge minimum, in accordance with the one of the following:
      1) Diameter: Eight inches; Length: Eight feet.
      2) Diameter: Five inches; Length: Six feet.
   b. Ends of pipe crimped to end seal of ½-inch interior-grade plywood.
   c. Containing compacted backfill of coke breeze of graded coal or recalcined petroleum coke, with the following additional requirements:
      1) Resistivity on dry basis: 60 ohms per centimeter cube, maximum.
      2) Chemical composition:

Material	Percent
Fixed carbon	78.22 - 78.40
Ash	18.6 maximum
Moisture	9.50 - 14.70
Volatile matter	3.00 - 3.14
Sulphur	1.2 maximum

      3) Gradation:
         a) Sieve size in accordance with ASTM E11.
         b) Requirements:

Percent Passing	Sieve Size
½ inch	100
3/8 inch	85
No. 6	65

B. Magnesium Anodes:

1. Packaged anodes, type and size as shown.
2. Chemical composition for high-potential type anodes:

Element	Percent
Aluminum	0.010 maximum
Manganese	0.50 - 1.30
Zinc	0.050 maximum
Silicon	0.050 maximum
Copper	0.020 maximum
Nickel	0.001 maximum
Iron	0.030 maximum

Element (Cont.)	Percent (Cont.)
Other metallic elements	0.050 each or 0.300 maximum total
Magnesium	Remainder

3. Lead wire: Single-conductor insulated cable, 12AWG minimum, factory-connected to anode with connection sealed with cast epoxy-resin encapsulation.
4. Anode packaged in permeable cloth sack containing compacted backfill of mixture with the following requirements:

Material	Percent
Gypsum	75
Bentonite	20
Sodium sulphate	5

C. Zinc Anodes: MS MIL-A-18001, bare-ribbon 5/8 by 7/8-inch section or packaged anode, type and size as shown, with the following additional requirements:
1. Lead wire: Single-conductor insulated cable, 12AWG minimum, factory-connected to the anode with connection sealed with cast epoxy-resin encapsulation.
2. Anode packaged in permeable cloth sack containing compacted backfill of mixture consisting of 50-percent hydrated gypsum and 50-percent bentonite.

D. Reference Electrode: ASTM B418, Type II, one galvanized-steel rod, factory-connected to electrode and equipped with two bolted connectors suitable for 12AWG single-conductor insulated cable.

E. Test Boxes:
1. Cathodic-protection test boxes: Plastic, each five inches inside diameter by 18 inches long, with cast-iron lid, collar and terminal board.
2. Stray-current test boxes: Six inches cubical, galvanized cast-iron box with watertight cover.

F. Wire and Cable:
1. Header cable, bond wire and cast-iron anode lead wire in accordance with the following:
   a. Single-conductor.
   b. Size: As shown.
   c. Insulation: HMWPE, 600 volt, in accordance with the following:
      1) ASTM D1248, Type I, Class C, Grade 5.
      2) ICEA S-61-402.
2. Magnesium or zinc anode lead and test wire:
   a. Single-conductor.
   b. Size: 12AWG unless otherwise shown.
   c. Color: As shown; anode lead as furnished.
   d. Insulation: TW, 600-volt, moisture-resistant thermoplastic in accordance with UL 83.

G. Pipeline-Casing Spacers:
1. Virgin polyethylene, molded.
2. Runner height: Sufficient to provide ½-inch clearance between pipe, couplings and hubs as well as internal casing wall.
3. Color: Natural.
4. In accordance with the following:

Characteristic	Reference	Requirement
Compressive strength	ASTM D693	3,200 psi
Tensile strength	ASTM D638,	3,100 - 5,500 psi
Impact strength	ASTM D256	1.5 - 2.0 foot-pound per inch notch
Water absorption	ASTM D570	0.1 percent
Temperature	-	180F (80C) maximum

5. Bolts:
   a. Steel, cadmium-plated.
   b. Sizes: As standard with the manufacturer.
6. Nuts:
   a. Steel, cadmium-plated, square.
   b. Sizes: To match bolts.

H. Pipeline-Casing End Seals:
1. Type L:
   a. Modular mechanical-type.
   b. Consisting of interlocking synthetic-rubber links with cadmium-plated steel nuts and bolts.
   c. Depth limitations: As shown.
2. Type H:
   a. Compression-ring seals.
   b. Nonconductive sleeve: Fiberglass reinforced epoxy (FRE), Adyl Type D or equal, with cadmium-plated steel nuts and bolts.

c. Depth limitations: As shown.

I. Insulating Gasket:
1. Asbestos, all-temperature.
2. Full-face.
3. Thickness: 1/8 inch.
4. Johns-Mansville 71 or equal.

J. Insulating Sleeves and Washers:
1. Up to 300F:
a. Sleeve: Mylar tube, 1/32-inch thick.
b. Washer: Phenolic, 1/8-inch thick.
2. 300F and above:
a. Sleeve: Klingerit or equal, 1/32-inch thick.
b. Washer: Johns-Mansville 71 or equal, Teflon.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Bury anodes or electrodes of type and at location shown. Excavate and backfill holes in accordance with Section 02320, with the following additional requirements:
1. Wet packaged anode thoroughly before backfilling hole.
2. Use fine clay soil, free from stones and bricks, for backfilling.

B. Install header cable of size and at location shown, in accordance with Section 16120.

C. Install test boxes of type and at location shown.

D. Connect anode lead wires to header cable or test boxes as shown.

E. Isolate pipes of different metals and Authority pipes from utility-company pipes using insulated union, compression insulating couplings, or insulated flange and bolt connections. Connect each side of insulated joints to test box using conductors as shown.

F. Where Authority pipes cross utility-company pipes, connect Authority pipes to test boxes using two 12AWG and one 4AWG conductors as shown.

G. Bond joints in buried metallic pipe and structure in accordance with Section 16060. Connect buried metallic pipe and structure to test boxes using single-conductor insulated cable of size shown.

H. Install conduit of type shown, in accordance with Section 16130.

I. Install single-conductor insulated cable in accordance with Section 16120. Leave one foot of slack in test boxes.

J. Use thermit weld sealed with cast epoxy-resin encapsulation for splices made in direct-burial cable.

K. Use compression-type connectors in accordance with Section 16125.

L. Install casing spacers in accordance with manufacturer's recommendation, except maximum spacer distance not to exceed 10 feet.

3.02 IDENTIFICATION:

A. Identify wire and cable in each test box using nonmetallic fiberboard or plastic tags or pressure-sensitive labels.

3.03 FIELD QUALITY CONTROL:

A. Provide necessary equipment and perform testing in the presence of the Engineer in accordance with Section 13115.

END OF SECTION

SECTION 13115

CORROSION CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies test procedures for corrosion-control systems.

B. Related Work Specified Elsewhere:
   1. Wire, cable and busways: Section 16120.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of jurisdictional authorities.

B. Instrument Calibration:
   1. Calibrate test instruments within six months prior to use on this project.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Working Drawings:
      a. Layout of system being tested, showing location of system components, including test stations.
      b. Instrument hook-up for each test.
   2. Certification:
      a. Certified test report for each test conducted including the following:
         1) Types, models, serial numbers, and dates of calibration of all instruments.
         2) Data resulting from specified test procedures, in approved format.
      b. Certificates of inspection.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Wire and Cable: Section 16120.

PART 3 - EXECUTION

3.01 TEST EQUIPMENT:

A. DC Voltmeter: Multi-scale, center zero, minimum sensitivity 50,000 ohm/volt, accurate to within one percent of full scale, covering the following full-scale ranges: 0-10 and 0-100 millivolts; 0-1, 0-10, 0-100 volts.

B. DC Ammeter: Multi-scale, maximum shunt drop of 20-mV sensitivity, or millivolt meter and shunts, accurate to within one percent of full scale, covering the following full-scale ranges: 0-1, 0-10, 0-100 amperes.

C. Resistivity Meter: Self-contained, synchronous-vibrator, battery-powered unit. Instrument readings unaffected by resistance of leads or probes.

D. DC-Power Sources: Automotive wet-cell batteries, six or 12 volts. For circuits with high internal resistance use two or more batteries, a dc generator or cathodic-protection rectifier.

E. Test Cable: Single-conductor cable, stranded copper, assorted sizes and lengths to suit test conditions.

F. Steel probes for making electrical contact to buried structures in absence of test stations.

G. Slide-Wire Resistors: 0-400 ohm, 15-ampere capacity over full-range of adjustment.

H. Reference Half-Cell: 7/8-inch diameter by eight inches long, saturated copper-copper sulfate.

3.02 TEST PROCEDURES:

A. Electrical Continuity:
   1. Test the following items for continuity:
      a. Mechanical and bell-and-spigot pipe joints: Test after backfilling is completed. Test individual and multiple bonds.
      b. Metallic tunnel-liner joints: Test after invert has been cast. Test longitudinal bonds individually or in sections not to exceed 150-linear feet.
      c. Concrete reinforcement in tunnel, station, retaining wall, reinforced-concrete pipe, aerial, floating slab and building structures: Test after concrete has been cast. Test bonded joints individually or in sections not to exceed 150 feet for tunnel and station structures, not to exceed 500-linear feet for other structures.
      d. Underpinning, soldier and structural piles: Test prior to backfilling or use leads in structure after backfilling. Test bonded piles individually or in longitudinal sections not exceeding 600-linear feet.
   2. Test Procedure:
      a. Single bond: Connect instruments across bond to be tested as shown. Use separate set of wires and contact points to structures for voltage and current circuits. Beginning with highest scales on voltmeter and ammeter, close switch and observe meter readings. Reduce meter ranges until lowest possible scale is reached. Adjust current level to less than five amperes. Read ON values of voltage and current, break circuit and immediately read OFF values. Record ON and OFF readings on data sheet and determine incremental change for current and voltage. Obtain minimum of three readings to ensure accuracy. Determine and record bond resistance for each reading. Resistance of bond not to exceed calculated theoretical resistance by more than 10 percent.
      b. Multiple bonds in parallel: Where two structures are bonded by multiple bonds in parallel, test as specified for single bond. Record resistance readings obtained. Actual resistance not to exceed 10 percent of calculated theoretical resistance of bonds.
      c. Multiple bonds in series: Connect instruments as shown. Determine and record resistance between points A and B, including bonds in series as specified for single-bond test. Total resistance measured between points A and B not to exceed 10 percent of theoretical resistance of sum of bonds plus theoretical resistance of structure between points A and B.

d. Multiple bonds in parallel on reinforcing steel: Connect instruments as shown. Determine and record resistance between points A and B, including bonds in parallel as specified for single-bond test.

B. Insulating Joints:
1. Test the following for zero-percentage leakage through insulation.
a. Insulated flanges and unions: Test buried flanges and fittings after backfilling is completed. Test exposed flanges and fittings after installation is completed. Test each flange or union individually, using existing test wires.
b. Casing and sleeve insulation: Test prior to backfilling. Test each casing or sleeve individually.
2. Test Procedures:
a. Set up instrumentation as shown. If pipe length is too short for proper test-connection spacing, use maximum possible spacing for L-value. With switches open, read and record value of E_0. Close switch in I1 circuit. Read and record current, I1, and voltage, E1. Calculate calibration factor (K) for millivolt shunt using equation shown.
b. With switches open, read and record value of E0. Close switch in I2 circuit. Read and record current, I2, and voltage, E2. Determine difference between E0 and E2.
c. Calculate and record percentage of leakage by equation shown.

C. Cathodic-Protection Systems Using Cast-Iron Anode:
1. Test the following:
a. Hydraulic-elevator well casing: Test casing having cathodic-protection system after pit invert has been constructed. Test each system individually using test stations in elevator pit.
b. Buried chilled-water, steam and condensate piping: Test after backfilling is complete. Test each system individually, using existing test stations along pipeline.
2. Procedures: Perform tests in the following order:
a. Electrical-continuity and insulating-joint tests as specified.
b. Anode tests:
1) Structure-to-anode resistance:
a) Connect instruments as shown.
b) With switch open, record voltage reading 1 on E.
c) Close switch and record voltage and current readings.
d) Reduce current level to less than five amperes by adjusting power source. Record voltage and current readings.
e) Open switch and immediately record voltage as current-off value for potential.
f) Using different values of current and voltage, determine and record resistance using formula shown. Obtain a minimum of three sets of readings to ensure accuracy.
g) Take necessary corrective measures to ensure that resistance is not less than 0.3 ohms.
2) Anode-to-earth resistance:
a) Procedure:
(1) Place copper-copper sulfate reference half-cell at least 50 feet away from anode location and connect voltmeter to read anode-to-earth voltage as shown.
(2) Perform test as specified for structure-to-anode resistance.

b) Acceptance criteria: Actual anode-to-earth resistance not to exceed 20 percent of design soil resistance.
c) Design resistance: As specified in Exhibit 13115-1.
d) Soil resistivity:
(1) If anode-to-earth resistance exceeds 20 percent of design resistance, obtain average soil resistivity in anode-location area.
(2) Make measurements by four-pin method as shown.
(3) Make measurements using suitable resistivity instrument or by battery, voltmeter and ammeter.
(4) Place pins at least 1.5-times pin spacing horizontally from underground metallic structures.

D. Cathodic-Protection Systems Using Magnesium Anode:
1. Test galvanic-anode cathodic-protection system for the following structures and utilities:
a. Buried potable-water, chilled-water and fire piping; sewage-ejector piping; and sewage-pump piping using test stations.
b. Piling: Test structures having cathodic-protection systems. Test each structure individually. Test electrical continuity between piles.
2. Procedures: Perform tests in the following order:
a. Electrical-continuity and insulating-joint tests as specified.
b. Anode tests:
1) Structure-to-anode resistance: Perform test as specified for cathodic-protection systems using cast-iron anode.
2) Anode-to-earth resistance test and soil resistivity: Perform tests as specified for cathodic-protection systems using cast-iron anode.

E. Wire and Cable: Install in accordance with Section 16120.

F. Coal-Tar Epoxy Coating:
1. Subject final coating to spark test for capability of maintaining dielectric integrity at 5,000 volts minimum.
2. Visually inspect coating prior to installation; repair damaged areas in accordance with field-correction recommendations of the coating manufacturer.
3. Backfilling prior to approval of coating is prohibited.

Exhibit 13115-1

G. Design Resistance:

Structure	Soil Resistance	Anodes	Anode-to-Earth Resistance

Exhibit 13115-1 (Cont.)

H. Evaluation:

1. When anode-to-earth resistance exceeds 20 percent of design value, use data from soil-resistivity test to recalculate design resistance.
2. If actual anode-to-earth resistance exceeds recalculated design resistance, install additional anodes as directed.

I. Recalculation: Resistance is calculated by use of the following formulae:

1. Single horizontal anode:

a. $$R_{H\,(N=1)} = \frac{0.00521e}{L}\left\{2.3 \log \frac{4L^2+4L(S^2+L^2)^{0.5}}{dS} + \frac{S}{L} - \frac{(S^2+L^2)^{0.5}}{L} - 1\right\}$$

b. Where:

$R_{H\,(N=1)}$	=	Resistance to earth of the horizontal-ground anode (ohms).
e	=	Effective soil resistivity (ohm-cm).
L	=	Horizontal-anode length (feet).
d	=	Anode diameter (feet).
S	=	Twice anode depth (feet).

2. Single vertical anode:

a. $$R_{V\,(N=1)} = \frac{eK}{L}$$

b. Where:

$R_{V\,(N=1)}$	=	Resistance of single vertical anode-to-earth (ohms).
e	=	Effective soil resistivity (ohm-cm).
L	=	Length of anode (feet).
K	=	Shape function (anode length/ anode diameter) from Table 1.

c. Table 1: The Shape Function:

L/d	K	L/d	K
1	.0056	16	.0201
2	.0092	18	.0207
3	.0113	20	.0213
4	.0128	25	.0224
5	.0140	30	.0234
6	.0150	35	.0242
7	.0158	40	.0249
8	.0165	45	.0255
9	.0171	50	.0261
10	.0177	55	.0266
12	.0186	60	.0270
14	.0194	-	-

3. Multiple vertical anodes in parallel:

a. $R_{V\,(N,S)} = \frac{R_{V\,(N=1)}}{N} + \frac{eP}{S}$

b. Where:

$R_{V\,(N,S)}$ = Resistance-to-earth of vertical anodes in parallel (ohms).

$R_{V\,(N=1)}$ = Resistance-to-earth of single anode (ohms).

e = Effective soil resistivity (ohm-cm).

N = Number of vertical anodes in parallel.

S = Spacing between anodes (feet).

P = Parallel factor from Table 2.

c. Table 2: Parallel Factor:

n	P	n	P
2	.00261	14	.00168
3	.00289	16	.00155
4	.00283	18	.00145
5	.00268	20	.00135
6	.00252	22	.00128
7	.00237	24	.00121
8	.00224	26	.00114
9	.00212	28	.00109
10	.00201	30	.00101
12	.00182	-	-

4. Resistance-to-earth of the horizontal ground bed:

a. $R_{H\,(N,S)} = \frac{R_{V\,(N,S)}}{R_{V\,(N=1)}/N} \times \frac{R_{H\,(N=1)}}{N}$

b. Where:

$R_{H\,(N,S)}$ = Resistance-to-earth of the horizontal ground bed (ohms).

$R_{V\,(N,S)}$ = Resistance-to-earth of N anodes, at spacing S, installed vertically (ohms).

$R_{V\,(N=1)}$ = Resistance-to-earth of single vertical anode (ohms).

$R_{H\,(N=1)}$ = Resistance-to-earth of single horizontal anode (ohms)

N = Number of anodes.

END OF SECTION

SECTION 13905

FIRE PROTECTION, SUPPRESSION AND ALARM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing dry standpipe, wet standpipe, sprinkler, exterior fire protection and clean agent fire-suppression systems.

B. Related Work Specified Elsewhere:
1. Water distribution system: Section 02515.
2. Storm and sanitary system: Section 02535
3. Firestopping: Section 07841.
4. Field painting: Section 09920.
5. Corrosion control system: Section 13115.
6. Identification of mechanical equipment and piping: Section 15075.
7. Piping system: Section 15205.
8. Control equipment: Section 15900.
9. Grounding and bonding: Section 16060.
10. Wire and cable: Section 16120.
11. Raceways, boxes and cabinets: Section 16130.

C. Description of System:
1. Dry standpipe system: Consists of siamese fire-department connection, dry fire line, check valves, automatic air vents, drain valves and angle hose valves.
2. Wet standpipe system: Consists of siamese fire-department connection, wet fire line, check valves, drain valves, fire water-line surveillance valve, angle hose valves and capped branch connections for sprinkler systems where shown.
3. Fire-suppression system for entrance escalators: Consists of fire line to point inside entrance escalator pit/machine room capped for future extension by escalator contractor, supplied from wet standpipe system.
4. Sprinkler system, other than escalator: Consists of sprinkler lines, fire water-line surveillance valve, flow-alarm check valve, drain valve, and sprinkler heads as well as heating tracers in areas subject to freezing temperatures, supplied from wet standpipe system or from domestic water line as shown.
5. Exterior fire-protection system: Consists of lead-ins to wet standpipe system, valves and accessories, supplied from the city water main.
6. Automatic, total-flooding clean agent suppression system: Consists of smoke detectors, agent storage containers, nozzles, clean agent suppression system control and detection panel, manual pull station, alarm bell, evacuation horn, clean agent suppression system discharge visual alarm and necessary interface boxes for signals from and to HVAC and communications. Each room or hazard area to have its own system designed to provide a concentration of 7 percent by volume.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. AWS: A5.13
3. FM Approval Guide.
4. NFPA: 12A, 13, 14, 15, 24, 2001.
5. UL: 262, 312, 1479, Fire Protection Directory.
6. ANSI/ASME: B16.1, B16.5, B16.9, B31.1.

7. ANSI: Z535.1.
8. NEMA: 250.
9. FS: A-A-1992 SS-C-153, WW-P-421, WW-P-501, WW-U-516, WW-U-531.
10. MSS: SP-58.
11. ASTM: A36, A47, A53, A135, A183, A234, A 240, A276, B766, D1752, D2000.

B. Qualification of Welding Personnel: Section 05120.

C. Design Criteria:
1. NFPA 12A, 13, 14, 15 and 2001 as applicable.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. Shop Drawings:
a. Methods of joining, welding, fastenings, and anchoring.
b. Materials and locations for wet standpipe, dry standpipe, sprinkler, clean agent suppression and external systems.
c. Pipes and piping layout, including pipe hangers and supports.
d. Pipe hangers and supports.
e. Valves.
f. Escutcheons.
g. Gauges.
h. Automatic air vents.
i. Pipe sleeves.
j. Mechanical couplings.
k. Layout of sprinkler and clean agent suppression systems and detail drawings approved by Fire Marshal of jurisdiction in which work is to be performed.
l. Reports covering test materials.
2. Certification:
a. Fire line test results.
b. Manufacturer's certification that pipe-joint gaskets and lubricants are satisfactory for use with pipe and fittings specified and that couplings are designed and tested as specified.
3. Samples: Paint, Section 09920.
4. Operation and Maintenance Manuals.

1.04 JOB CONDITIONS:

A. Do not perform welding when the temperature of the base metal is less than zero degree F.

B. Do not perform welding when surfaces are wet or during periods of high winds unless operator and work are properly protected.

C. Environmental Requirements: Paint, Section 09920.

1.05 OPERATION AND MAINTENANCE TRAINING:

A. Upon completion of installation and in accordance with the General Requirements furnish for a period of not less than two consecutive man-days services of a manufacturer's field engineer with specialized experience in the components of the system to instruct Authority personnel in the proper operation and maintenance of the systems.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General Requirements:
1. In design and purchase of equipment, provide for interchangeability of items of piping and electrical equipment sub-assemblies, parts and relays.

B. Pipe and Fittings:
1. Exterior fire-protection system:
a. Ductile-iron pipe and fittings:
1) Piping embedded or otherwise inaccessible: FS WW-P-421, Type III, Grade C, 250-pound pressure class.
2) Piping from point of connection to inside of structure: FS WW-P-421, Grade C, 250-pound pressure class, flanged. Flanges: ANSI B16.1.
3) Pipe coated on outside with bituminous coating and lined with cement mortar of twice standard thickness specified for pipe size used.
a) Cement-mortar lining having seal coat of nontoxic, tasteless and odor-free bituminous material.
4) Neoprene gaskets furnished for joints.
2. Interior fire-protection system:
a. Fire lines, embedded or otherwise inaccessible:
1) Pipe: Galvanized steel, ASTM A53, Type E ,Grade B, with the following additional requirements:
a) Fire-protection piping: Extra-strong weight, Schedule 80.
2) Fittings and flanges: Galvanized, furnished with wall thickness equal to or greater than that of adjacent pipe, with the following additional requirements:
a) Fire lines: ASTM A234, Grade B, and ANSI B16.9 for dimensions and tolerances.
(1) Flanges: ASTM A234 and ANSI B16.5 for dimensions and tolerances.
b. Fire lines, exposed or otherwise accessible:
1) Pipe:
a) Galvanized steel: One of the following:
(1) ASTM A53: One of the following:
(a) Type E, Grade B.
(b) Type F, Grade A.
(2) ASTM A13
b) Welded or seamless.
c) Standard weight, Schedule 40, with grooved ends. Use of Schedule 10 pipe is not allowed.
2) Mechanical joint couplings: Keyed for joining grooved-end piping.
a) Coupling housing: Malleable iron in accordance with ASTM A47, Grade 32510, galvanized, fabricated in two or more parts enclosing resilient gasket seal, with keys to fit machined grooves on pipe ends. Rated at 300-psig minimum pressure and factory-finished with manufacturer's standard paint coating.
b) Coupling gasket: Chlorinated butyl, ASTM D2000, specification 3-BA-615-A14-B13, with following additional requirements:
(1) Molded grooves.

(2) Pressure-responsive seal, integrity increasing with internal pressure.

c) Coupling bolts and nuts: Oval-neck track-type bolts with hexagonal nuts conforming to ASTM A183 permitting single-wrench assembly, having minimum tensile strength of 110,000 psi, with cadmium-plated finish ASTM B766, Type III.

3) Fittings:

a) Grooved-end, fabricated of malleable-iron casting in accordance with ASTM A47, Grade 32510, galvanized; nonstandard fittings fabricated from Schedule 40 steel pipe.

b) Mechanical branch outlets:

(1) Victaulic 920 or equal.

(2) Victaulic Style 72 or equal.

c) Threaded pipe fittings: FS WW-P-501, Type 1, Class B.

d) Welding fittings made of same wall thickness as pipe.

(1) Factory-made welding fittings.

(2) Mitered-joint elbows and field-made reducers are prohibited.

e) Butt-welded fittings larger than 1-1/2 inches: ANSI B16.9.

f) Flanges for welded piping system: ANSI B16.5, galvanized forged steel, welded-neck type, 175 pressure class for stations and 250 pressure class for tunnels.

4) Paint, Primer, and Undercoat: Alkyd Semigloss System as specified in Section 09920, Color: OSHA Red (Safety Red) in compliance with ANSI Z535.1 for piping, White for stenciling.

c. Unions: WP 175 psig.

1) 1-1/2 inches and smaller: Threaded, FS WW-U-531, Type B to match piping.

2) Two inches and larger: Flanged.

a) Two union flanges, 2-1/2 and three inches: Steel, FSA WW-U-531, or cast iron, ANSI B16.1.

3) Four inches and larger: Forged steel, slip-on weld neck flanges, ANSI B16.5.

4) Nonferrous piping unions: Brass, FS WW-U-516.

C. Valves:

1. Fire-line valves, outside stem and yoke (OS&Y), UL Fire Protection Directory listed or FM Approval Guide listed for 175-psig minimum, meeting requirements of listed NFPA Standards, with UL or FM symbol cast or stamped on valve body.
2. Gate valves: UL 262 or FM Approval Guide listed, 175-psig WP
3. Check valves: UL 312 or FM Approval Guide listed, 175-psig WP, flanged-end connections, swing-type, metal-to-metal, rubber-faced or equivalent, valve seat 15 degrees from perpendicular to direction of flow.
4. Sprinkler flow-alarm check valves: Designed to operate on 10 gpm or more with restriction bypass which allows restricted flow of water to pass from supply to system side of alarm-valve clapper, to decrease possibility of false alarms resulting from increase in supply water pressure or from water hammer.
   a. Furnished with retarding chamber, test and drain connections and electric contact unit.
   b. Cast-iron bodies with nonferrous-metal seat, rings, bearings and renewable clapper facing.
   c. Contacts: Section 15900.
5. Fire water-line surveillance valve:

a. Double-disc, solid-wedge gate-type with outside stem and yoke (OS&Y) and renewable ring seats.
b. Designed for position indicator contact:
1) Contacts open with valve fully open.
2) Contacts close and alarm condition is initiated with two turns of hand wheel or when valve stem has moved one-fifth of distance from normal fully open position.

6. Sprinkler alarm check-valve surveillance: Contact closes on flow amounting to 10 gpm or greater.
7. Ball drip valves: 3/4 inch, threaded both ends and rated at 175-psig minimum.
8. Air and vacuum valves:
a. Automatic.
b. High-capacity; minimum flow, 3.0 cfs; pressure differential, 5.0-psig maximum.
c. Designed for maximum system working pressure; 175-psig minimum; suitable for working pressures from zero psig to maximum capacity.
9. Angle hose valves:
a. Cast bronze, male outlet, replaceable rubber disc and rising stem.
b. Rough-bronze body, polished-finish bonnet, nut and stem, complete with cap and chain.
c. Cast-iron or aluminum hand wheel, red-enameled.
d. Working pressure: 200 psig.
e. UL Fire Protection Directory listed with symbol cast or stamped on valve body.
f. American National Standard Fire Hose threads.
10. In-line cut-off valves:
a. Flanged gate valve, with outside stem and yoke
b. Comply with UL 262, UL Fire Protection Directory listed or FM Approval Guide listed with symbol cast or stamped on valve body.
c. Working pressure, 175 psig.
d. Cast-iron or aluminum hand wheel, red-enameled.

D. Fire Department Siamese Connection:
1. Free standing:
a. Paved areas: Double clapper, with sidewalk sleeve, sidewalk plate, two rocker-lug plugs and chains, polished brass, two female inlets with 2-1/2 inch American National Standard Fire Hose Threads, UL Fire Protection Directory listed or FM Approval Guide listed, working pressure of 200 psig and with cast recessed Type B Metro logo and inscription, as shown, except inside fenced Authority property.
b. Landscaped areas: As specified for paved areas, except no sidewalk sleeve or plate.
c. Paint, Primer, and Undercoat: Alkyd Semigloss System as specified in Section 09920, Color: OSHA Red (Safety Red) in compliance with ANSI Z535.1 for piping, White for stenciling.
2. Wall-mounted: Double clapper rectangular wall plate for flush mounting, two rocker-lug plugs and chains, polished brass, two female inlets with 2-1/2 inch American National Standard Fire Hose Threads, UL Fire Protection Directory listed or FM Approval Guide listed, working pressure of 200 psig, and with cast raised Type B Metro logo and inscription as shown. Provide sill cock where necessary for drainage.

E. Sprinkler Heads:
1. Standard fusible-link type.
2. Bronze finish, exposed and temperature rating of 165F in accordance with listed NFPA Standards.

F. Sprinkler Test Connections:
   1. Drain piping, valves and fittings necessary for testing in accordance with listed NFPA Standards.

G. Control System: Except as specified for clean agent suppression systems: Provided by others.

H. Supporting Devices:
   1. Pipe hangers and supports:
      a. Adjustable, stainless steel, clevis-type, threaded full length, with diameter consistent with pipe size and the load imposed: MSS SP-58.
      b. Hanger rods: 3/8-inch minimum diameter, stainless steel, ASTM A276,Type 304, threaded full length, with diameter consistent with pipe size and the load imposed: MSS SP-58.
      c. Nuts and washers: Stainless steel.
      d. Supported from stainless steel inserts in concrete slab: MSS SP-58.
   2. Adjustable U-bolt type:
      a. U-Bolt: Fabricated from stainless steel, MSS SP-58.
      b. Nuts and washers: Stainless steel..
      c. Chair: Cast iron or fabricated from stainless steel.
   3. Z-bar: Fabricated from stainless steel: ASTM A240, Type 304.
   4. Pipe anchors:
      a. Designed to withstand a minimum of five times anchor load.
      b. Vertical pipes anchored by means of clamps welded around pipes and secured to wall or floor construction.
   5. Expansion-bolt anchors:
      a. Consisting of bolt, expander, star lock washer and nut.
      b. Fabricated of stainless steel, Alloy S30300 in accordance with ASTM E527, including expander and star lock washer.
      c. Anchor assemblies: FS A-A-1992, Group II, Type 4, Class 1.
   6. Self-drilling anchors:
      a. Self-drilling, expansion anchors with self-cutting annular broaching grooves.
      b. Anchor and expander plug: Double-plated, FS A-A-1992, Group III, Type 1.
   7. Pipe sleeves:
      a. Through interior masonry-unit walls: PVC, as shown, large enough to accommodate pipe but minimum two sizes larger than pipe size.
      b. Through cast-in-place concrete interior walls and concrete ceilings: Factory-made cast iron with anchor flange and cast-iron plate collar screw-fastened to slab and pipe.
         1) Sleeves minimum two sizes larger than pipe; for floors and ceilings projecting four inches above finish floor.
      c. Through exterior structural elements: Minimum two sizes larger than pipe and as shown.
      d. Sleeves designed for pipe-movement allowance due to expansion and contraction.
   8. Escutcheon plates:
      a. Polished brass or stainless steel, screw-fastened to wall or ceiling.
      b. Plate collars caulked with silicone sealant or intumescent putty.
      c. Sealant: UL-1479.

I. Pressure Gauges: Spring pressure-type, 3-1/2 inch dial, in accordance with NFPA 14.

J. Bonding Strap: 2AWG single-conductor cable: Section 16060.

K. Preformed Joint Filler: ASTM D1752.

L. Coal-Tar Epoxy: Section 02535.
   1. Thinner of type recommended by manufacturer of coating and used only when approved.

M. Water-Flow Indicator: Vane-type water flow switch, UL Fire Protection Directory listed, FM Approval Guide listed. Electrical rating: 24 volts dc, 1.5 amperes, normally open contacts to actuate with flow of 10 gpm or more.

N. Clean agent suppression system:
   1. Smoke detectors: Products of combustion, dual-chamber, ionization-type, operating voltage of 22 to 28 volts dc, 30 milli-amperes (ma) standby current drain at 24 volts dc and alarm current drain of 60 ma at 24 volts dc. Three amperes minimum alarm contact rating at 24 volts dc. Detector will activate alarm approximately five seconds after product of combustion particulate enters ionization chamber. Detectors equipped with indicator lamp which will remain lighted until reset. Unit listed by UL Fire Protection Directory and FM Approval Guide as signal and release device.
   2. Manual pull station: Contained in cast-metal housing for mounting on standard four-inch junction box unit to have dual-action release configuration such as discharge lever protected by lift cover, to prevent accidental discharge, and tamper-resistant screw to prevent unauthorized access to reset procedure. For operation at 24 volts dc. Listed by UL Fire Protection Directory as release device.
   3. Abort switch: A momentary, normally closed push-button switch. Time delay to restart at designated setting when abort switch is released. Switch to be accessible and labeled 'CLEAN AGENT ABORT.' Activation of the abort switch to silence discharge warning horn.
   4. Clean agent suppression system control equipment:
      a. Control panel: Multizone for operation by smoke detectors and manual pull station, singly or in combination, to activate prealarm or release of agent as required. Power source for operating extinguishing system as well as specified auxiliary functions.
         1) Panel enclosure: NEMA 250, Type 1 surface-mounted, dead front; indicators and control switches visible, mounted on panel behind hinged, locked glass-paneled door, complete with relays, trouble and alarm bell, silencing switch with ring-back feature, LED indicating lamps, nameplates, switches and terminals to provide relays for fire-alarm system tie-in, for HVAC systems fan shut-down, HVAC-damper closing, for test delay switch with automatic reset to permit testing fire-alarm system without activating auxiliary control functions.
         2) Operating circuitry: Solid-state electronics with plug-in circuit modules for detection and release circuits; 120-volt ac, 60-Hertz supply; 24 volts dc signal and release circuits including power for operating extinguishing sub-system and other functions. Power consumption 10 watts steady state, 200 watts peak.
         3) Functional circuitry: Provide two detection zones and two output circuits for signal and release, all Class B supervised. Detection circuits to accommodate smoke detectors and manual stations intermixed. Signal output circuit of the polarity-reversal type. Release circuit to include supervised abort switch and adjustable time delay. Provide separate relay output for each zone alarm, general alarm, trouble, predischarge and system-fired circuit; utilize 10-ampere contact.
         4) Operation: Activation of detector, circuit to light zone alarm lamp on indication panel, sound audible local alarm, activate the extinguisher system and energize auxiliary relays for remote alarm

or equipment shut-down. Loss of dc power or discontinuity in detection circuits to light trouble lamp on indicator panel and actuate bell alarm; provide trouble bell silence switch with ring-back circuit to silence trouble bell alarm. Receipt of zone alarm to override trouble alarm. A single switch to reset control unit.

5) Indicator lights, as follows:
   a) POWER ON: Green.
   b) TROUBLE: Yellow.
   c) ALARM ZONE 1: Red.
   d) ALARM ZONE 2: Red.
   e) PRE-DISCHARGE: Red.
   f) SYSTEM FIRED: Red.

b. Extinguishing system:

1) Provide system designed to discharge seven-percent volume concentration of extinguishing agent with discharge not to exceed 10 seconds. The system to comply with NFPA 2001. Each extinguishing system to include the following
   a) Agent storage container: Container fabricated of high-strength alloy steel with burst-disc actuator valve assembly, safety plug, cable assembly, 0 - 600-psig pressure gauge, pressure switch and lifting ring. Container to conform to applicable DOT specifications; to automatically relieve between 850 psi and 100 psi in event of excessive pressure buildup. Super-pressurize filled container with dry nitrogen to 390 psig at 70F to assist rapid distribution. Container designed for on-site reconditioning and refilling. Actuator valve assembly to be an integral part of container.
   b) Discharge nozzle: Provide series of one-piece, nonclogging nozzles to distribute agent in protected volume. Nozzle size selection determined by container size and geometry of volume to be protected. Nozzles connected through reducer, elbow and piping. Nozzle discharge pattern to deliver uniform agent coverage to all areas of enclosed hazard.
   c) Actuator: Electrical device to operate on demand to provide path for relief and discharge of agent.
   d) Mounting bracket: Designed for wall-mounting agent storage container and capable of withstanding 1,000-pound thrust for five seconds in any direction.
   e) Agent: Liquefied compressed clean agent suppression system conforming to requirements of NFPA 2001.
   f) Alarm bell: Motor driven, with six-inch gong, 24-volt dc operating voltage, 90 dBA sound-pressure level at one meter and OSHA Safety Red finish.
   g) Evacuation horn: Vibrating, 24-volt dc, 0.063 amperes, 97 dBA sound-pressure level at one meter.
   h) Discharge indication light: Flashing device with legend CLEAN AGENT DISCHARGE; 24-volt dc.
   i) Clean agent suppression system interface box: Data-transmission system (DTS) cabinet specified in Section 16130, with the following additional requirements:
      (1) Cabinet: Hoffman A161206LP.
      (2) Terminal strip: 16 terminals minimum.
      (3) Exterior finish color: OSHA Safety Red.
      (4) Identify cabinet on cover with COMMUNICATION INTERFACE in one-inch high yellow letters.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Fit equipment and appurtenances to space provided and make serviceable.

B. Provide support beams, concrete pads, platforms, and hangers necessary for proper installation of equipment as recommended by manufacturer.

C. Install complete fire-protection systems as shown and as specified. During installation, protect work, equipment, and materials. Plug or cap pipe openings.

D. Flush underground mains before connection to wet-standpipe risers at following minimum flow rates:
   1. Six-inch pipe: 750 gpm.
   2. Eight-inch: 1,000 gpm.
   3. 10-inch pipe: 1,500 gpm.
   4. 12-inch pipe: 2,000 gpm.

E. Fasten escutcheon plates to wall or ceiling. Seal plate collars watertight with mastic.

F. Welding Procedure:
   1. As specified in Section 05120, with the following additional requirements:
      a. Manual metallic arc process, except for pipe sizes four inches and smaller where oxyacetylene welding may be used.
         1) Use electrodes and rods of composition recommended by AWS A5.13 for pipe.
         2) Heat surface within three inches from point where weld will start to a temperature warm to hand before welding.
      b. Leave joint surfaces smooth, uniform and free from fins, tears and other defects which adversely affect proper welding.
      c. After each pass of weld on multiple-pass welding, clean weld free of slag and other deposits before applying next pass.
      d. Peen with light blows of blunt-nosed peening hammer. Do not peen surface layers or first pass in groove welds.
      e. For groove welds, center surface pass substantially on seam, smooth and free from depressions.
      f. Fillet weld with minimum cutting back of outside surface of pipe.
         1) Leave throat of full fillet weld not less than 0.707 of thickness of pipe.
         2) Repair excess cutting back and undercutting of base metal in pipe adjoining the weld.
         3) Fill craters to full cross section.
      g. Position pipes to be welded so that joints will be in alignment. Joints misaligned more than 20 percent of pipe wall thickness or maximum of 1/8 inch are prohibited.
      h. Install welding pipe in accordance with ANSI B31.1.
   2. Cut ends of screw-jointed pipes squarely to seat in bottom of recess of fittings. Ream after cutting so waterway is not reduced in size.
   3. Apply thread dope or compound to male thread only.
   4. Where cathodic protection is shown, apply coal-tar epoxy coating as specified in Section 02535 and test as specified in Section 13115.

G. Buried Ductile-Iron Pipe: Install as specified in Section 02515, except use mechanical joints.

H. Steel-Pipe Installation:
1. Maintain OSHA required head clearance.
   a. Install horizontal piping with minimum pitch of one inch in 40 feet.
   b. Provide drains at low points: Minimum 3/4-inch valves with hose connection.
   c. Install vertical pipes near wall from which they are supported.
2. Make connections to equipment without placing strain on piping and equipment.
3. Tunnel, vent and fan-shaft piping:
   a. Joints of the following types:
      1) Butt weld joints in pipe recessed in tunnel lining.
      2) Use mechanical grooved couplings for remainder of joints in horizontal and vertical mains unless otherwise shown.
      3) Use threaded joints in branch lines 2-1/2 inches or smaller.
   b. Provide number of mechanical couplings necessary to allow minimum 1-1/4 inch expansion per 100 feet of main.
   c. Use reducing tee for mechanical couplings or mechanical branch outlet at main-to-branch connections.
   d. Make in-line cut-off valves accessible from floor or walkway level.
4. Underplatform station piping:
   a. Provide the following types of joints or couplings:
      1) Couplings: Mechanical, grooved, at intervals not to exceed 21 feet.
      2) Where possible, cut grooves before galvanizing.
      3) Where grooves are cut after galvanizing, apply zinc coating.
      4) Other joints:
         a) In lines four inches and larger: Welded joints.
         b) In lines less than four inches: Welded or threaded joints.
   b. Provide anchors, horizontally and vertically rigid, within one foot of one end of each length of pipe jointed with Victaulic-type mechanical couplings. Provide clevis-type support within one foot of other end, at midpoints between mechanical couplings and at each angle hose valve. Locate supports at angle hose valves to ensure resistance to rotation of valves and adjacent piping by water pressure at valve. Provide restraint for every third length of pipe to prevent excessive movement by a horizontal thrust. Roller-type hangers and pipeline guides are not required
5. Other station piping: Joints in balance of station fireline piping of mechanical-type, grooved or welded couplings for lines four inches and larger and screwed or welded for lines under four inches, except that mechanical-type groove couplings must be accessible.

I. Mechanical-Type Groove Couplings: Install couplings according to manufacturer's instructions and as follows:
1. After grooving, remove indentations, projections and roll warps as necessary. Cut pipe ends square to tolerance of plus-or-minus 0.03 inch. Provide zinc coating on exposed surface.
2. Lightly coat pipe ends and coupling gasket with non-petroleum-based lubricant.
3. Center gasket, install housing and ensure that keys are securely located in pipe grooves.
4. In underplatform station piping, provide separation of 1/8 inch between ends of adjacent sections of pipe within coupling, based on air temperature of plus 60F. Adjust based on actual air temperature at time of installation.
5. Install bolts and nuts tightened uniformly to manufacturer's recommended limits using torque wrench, without pinching gaskets.
6. Provide bonding across couplings for stray-current protection.

J. In-Line Valves: Install in-line valves by bolting fitting to valve and welding fitting to pipe.

K. Pipe Anchors: Securely anchor piping as specified, where shown and where necessary for proper installation to force pipe expansion in proper direction.

L. Expansion-Bolt Anchors: Drill holes and install expansion-bolt anchors in manner recommended by anchor-bolt manufacturer. Do not install less than eight inches from concrete edge.

M. Pipe Sleeves: Fill annular space between pipe and sleeves with preformed joint filler, tightly placed to form effective seal against groundwater.

N. Bonding: In accordance with Section 16060, and with the following additional requirements:
1. Bond mechanical joints and fittings, including valves, by exothermic-welding method.
2. Make welds in accordance with manufacturer's recommendations. Clean and coat with coal-tar epoxy.
3. Bond pipe using bonding strap welded to each side of joint not less than six inches from joint. Allow sufficient slack in conductor for expansion of pipe.

O. Air Vents: Install high-capacity automatic air vent(s) at opposite end(s) of dry-standpipe system from fire-department siamese connection or where shown. Pipe air-vent outlet to nearest drain or as directed.

P. Firestopping: Section 07841.

3.02 PROTECTION OF PIPING AND EQUIPMENT:

A. Protect pipe, openings and valves from dirt, foreign objects and damage during construction.

B. Replace damaged piping, valves and other appurtenances, should damage occur prior to final acceptance of the work.

3.03 FIELD QUALITY CONTROL:

A. Field Tests:
1. Flush piping with water until clean and free of scale, slag, dirt, oil, grease and other foreign material.
2. Perform final testing, acceptance, and certification in accordance with NFPA 13, 14, and 24, as applicable.
3. Test electrical continuity of bonded joints by measuring resistance. Total resistive value of joint not to exceed calculated resistance of bond cable plus 10 percent.

B. Water-Pressure Testing:
1. In the presence of the Engineer, test piping, prior to burial or concealment, using specified procedures specified.
2. In the presence of the Engineer, completely test piping system for leaks until approved.
3. Notify the Engineer at least 36 hours prior to tests.
4. Test piping at the following pressures:
   a. Fire-protection piping, inaccessible: 400 psi-minimum.
   b. Ductile-iron pipe: At lowest point in system, 150 psi or 1-1/2 times maximum working pressure, whichever is greater.
   c. Fire-protection piping, exposed and accessible: At lowest point in system, 150 psi or 1-1/2 times maximum working pressure, whichever is greater.

C. Test Procedures:
   1. Test fire-protection piping in accordance with NFPA.
   2. Fire-protection piping, inaccessible:
      a. Avoid excessive pressure on safety devices and mechanical seals.
      b. Fill entire system with water and vent air from system at least 24 hours before test pressure is applied.
      c. Apply test pressure when water and average ambient temperature are approximately equal and constant.
      d. Maintain test pressure for six hours minimum without drop after force pump has been disconnected.
   3. Water-test entire system with pressure at highest point of 250 psig.
   4. After filling system, shut off water supply and allow it to stand for two hours under test without loss or leakage.
   5. Coordinate with and assist local fire department in performing flow tests. After performing hydrostatic test, drain water from firelines. Perform flow test at rate of 500 gpm with pumper connected to siamese connection, starting testing with sudden full flow into empty firelines.
   6. Drain system immediately after hydrostatic and flow testing.

D. Repair of Leaks:
   1. The following are prohibited:
      a. Repair of leaks by mechanical caulking.
      b. Introduction of material inside piping system to stop leakage.
   2. Repair leaks in threaded piping by breaking joint, cutting new threads on pipe and installing new pipe fitting.
   3. Coat field welds and repair damages to zinc-coated surfaces as follows:
      a. Wire brush areas to be coated to bright metal.
      b. Apply galvanizing repair compound at rate of two ounces per square foot.
   4. Replace defective coupling assembly as necessary.
   5. Remove defective welds by chipping or gouging.
      a. Reweld the chipped-out places.
      b. When base metals of fillet welds are cut back or throat of welds are less than specified, repair defect by adding additional weld metal.

3.04 CLEANING:

A. Flush firelines with water to remove sediment after completion of tests, repairs or replacements.

B. Disinfect firelines connected to potable-water system as follows:
   1. Use chlorine for disinfection in form of hypochlorite solution or in form of compressed gas applied through approved chlorinator.
   2. Operate valves and equipment during chlorination to ensure that chlorine reaches entire system.
   3. Feed water and chlorination agent into system at rate providing for 50 ppm of chlorine and allow to stand 24 hours before flushing.
   4. Residual chlorine, at end of 24-hour retention period, not less than 10 ppm.
   5. Flush treated water from system completely after disinfection.
   6. Continue flushing until samples show that quality of water delivered is comparable to public water supply and satisfactory to public-health authority having jurisdiction.
   7. Do not take samples from hydrants or through unsterilized hose.

3.05 FIELD PAINTING: Section 09920.

A. Prepare piping, apply primer, undercoat and finish coats in accordance with Section 09920.

3.06 IDENTIFICATION OF PIPING AND VALVES: Section 15075.

3.07 CLEAN AGENT SUPPRESSION SYSTEM:

A. General:
   1. Install clean agent suppression system sized and adjusted to discharge seven-percent concentration within protected spaces in accordance with NFPA 2001. Smoke detectors to be cross-zoned so that at least one detector from each loop shall react to smoke before extinguishing system will be activated. First detector actuated to sound alarm bell, illuminate indicator lamp for appropriate alarm zone and energize fan shut-down relays and close dampers of HVAC systems serving involved space. Second detector actuated to energize evacuation time-delay relay in clean agent suppression system control panel, sound evacuation horn and illuminate SYSTEM FIRED indicator light at clean agent suppression system control panel to indicate system discharged. Actuation of manual pull station to by-pass time-delay function, sound evacuation horn, energize fan shut-down relays of HVAC system serving area and release FM200.

B. Trouble Operation:
   1. Opens or ground in wiring to ring bell on FM200 control panel. Silencing switch to silence trouble bell during correcting of fault.

C. Remote Alarms:
   1. Activation of the following to generate alarm indicators at clean agent suppression system control panel:
      a. Alarm Zone 1.
      b. Alarm Zone 2.
      c. System fired.
      d. Trouble.

D. Performance Testing:
   1. Performance-test completed system except smoke detectors.
   2. Provide instrumentation and test gases-test systems including detection system in accordance with jurisdictional requirements.
   3. Operate mechanical and electrical systems.
   4. Inspect nozzles and agent storage containers.
   5. Full equivalent test of gas discharge into each zone area. Use meter to verify delivery of specified concentrations within required time and maintained for minimum of 10 minutes.
   6. After completion of satisfactory testing, refill storage containers.

END OF SECTION