(c) **Sheet Lead and Common Desilverized Bedding Material:** Material shall conform to the requirements of ASTM B749 and shall be furnished in single sheets of the specified thickness.

(d) **Preformed Fabric Bedding Material:** Material shall be composed of multiple layers of 8-ounce cotton duck impregnated and bound with high-quality natural rubber or its equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plys shall be such as to produce the specified thickness after compression and vulcanizing. Finished pads shall withstand compression loads perpendicular to the plane of the laminations of at least 10,000 pounds per square inch without a detrimental reduction in thickness or extrusion.

SECTION 238—ELECTRICAL AND SIGNAL COMPONENTS

238.01—Description.

These specifications cover conduits, conductors, junction boxes, traffic signal components, and necessary fittings to complete a described electrical or traffic signal system.

238.02—Detail Requirements.

(a) **Metal Conduit and Fittings:** Conduit shall conform to the requirements of, and be galvanized in accordance with the requirements of UL-6. Fittings for metal conduit shall conform to the requirements of, and be galvanized in accordance with the requirements of UL-514. Conduit for use in underground installations, concrete encasements, or corrosive environments shall also be coated on the outside with an asphalt mastic in accordance with the requirements of AASHTO M243 or shall have a PVC coating of 40 mils or another approved coating.

(b) **PVC Conduit and Fittings:** Conduit shall be heavy wall conduit conforming to the requirements of UL-651. Fittings for PVC conduit shall conform to the requirements of UL-514. Exposed PVC conduit shall be UL listed or ETL Testing Laboratories, Inc. listed for use in direct sunlight. Each section of conduit shall be marked with the letters UL or ETL. Solvent cement used for joining shall conform to the requirements of ASTM D2564. Protective shields shall be galvanized sheet steel of commercial quality with an ASTM A525 coating designation of G115 and a thickness of 0.0625 in.

(c) **Fiberglass Reinforced Epoxy Resin Conduit and Fittings:** Conduit and fittings shall conform to the requirements of NEMA TC-14. Conduit shall be standard wall except when the conduit diameter is 3 inches or less or

when used in exposed areas. In such cases, conduit shall be heavy wall. Epoxy adhesive used for joining shall conform to the requirements of NEMA TC-14. Protective shields shall conform to the same requirements as those used with PVC conduit.

(d) **PE Conduit:** PE conduit shall conform to the requirements of NEMA TC-7 for a high density PE duct except that the wall thickness of conduit with a diameter of 1/4 inches and less shall conform to UL-651 for heavy wall PVC conduit. Conduit shall have a carbon black loading of 2.5 ± 0.5 percent by weight per ASTM D1603. The average diameter of the carbon black shall not be larger than 40 millimicrons in accordance with the requirements of ASTM D1514. Conduit shall contain at least 1,000 parts per million of hindered phenolic long-term antioxidant per ASTM D3895.

(e) **Splice Boxes or Pull Boxes** (512 cubic inches or less): Boxes will be permitted only in exposed areas and shall conform to the requirements of UL-514 and be compatible with the appropriate conduit.

(f) **Electrical and Signal Junction Boxes:** Boxes, frames, and covers shall be watertight except for weep holes. Covers shall be fitted with synthetic rubber blend gaskets and secured with bronze or stainless steel screws.

Boxes, frames, and covers for bridge structure encasements shall be one of the following types:

1. steel castings conforming to the requirements of Section 224, galvanized inside and out

2. welded sheet steel having a thickness of at least 3/16 inch or 7 gage, galvanized inside and out

3. polymer concrete with fiberglass sides

Boxes, frames, and covers for other uses shall withstand H-20 loading in accordance with the requirements of AASHTO's *Standard Specifications for Highway Bridges* HS20-44. Boxes shall be one of the following types:

- polymer concrete with fiberglass sides

- cast iron with an asphalt mastic coating on exterior surfaces, except the cover, conforming to the requirements of AASHTO M243 or other protective coating materials specifically manufactured for use in corrosive environments as approved by the Engineer

- concrete conforming to the requirements of Section 217

- 1/4-inch steel plate conforming to the requirements of ASTM A36, galvanized in accordance with the requirements of Section 233, and

uniformly coated on exterior surfaces, except the cover, with an asphalt mastic conforming to the requirements of AASHTO M243

Alternate types of boxes may be submitted for review provided they conform to the following:

- **Loading:** Boxes shall withstand H-20 loading in accordance with AASHTO's Standard Specifications for Highway Bridges HS20-44.

- **Fire resistance:** Material shall be fire resistant and shall not burn at a rate greater than 0.3 inches per second per 0.1 inch of thickness when tested in accordance with The requirements of ASTM D635.

- **Density:** Material shall have an absorption rate less than the requirement for a concrete pipe specified in Section 232.02(a)1.b(7).

- **Chemical resistance:** Material shall not show appreciable change in physical properties after exposure to weather, oil, gasoline, or snow removal chemicals.

(g) **Conductor Cables:**

1. **Power conductor cables** shall be copper conforming to the requirements of ASTM B3 and B8. Conductor cable sizes shall be based on No. 8 AWG minimum. Conductor cables of No. 8 AWG and larger shall be stranded. Conductor insulation shall be UL listed for the use specified on the plans and rated for 600-volt operation.

    a. **Service entrance conductor cables** shall be UL with Type SE insulation.

    b. **Underground service entrance conductor cables** shall be UL with Type USE insulation.

    c. **Direct burial conductor cables** shall be UL with Type USE or UF insulation.

    d. **Conductor cables in conduit** shall be UL with Type THWN insulation except as follows: When the conduit size specified on the plans is such that the allowable percentage of conduit fill in Table 1, Chapter 9, of NEC is not exceeded, then UL Type RHW, TW, THW, XHHW, or XLPE insulation may be used.

    Where direct burial conductor cables enter a conduit, they may be spliced to THWN conductor cables only at accessible locations.

2. **Communication and signal cables:**

   a. **Signal cables from the controller cabinet to signal heads** shall be No. 14 AWG copper with 3, 4, 7, or 12 straight-lay conductors conforming to the requirements of IMSA 19-1 or 20-1 (aerial and duct) or 19-5 or 20-5 (direct buried). Signal cable used for preemption or pedestrian pushbuttons shall be two-conductor No. 14 AWG conforming to the requirements herein.

   b. **Interconnect cables between controllers** shall be No. 14 AWG solid copper conforming to the requirements of IMSA 19-2 or 20-2 (aerial and duct), 19-4 or 20-4 (self-supporting aerial), or 19-6 or 20-6 (direct buried). When interconnect cable is specified to be either No. 18, 19, or 22 AWG, it shall be solid copper conforming to the requirements of IMSA 39-2 or 40-2 (aerial and duct), 39-4 or 40-4 (self-supporting aerial), or 39-6 or 40-6 (direct buried).

   c. **Loop detector cables** shall be No. 12 AWG stranded copper conforming to the requirements of IMSA 51-3. Insulation shall be Type XHHW. Loop detector cable enclosed in tubing shall be No. 14 AWG stranded copper. Loop detector cable and tubing shall conform to the requirements of IMSA 51-5.

   d. **Loop and magnetic detector lead-in cables** shall be stranded copper, twisted pair, No. 14 AWG conforming to the requirements of IMSA 50-2.

(h) **Electrical Components:**

1. **Safety switches** shall be enclosed in a raintight box conforming to the requirements of NEMA 3R, with a lock on-lock off external switch handle. For signal installations, safety switches shall be rated at 60 AMP/240 volts, two pole, solid neutral, 120 volt AC, fused to be compatible with the equipment load.

2. **Circuit breaker boxes** (service panel) shall be a NEMA 3R enclosure rated at 60 AMP/240 volts with a solid neutral and shall contain two single-pole, 120-volt AC breakers with an ampere rating compatible with the equipment load, and shall have provisions for padlocking. The service load shall be wired to only one breaker.

3. **Ground rods** shall conform to the requirements of ANSI 135.3 and ASTM A153 or shall be copper-clad rods conforming to the requirements of UL-467. Ground rods shall have a diameter of at least 5/8 inch and a length of at least 8 feet.

4. **Ground wires** shall be at least No. 6 AWG conforming to the requirements of ASTM B2.

5. **Ground clamps** shall be heavy-duty bronze or brass or galvanized malleable iron conforming to the requirements of ASTM A220, any grade.

6. **Signal head sections:**

   a. **Standard traffic signal head sections** shall conform to the ITE Standard for Vehicle Traffic Control Signal Heads, with the following exceptions and additions:

      (1) Lenses shall be made of glass.

      (2) Reflectors shall be made of glass or aluminum and shall be attached to the signal head housing by a hinged support system that is separate from the door and lens.

   b. **Selective view signal head sections** shall conform to the requirements of Section 4.04 of the ITE Standard for Vehicle Traffic Control Signal Heads.

   c. **Pedestrian signal head sections** shall be made of plastic, nonferrous metal, or a combination thereof. Strength requirements shall conform to the ITE Standard for Vehicle Traffic Control Signal Heads except the number of sections in an assembly shall be as required to provide "Walk" and "Don't Walk" indications.

   d. **Lane use control signal head sections** shall conform to the ITE Standard for Lane Use Traffic Control Signal Heads, with the following exceptions and additions:

      (1) Strength requirements shall conform to the ITE Standard for Vehicle Traffic Control Signal Heads.

      (2) Lenses shall be made of glass.

      (3) Reflectors shall be attached to the signal head housing by a hinged support system that is separate from the door and lens.

7. **Backplates for signal heads:**

   a. **Aluminum** shall conform to the requirements of ASTM B209, alloy 5052-H38, 5154-H38, or 6061-T6, with a thickness of at least 0.050 inch.

   b. **Virgin ABS plastic** shall contain 60 percent styrene, 20 percent rubber, and 20 percent acrylic, with a thickness of at least 0.125 inch. Plastic shall contain ultraviolet inhibitors and stabilizers and shall be compounded for application in cold

weather. Plastic shall have a tensile stress at yield of at least 5,300 pounds per square inch at 73 degrees F and a flexural strength at yield of at least 9,300 pounds per square inch at 73 degrees F. Plastic shall conform to or exceed the requirements of UL-94 test H.B. for fire retardance. The color of backplates shall be impregnated into the plastic. Backplates shall be vacuum formed; the inside and outside edges shall be formed with at least a 1/2-inch flange turned away from the front surface.

8. **Cable clamps:**

   a. Two bolt clamps shall be 4 inches in length, made to accommodate span wire ranging from 1/4 to 7/16 inch in diameter, and shall conform to the requirements of NEMA PH-23 except for clamp dimensions.

   b. Three bolt clamps shall be the heavy 6-inch length type conforming to the requirements of NEMA PH-23 except the clamp dimensions shall be as required to accommodate span wire ranging from 3/8 to 5/8 inch in diameter.

9. **Cable rings and lashing wires** shall be weather resistant and the industry standard.

10. **Connectors and terminals** shall conform to the requirements of NEC 110. Breakaway connectors shall consist of line and load side sections designed to separate without breaking the conductor. Connectors shall be waterproof with an insulation rating of 600 volts. Current carrying components exposed when the connector is separated shall be in the load section of the connector. Connectors for the hot conductors shall be designed for 13/32 inch by 1 1/2 inch cartridge type fuses. Fuses shall be rated at 10 amps.

11. **Angle thimbleyes** shall conform to the requirements of REA, Item 5.

12. **Span wire saddle clamps** for span wire connection on a bridle span shall use U-bolts for securing the clamp to the span wire and shall be galvanized malleable iron with a tensile strength of 25,000 pounds.

13. **Stainless steel straps** shall be solid, with a tensile strength of at least 100,000 pounds per square inch.

14. **Service entrance heads** shall be galvanized malleable iron.

15. **Signal lamps** shall conform to the requirements of the ITE Standards for Traffic Signal Lamps.

16. **Tether wire** shall conform to the requirements of ASTM A475, Common Grade, Class A, seven strand; or Type I, General Purpose,

Class I, 6 x 7, iron, galvanized, fiber core, conforming to the requirements of FS RR-W-00410C. The breaking strength of tether cable shall be not more than 3,000 pounds.

17. **Thimbleye bolts** shall conform to the requirements of ANSI C135.4 and the following:

    a. The tensile strength shall be at least 18,350 pounds for 3/4-inch bolts.

    b. Dimensions for 3/4-inch bolts shall be in accordance with the following as related to Figures 1 and 2 in ANSI C135.4:

Bolt Diameter	A	D	E
3/4 in	13/16 in	9/32 in	11/32 in

18. **Thimbleye nuts** shall conform to the requirements of ANSI C135.4.

19. **Washers for use with thimbleye bolts** shall conform to the requirements of NEMA PH-10.

20. **Tape:**

    a. **Friction tape** shall conform to the requirements of ASTM D69.

    b. **Vinyl tape** shall conform to the requirements of ASTM D2301, Type 1.

    c. **Rubber tape** shall conform to the requirements of FS HH-T-111C.

21. **Photoelectric controls** shall conform to the requirements of ANSI C136.10 and the following. The photoelectric control shall be solid state, fail-on type, single voltage rated and shall be factory preset and calibrated to turn on at 1.5 footcandles ± 0.5 footcandle. The ratio of the turn-off light level to the turn-on light level shall not exceed 1.6. The photoelectric control shall use a cadmium sulfide sensor. The output control relay shall have a time delay of 5 to 15 seconds. The photoelectric control shall have a built in 160-joule metal oxide varistor for surge/transient protection. The contact shall be mechanical and contact “chatter” upon opening of the contacts shall not exceed 5 milliseconds. The cover shall be an impact and ultraviolet resistant material that meets the flammability and impact requirements of UL 773. The window shall be made of acrylic with the proper ultraviolet stabilizers added to prevent discoloration. The control shall be capable of withstanding a drop of 3 feet onto a concrete floor without causing damage to the housing or changing the electrical operation.

22. **Miscellaneous signal line hardware and/or attachments** shall be galvanized or stainless steel.

23. **Span wires** shall conform to the requirements of ASTM A475, High-Strength Grade, Class A.

24. **Splice kits** shall be prepackaged and shall consist of a plastic molded body with a compound that moisture seals and provides insulation for the conductor cables for at least 1,000 volts.

25. **Balance adjusters** shall be galvanized ductile iron conforming to the requirements of ASTM A536, Grade 65-45-12; aluminum conforming to the requirements of ASTM B26, alloy ZC81A; or bronze conforming to the requirements of ASTM B584, alloy C83600.

26. **Span wire clamps** for signal head mounting shall use U-bolts for securing the clamp to the span wire and shall be galvanized malleable iron or aluminum with a tensile strength of 6,000 pounds.

SECTION 239—SODIUM CHLORIDE AND CALCIUM CHLORIDE

239.01—Description.

These specifications cover chloride used as a stabilizer or to control snow and ice.

239.02—Detail Requirements.

(a) **Sodium chloride** shall conform to the requirements of AASHTO M143, Type I, with the following exceptions:

1. The sodium chloride content shall be at least 97 percent of the dry weight.

2. The moisture content shall be not more than 5 percent.

3. When shipped in bulk, sodium chloride shall contain an anticaking additive.

4. Sodium chloride will be tested in accordance with the requirements of VTM-28.

When practicable, samples will be taken at the source from indoor storage or adequately protected outdoor storage at the rate of approximately