Crest Road Asphalt Surface Treatment and Joint Sealant/Repair
Gavins Point Project

Appendix “B”

SDDOT Technical Specification

STANDARD SPECIFICATIONS FOR
ROADS AND BRIDGES

Version:
10-1-2025
SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

330 PRIME, TACK, FOG SEAL, AND FLUSH SEAL

330.1 DESCRIPTION

This work consists of preparing and treating a prepared surface with asphalt material and sand as required.

330.2 MATERIALS

Materials will conform to the following Sections:

A. Asphalt: Section 890.

B. Blotting Sand for Prime: Section 879.

C. Sand for Flush Seal: Section 879.

D. Sand for Fog Seal: Section 879.

330.3 CONSTRUCTION REQUIREMENTS

A. Weather and Seasonal Requirements:

Application will be made only during daylight hours, when the wind does not adversely affect the spraying operation and when the following conditions are met:

1. **Asphalt for Prime:** The application of asphalt for prime will be permitted only:

   a. When the ambient air and surface temperatures on the project are both at least 60°F in the shade.

   b. When conditions are dry.

   When plans call for prime on interim surfacing, the prime application will closely follow the base finishing operation and at no time will the prime operation be more than 3 miles from the base finishing operation. The cure time for the processed base, prime, and blotting sand application will be determined by the Engineer.

   Surfaces primed with cutback asphalt will be allowed to cure for a minimum of 72 hours prior to being overlaid with asphalt concrete.

2. **Asphalt for Tack:** The application of asphalt for tack will be permitted only:

   a. When the ambient air and surface temperature on the project are both at least 35°F in the shade.

   b. When conditions are dry, except emulsified asphalt may be applied when the surface is slightly damp.

3. **Asphalt for Fog Seal:** The application of asphalt for fog seal will be permitted only:

   a. When the ambient air and surface temperature on the project are both at least 60°F in the shade.

   b. When conditions are dry.

   c. Fog seal application will begin after the asphalt surface treatment is cured and will not begin prior to completing final brooming. Fog seal application will be completed no later than 7 calendar days following asphalt surface treatment application.

4. **Asphalt for Flush Seal:** The application of asphalt for flush seal will be permitted only:

   a. Between May 1 and November 1, inclusive.

   b. When ambient air and surface temperatures on the project are both at least 50°F in the shade.

   c. When the surface is dry or slightly damp.

B. Dilution of Tack, Fog Seal, and Flush Seal: Emulsified asphalt for tack, fog seal, and flush seal with a specified application rate of 0.07 gallons per square yard or less may be diluted.

The rate of dilution for tack will be at a ratio of at least 1 part emulsion to no more than 1 part added water (1:1 ratio minimum) by volume, unless otherwise approved by the Engineer.

The rate of dilution for fog seal and flush seal will be at a ratio of not more than 3 parts emulsion to 1 part added water (3:1 ratio maximum) by volume to not less than 1 part emulsion to 1 part added water (1:1 ratio) by volume, unless otherwise approved by the Engineer.

The emulsion will be uniformly mixed by adding potable water and if necessary, agitating the mixture. The amount of emulsion and any added water will be included on the ticket delivered to the project. If the emulsion is diluted, the emulsified asphalt supplier will perform the dilution.

Dilution of asphalt emulsion in the field will not be allowed unless approved by the Engineer. Field dilution of the emulsified asphalt will only be allowed when the rate of dilution is accurately controlled and reported to the Engineer. Field dilution will be performed as recommended by the emulsified asphalt supplier.

The final rate of dilution will not be less than the minimum ratio of at least 1 part emulsion to no more than 1 part added water (1:1 ratio minimum).

Diluted emulsified asphalt for tack, fog seal, and flush seal will be applied at an adjusted rate proportional to the dilution ratio resulting in application of the specified rate of emulsion. Emulsified asphalt for tack, fog seal, or flush seal with a specified rate exceeding 0.07 gallons per square yard will not be diluted.

The storage tank for diluted emulsified asphalt must utilize a recirculation system or agitator that will prevent settlement or separation of the material.

C. Equipment:

The following minimum equipment will be furnished by the Contractor.

1. Brooms:

a. Pickup Broom: In curb and gutter sections or in rural sections where a finished and maintained lawn extends to the edge of the shoulder, the Contractor must use a pickup broom with an integral self-contained storage. The pickup broom must be a minimum of 6 feet wide. The sweeping operation must remove all loose material, including loose material from the gutter.

b. Rotary Power Broom: A rotary power broom may be used in all other areas.

2. Heating Equipment: Equipment for heating the asphalt material in or at the tank car, transport truck, or distributor will be designed and constructed to heat the material without burning, scorching, or overheating, and with positive control of the heat. The introduction of steam directly into the material will not be permitted.

3. Distributors: Distributors used to apply the asphalt material will be self-propelled, equipped with pressure type mechanical circulating pumps and valves, a heating system and insulated tank, which will provide the uniform required temperature throughout the entire contents of the distributor tank. The distributor will have a capacity of at least 800 gallons. Detachable distributor units separate from the tank will not be allowed.

The distributor will uniformly apply the heated asphalt material to the road surface in accurately measured quantities and maintain the specified rate of application during the distribution of the entire tank-load, regardless of change in gradient, superelevation, direction, or content level in the tank. Calibration runs for verification will be made at the start of the work.

The spray nozzles will be designed, sized, and arranged to ensure uniform distribution of heated asphalt material at the designated rate, in an overlapping fan shaped spray without surge, streaks, ridges, or bare spots. A strainer will be provided in the discharge line to prevent nozzles from clogging. The output of each and every nozzle on the bar will be the same and a test will be made, in advance of use to determine compliance with this requirement. Different sizes, heights, pressures, and settings of nozzles for different designated rates will be provided.

The distributor will be equipped with a tachometer, clearly visible to the operator, which accurately shows the speed in feet per minute.

Pressure metering distributors will be furnished with an accurate pressure gauge showing the distribution pressure. Volume metering distributors will be furnished with a pump tachometer or meter showing the volume furnished. The distributor will include an accurate, mercury actuated thermometer showing the temperature of the material in the tank and a contents gauge showing the number of gallons in the tank at any content level.

The distributor will be equipped with adjustable spray bars arranged so the application width will be available in 2 foot intervals.

The distributor spray bars will be capable of operating at a constant controlled height and will be of the full circulating type. Each nozzle of the distributor bar will be equipped with a cutoff valve, which immediately stops the flow without dripping. Compliance with these requirements must be proven before the distributor can be used.

D. Surface Preparation: The surface will be thoroughly swept and cleaned of all foreign material. Appurtenances immediately adjacent to the surface to be treated will be protected from the splatter of asphalt. Manhole covers, water shut valves, and other utility access points will be covered to ensure liquid asphalt is not applied to them, as directed by the Engineer. Surfaces to receive a prime coat will be satisfactorily compacted and cured.

E. Application of Asphalt: During application the temperature of the asphalt will be maintained within the temperature range furnished by the asphalt supplier. Asphalt will be applied by a pressure distributor in a uniform and continuous manner. Coverage will be made to the satisfaction of the Engineer.

Unauthorized increases in rate of application will not be eligible for payment.

The angle of the spray nozzles and the height of the spray bar will be set to obtain uniform distribution. The distributor will travel at the established speed when the spray bar is opened. Areas inaccessible to the distributor will be covered by hand spray methods. When the distributor is not in operation, it will be parked off the roadbed or drip pans will be placed under the spray bar.

The tack coat will be allowed to break (turn from brown to black) and will be allowed a cure period, as determined by the Engineer, ahead of mat laydown. Tack application ahead of mat laydown will be limited by job conditions and will not exceed the amount estimated for the current day's operation. Tacked areas, which become unsatisfactory as a result of traffic, weather, or other conditions, will be retacked. Required retacking which is not the fault of the Contractor will be paid for at the contract unit price for tack asphalt.

F. Application of Sand: Blotting of prime will be accomplished by broom sweeping or spreading sand on the primed surface with a mechanical spreader. Hand spreading will be permitted on odd shaped or inaccessible areas. Application of sand will not be permitted until the prime has set for at least 24 hours, unless otherwise directed by the Engineer.

The fresh application of asphalt for flush seal will be covered with a uniform spread of sand immediately behind the distributor. The sand will be placed by a self-powered aggregate spreader with positive controls or other equipment acceptable to the Engineer. The sand will be placed uniformly on the asphalt application. Rolling will not be required. The finished surface will be smooth riding without transverse or longitudinal ridges and will present a uniform satisfactory appearance. Bleeding areas will be resanded. Rough and nonuniform areas will be corrected.

When applying fog seal coats, a light application of sand may be ordered by the Engineer to prevent material pick up. If ordered, the sand will be placed by a self-powered aggregate

spreader with positive controls or other equipment acceptable to the Engineer. The sand will be placed uniformly on the asphalt application. Rolling will not be required. The finished surface will be smooth riding without transverse or longitudinal ridges and will present a uniform satisfactory appearance. Bleeding areas will be resanded. Rough and nonuniform areas will be corrected.

The loose sand material remaining on the surface will be lightly broomed off after a waiting period of twenty-four hours from the time of application or as otherwise directed by the Engineer. Excess material in curb and gutter sections will be broomed towards the gutter and will be picked up and disposed of by the Contractor.

Unauthorized increases in rate of application will not be eligible for payment.

G. Temporary Traffic Control: The Contractor will provide flaggers, signs, and barriers to warn, direct, and prevent traffic from traveling on the freshly applied asphalt until it has penetrated, and does not track or pickup on the tires of traveling vehicles or the surface has been blotted with sand. Temporary traffic control will conform to Section 634.

330.4 METHOD OF MEASUREMENT

A. Asphalt: Asphalt will be measured to the nearest 0.1 ton.

B. Blotting Sand for Prime: Blotting sand for prime will be measured to the nearest 0.1 ton.

C. Sand for Flush Seal: Sand for flush seal will be measured to the nearest 0.1 ton.

D. Sand for Fog Seal: Sand for fog seal will be measured to the nearest 0.1 ton.

330.5 BASIS OF PAYMENT

A. Asphalt: Asphalt will be paid for at the contract unit price per ton complete in place. Separate payment will not be made for water for dilution of emulsified asphalt.

B. Blotting Sand for Prime: Blotting sand for prime will be paid for at the contract unit price per ton complete in place. Payment will be full compensation for furnishing, installing, and all incidentals required to complete the work.

C. Sand for Flush Seal: Sand for flush seal will be paid for at the contract unit price per ton complete in place. Payment will be full compensation for furnishing, installing, and all incidentals required to complete the work.

D. Sand for Fog Seal: Sand for fog seal will be paid for at the contract unit price per ton complete in place. Payment will be full compensation for furnishing, installing, and all incidentals required to complete the work.

350 ASPHALT CONCRETE CRACK SEALING

350.1 DESCRIPTION

This work will consist of routing and sealing transverse and longitudinal cracks in an asphalt concrete roadway surface with the specified sealant.

350.2 MATERIALS

Asphalt concrete crack sealant will conform to Section 871.

350.3 CONSTRUCTION REQUIREMENTS

A. Routing

1. Routing equipment will be mechanical, power driven, and capable of cutting a reservoir to the required dimensions. Equipment designed to plow the cracks to dimension will not be permitted.

2. Cracks which are less than 3/4 inch in width or depth will require routing to a width and depth of 3/4 to 7/8 inch.

3. Cracks which are 3/4 inch or greater in width and depth will not require routing but will be thoroughly cleaned of foreign material to a depth equal to the width of the crack.

4. The walls of the finished reservoir will be vertical, and the reservoir bottom will be flat.

5. Routing will not be allowed when the roadway is wet.

B. Cleaning

1. Cleaning will be accomplished with an air compressor producing a minimum of 125 cubic feet per minute output and equipped with a maximum 3/4 inch nozzle. The air compressors will be equipped with traps capable of removing all free water and oil from the compressed air.

2. Reservoirs and cracks will be thoroughly cleaned of dust, dirt, and loose materials so the reservoir is clean and dry at the time the blocking medium or sealant is applied.

3. If a routed reservoir or crack is left overnight, the reservoir will be re-cleaned immediately before the blocking medium or sealant is applied.

4. The routed asphalt concrete and foreign material resulting from the reservoir preparation will be removed from the roadway surface before an area is opened to traffic.

C. Sealing

1. Cracks 3/8 inches or greater in width, which exist below the routed and cleaned reservoir, will be filled with a blocking medium to ensure a nominal sealant depth equal to the width of the reservoir.

2. Sealant material will be placed within 72 hours of routing.

3. There will be no visible signs of moisture on the roadway surface or in the reservoir at the time the sealant is applied.

4. The sealant handling, mixing, and application temperature restrictions will conform to the manufacturer's recommendations.

5. Sealant will be applied with a pressure type applicator.

6. When applying the sealant on all transverse cracks and any longitudinal cracks that are located more than 12 inches from a lane line, the reservoir will be overfilled and squeegeed to provide a film of sealant on the roadway surface 1 to 2 inches on both sides of the reservoir. When applying the sealant on longitudinal cracks that are located within 12 inches of a lane line, the reservoir will be overfilled and squeegeed to provide a film of sealant on the roadway surface up to 1 inch on both sides of the reservoir.

7. The squeegee will be a "U" shaped device which will produce a full, uniform, and neat appearing reservoir and adjoining surface area. Other type devices will require prior approval by the Engineer.

8. A blotting material, such as toilet tissue, or an approved de-tacking agent will be placed over the sealant material immediately after placement at intersections, superelevated curves, urban areas, grades steeper than 4%, and other locations specified on the plans. Blotting material or an approved de-tacking agent will be required when traffic is allowed to cross a sealed area before track free status has been achieved.

9. The Contractor will repair or refill, at the Contractor's expense, any part of a sealed reservoir damaged by traffic.

D. Seasonal and Temperature Limitations

1. Routing and sealing of asphalt concrete surfaces will be permitted only during daylight hours between April 1 and June 30 (inclusive) and between August 15 and November 30 (inclusive).

2. Application of the sealant material will only be allowed when the pavement surface temperature is at least 35°F and rising.

3. Application of the sealant material will only be allowed when the ambient air temperature is between 40°F and 85°F.

4. Application of the sealant material will only be allowed when the relative humidity is less than 75%.

E. General

1. Only one-half of the roadway will be worked on at a time unless a traffic control plan to work full width is submitted by the Contractor and approved by the Engineer.

2. Routing and crack sealing will be considered as one work zone. A work zone will not exceed 2 miles in length at any one time.

350.4 METHOD OF MEASUREMENT

Asphalt concrete crack sealing will be measured by the pound of sealant used. The manufacturer's weight of the sealant will be accepted as the basis for measurement.

Quantities of asphalt concrete crack sealing with a manufacturer’s unit weight in excess of the specified unit weight will be reduced to the specified maximum unit weight prior to measurement for payment.

350.5 BASIS OF PAYMENT

Asphalt concrete crack sealing will be paid at the contract unit price per pound and will be full compensation for routing and for furnishing, heating, placing, and blotting the sealant. Blocking medium will be incidental to the asphalt concrete crack sealing. Traffic control will be paid at the contract unit price.

360 ASPHALT SURFACE TREATMENT

360.1 DESCRIPTION

This work consists of an application of asphalt covered with a spread of cover aggregate.

360.2 MATERIALS

A. Asphalt: Asphalt will conform to Section 890.

B. Cover Aggregate: Cover aggregate will conform to Section 881.

360.3 CONSTRUCTION REQUIREMENTS

A. Weather and Seasonal Requirements: Surface treatment operations will be permitted only during daylight hours, when conditions are dry, when wind does not adversely affect the spraying operation, and when overnight low air temperatures within 24 hours of the planned application are forecasted to be at least 45°F.

Minimum temperatures and seasonal limitations are as follows:

Minimum Temperature and Seasonal Limitations		
Cover Aggregates	**Air and Surface Temperature (in the shade and rising)**	**Seasonal Limitations (dates are inclusive)**
Type 1	60°F	May 15 – Aug. 31
Type 2	60°F	May 15 – Aug. 31
Type 3	60°F	May 15 – Sept. 15

B. Equipment: The following equipment will be furnished:

1. Broom:

a. Pickup Broom: In curb and gutter sections or in rural sections where a finished and maintained lawn extends to the edge of the shoulder, the Contractor will use a pickup broom with an integral self-contained storage. The pickup broom must be a minimum of 6 feet wide. While sweeping in curb and gutter sections, the sweeping operation must remove all loose material, including loose material from the gutter.

b. Rotary Power Broom: A rotary power broom may be used in all other areas.

2. Equipment for heating and applying the asphalt conforming to the requirements of Section 330.3 C.

3. A self-propelled aggregate spreader, with positive controls capable of depositing the required quantity of aggregate uniformly over the full width of the asphalt application.

4. A minimum of four self-propelled pneumatic smooth tired rollers for each spreader in use. Each roller will completely cover an overall surface width of at least 60 inches and furnish a minimum uniform rolling weight (mass) of 250 pounds per of rolling width.

C. Cover Aggregate Preparation: Following production of the cover aggregate stockpile and at least 14 calendar days prior to starting the asphalt surface treatment, the Contractor will submit a sample of the cover aggregate to the asphalt supplier for evaluation of compatibility and design of the surface treatment. Prior to starting the surface treatment, the Contractor will submit a copy of the compatibility test results and the asphalt surface treatment design from the asphalt supplier to the Engineer and the Department's Bituminous Engineer.

The Contractor will notify the Area Office a minimum of 5 calendar days prior to sampling and submitting the cover aggregates. Satisfactory quality test results for the cover aggregate will be obtained prior to use on the project.

D. Surface Preparation: The surface will be thoroughly swept and cleaned of all foreign material. Appurtenances immediately adjacent to the surface to be treated will be protected from the splatter of asphalt. The Contractor will repair any damage to the satisfaction of the Engineer at no additional cost to the Department. Manhole covers, water shut valves, and other utility access points will be covered to ensure liquid asphalt is not applied to them, as directed by the Engineer. The methods used for covering will be removed after completion of the final asphalt surface treatment application. Freshly primed bases will be cured prior to the application of surface treatments.

The Contractor will ensure transverse rumble strips are not damaged or otherwise modified to lose their functionality during the application of the surface treatment. The Contractor will only apply a fog seal to the rumble strips. The Contractor will repair any damage or loss of functionality of rumble strips to the satisfaction of the Engineer at no additional cost to the Department.

E. Application of Asphalt: The asphalt will be maintained within a temperature range of 120°F to 180°F during application. Asphalt will be applied by a pressure distributor in a uniform and continuous manner.

Unauthorized increases in the asphalt application rate will not be eligible for payment.

The angle of the spray nozzles and the height of the spray bar will be set to obtain uniform distribution. When starting and stopping emulsion application, a strip of building paper or other suitable material, at least 3 feet in width and at least 1 foot longer than the width of the spray bar, will be used to prevent a double application of emulsion. The distributor will travel at the established speed when the spray bar is opened. Skipped areas and deficiencies will be immediately corrected. Areas inaccessible to the distributor will be satisfactorily covered by hand spray methods.

Spraying operations will not proceed when it is evident the asphalt spread will not be covered with aggregate and rolled all in accordance with the prescribed schedule.

F. Application of Cover Aggregate: Cover aggregate will be spread immediately following application of all rapid-setting emulsions. For wind conditions of 5 miles per hour or less, the cover aggregate will be spread within 5 minutes of the application of the medium-setting emulsion. For wind conditions greater than 5 miles per hour, the time may be reduced in the field to ensure the aggregate is applied before the medium setting emulsion breaks. Time

limits for spreading of cover aggregate when using medium-setting emulsions will be adjusted as directed to satisfy project conditions. The aggregate will be applied before the emulsion begins to break (emulsion still brown in color).

A complete aggregate coverage will be continually maintained. A strip of asphalt application approximately 6 inches wide for a double overlap spray bar or 8 inches wide for a triple overlap spray bar, along that side of the spread forming a longitudinal joint with the adjacent spread will be left uncovered. The adjacent asphalt and cover aggregate application will overlap this strip. In lieu of this procedure a butt joint may be constructed using special end nozzles.

Longitudinal joints, other than at centerline, will not be permitted within the center 24 feet unless otherwise approved by the Engineer.

When loading trucks, the Contractor will screen the cover aggregate to minimize segregation, eliminate oversize, reduce aggregate dust, and effectively break up or discard material bonded into chunks. At the discretion of the Engineer, if the cover aggregate does not prove the need for screening, the screening requirement may be waived provided all test results and visual inspections produce satisfactory results. If segregation, oversize material, excessive dust, or material bonded into chunks becomes evident during cover aggregate placement, the Contractor will immediately resume screening of the cover aggregate. When required, aggregate will be uniformly moistened before or during loading.

Unauthorized increases in application rates will not be eligible for payment.

Prior to rolling, the contractor may be directed to adjust inequalities in the spread of Type 3 cover aggregate with a drag broom.

G. Rolling: Rolling will begin immediately behind the spreader and will consist of four complete coverages using pneumatic tired rollers. A complete coverage is defined as rolling full width in one direction. The rolling will be completed within 40 minutes after the cover aggregate is applied. Rollers will be operated in unison at a close interval, and if the width of spread allows, in a staggered formation. Rollers will not be operated at a speed in excess of 5 miles per hour. Asphalt and cover aggregate applications will not extend more than 1/2 mile beyond the rolling operation. With the use of minimum specified equipment, the project will be completed in 1/2 mile increments, except for the sweeping of excess cover aggregate. The weight and tire pressures of the rollers will be varied as directed to obtain optimum embedment of the cover material without undue crushing of the aggregate. Special attention will be given to the transverse and longitudinal joints during rolling. Unsatisfactory joints will be corrected without additional compensation. Turning of rollers on the freshly treated surface is prohibited. Rolling at night or when light conditions would create a traffic hazard will not be allowed.

H. Traffic Control: Construction operations will be coordinated to minimize traffic delays. One-way traffic will be maintained during application of the surface treatment on driving lanes. Upon completion of rolling, traffic will be permitted to travel on the treated surface. Traffic will be controlled by pilot cars and flaggers during application of the surface treatment on driving lanes with the speed of pilot cars not to exceed 20 miles per hour on the freshly applied surface treatment for a period of at least 1 hour after application or until the asphalt surface

treatment is sufficiently cured. Prior to moving the pilot car operation from the section of roadway, the Contractor will perform initial brooming in accordance with Section 360.3 I.

The width, arrangement, and sequence of the parallel application strips will not unduly inconvenience traffic.

I. Brooming: In curb and gutter sections and in areas where a finished and maintained lawn extends to the edge of the shoulder, the loose material will be swept up with a pickup broom. The pickup broom must be a minimum of 6 feet wide. The sweeping operation must remove all loose material, including loose material from the gutter. Brooming the material into a pile with a rotary broom for pickup will not be allowed. In sections without curb and gutter and in areas where a finished and maintained lawn does not extend to the edge of the shoulder, the loose material may be swept onto the roadway inslopes, as approved by the Engineer.

Broomed off material picked up by the Contractor will be disposed of at sites provided by the Contractor and approved by the Engineer.

1. **Initial Brooming:** The Contractor will perform initial brooming while traffic is maintained as described in Section 360.3 H. Initial brooming will consist of a light brooming of the surface to remove loose chips. The initial brooming will not cause damage to the asphalt surface treatment. If initial brooming causes damage to the asphalt surface treatment, the Engineer, in the Engineer's discretion, may require the Contractor to alter the initial brooming operation or to waive the initial brooming requirement.

2. **Final Brooming:** The Contractor will perform final brooming during a cool period of the following morning, within 24 hours of application, to remove all loose material remaining on the surface. The brooming will include the entire surface of the asphalt surface treatment application, additional lane widths, intersections, and shoulders.

J. Maintenance and Repair: Areas of the surface treatment, which peel or are otherwise unsatisfactory, will be repaired with additional asphalt, cover aggregate, and rolling. Compensation for repairs due to causes beyond the control of the Contractor will be paid at the contract unit price for asphalt surface treatment.

The finished surface treatment will be uniform and smooth riding. Transverse or horizontal ridges, raveled spots, wheel marks, depressions, abrupt color changes, and other inequalities will be corrected. Payment will not be made for this correction work.

Asphalt splattered on roadway appurtenances will be satisfactorily cleaned off by the Contractor.

360.4 METHOD OF MEASUREMENT

A. Asphalt for Surface Treatment: Asphalt for surface treatment will be measured to the nearest 0.1 ton.

B. Cover Aggregate: Cover aggregate will be measured to the nearest 0.1 ton.

360.5 BASIS OF PAYMENT

A. Asphalt for Surface Treatment: Asphalt for surface treatment will be paid for at the contract unit price per ton.

B. Cover Aggregate: Cover aggregate specified will be paid for at the contract unit price per ton. Payment will be full compensation for furnishing, installing, and all incidentals required to complete the work.

633 PAVEMENT MARKING

633.1 DESCRIPTION

This work consists of furnishing and applying pavement marking materials and surface grooving of Portland cement concrete pavement or asphalt concrete pavement.

633.2 MATERIALS

Materials will conform to the following Sections:

A. Cold Applied Plastic Pavement Markings and Legends: Section 983.

B. Paint: Section 980.

C. Glass Beads: Section 981.

633.3 CONSTRUCTION REQUIREMENTS

A. Cold Applied Plastic Pavement Marking and Legends:

1. **Prefabrication:** Prefabricated legends and symbols will conform to the applicable shapes and sizes as outlined in the current edition of the MUTCD.

2. **Width Tolerance:** Width will be as specified with a tolerance of ±1/8 inch.

3. **Surface and Air Temperature:** The surface will be 70°F minimum, and ambient air temperature of 60°F minimum and rising, at a season when daily highs are above 70°F and lows are above 40°F. If the manufacturer's recommendations allow for installation at temperature below the minimum required by this section, the Contractor may install the material in accordance with the manufacturer's recommendations, including any additional adhesives.

4. **Pavement Condition:** Pavement must be dry and free of dirt, dust, and oily substances.

5. **Application Instructions:** The manufacturer will supply proper application instructions and will identify activators and adhesives which are to be used. An adhesive activator supplied by the manufacturer will be utilized on applications of this material, except on newly installed asphalt when the surface temperature is 80°F or above. A copy of the application instructions will be provided to the Engineer prior to use. The plastic markings will be manufactured and packaged in a manner, which will permit storage at normal temperatures for up to one year after purchase.

6. **Lane Lines:** Lane lines will not be placed over a longitudinal pavement joint and will not be installed closer than 1½ inches from the joint. Lane lines will not deviate more than 1 inch per 200 feet, nor will any deviations be abrupt.

7. **Bonding:** To ensure a uniform bond of material to asphalt or concrete surfaces after initial laydown, rolling of the material with a truck wheel, car wheel, or heavy hand roller in accordance with the manufacturer's recommendations is required.

8. **Molding and Sealing:** The material will mold to the pavement contours, breaks, and faults by the action of traffic. The material will have resealing characteristics, which enable the material to fuse with itself and with previously applied marking materials of the same composition without externally applied tackifiers or adhesives.

9. **Waste Disposal:** It will be the responsibility of the Contractor to provide for disposal of empty material cartons, liner papers, and other waste.

B. Pavement Marking Paint and Beads: Pavement marking paint will be applied by machine. On special areas and markings that are not adaptable to machine application, hand application will be permitted.

The paint will be used as furnished by the manufacturer. Thinner or diluent will not be added. The paint will be thoroughly mixed in the original container before it is transferred to the tank of the spraying equipment. Filling tanks, pouring paint, or cleaning of equipment will not be allowed on the pavement.

The pavement marking will be applied during daylight hours when the ambient air temperature is above 40°F and the road surface is dry. The pavement will be cleaned of dirt, loose stones, and other foreign material before the paint is applied.

The paint applicator will be a self-propelled spraying machine. The paint applicator will be capable of applying marking materials in a solid and intermittent line pattern, according to the details in the plans. The equipment will be capable of placing lines on the left and right sides with each line in a solid or intermittent pattern and each gun applying 4 to 8 inches wide. The left carriage will simultaneously place a dashed marking, a solid marking and a dashed marking, or two solid markings as detailed in the plans. The paint will be applied at a maximum speed as recommended by the paint applicator manufacturer and will not exceed 13 miles per hour. The paint applicator will be capable of applying glass beads in a pressurized system, synchronized with the spray guns, uniformly across the entire painted line. All guns on the spray carriages will be in full view of the operator during operation.

The equipment in the striping train will be capable of displaying a left or right Type C sequential chevron. The Type C sequential chevrons will meet current MUTCD standard for minimum size, legible distance, number of elements and other specifications. All traffic control items that are mounted on the equipment will be incidental to the other contract items. No separate payment will be made.

During pavement marking operations on sections of roadway open to traffic, the Contractor will protect the markings from tracking either by placing suitable traffic control devices or by utilizing a shadow vehicle. The work will be arranged such that half of the traveled roadway will be open to traffic at all times.

The Contractor will take the steps necessary to ensure that the permanent pavement markings will match the markings on the existing surface.

Tolerances:

1. The length of the painted line will not vary more than plus or minus 3 inches from the plans requirement.

2. The width of the painted line will not vary more than plus or minus 1/2 inch from the plans requirement.

3. The length of a 40 foot cycle length consisting of a 10 foot dashed line and a 30 foot gap will not vary more than 3 inches.

4. The alignment from the plans requirement or existing markings will not vary more than plus or minus 2 inches.

5. The maximum longitudinal deviation from the existing markings at either end of the painted roadway segment will not vary more than plus or minus 6 inches.

6. Lane lines will not deviate more than 1 inch per 200 feet, nor will any deviations be abrupt.

The Contractor may be required to remove and replace pavement markings not meeting the specifications and tolerances at no additional expense to the Department. Removal methods will minimize damage to the surface and will be approved by the Engineer

The Contractor will apply the pavement marking paint, glass beads, and bonded core reflective elements (if required) at the rates specified in the plans. Restriping of pavement markings to meet this requirement and to provide a quality retroreflective line will be at the expense of the Contractor with no additional cost to the Department. Sections to be restriped will be determined by the Engineer.

The paint will be capable of being applied at a paint temperature up to 160°F. When applied with glass beads at pavement temperatures above 45°F and at a relative humidity of up to 75%, the paint will dry to a no-track condition within 3 minutes.

C. **Grooving for Cold Applied Plastic Pavement Marking:** The equipment will be capable of performing uniform grinding for alignment and depth.

The grooving will be performed by a self-propelled machine equipped with gang mounted specially prepared circular diamond blades on a turning head. The equipment will be capable of grooving the total width of the groove in one pass or be capable of grooving uniform depths with multiple passes. The equipment will be capable of grooving double lines simultaneously or parallel lines to a uniform depth with two passes.

If damage to joints, joint sealant material, backer rod, etc. occurs, the grooving operation will be stopped, and modifications will be made to the grooving operation to prevent further damage. Damage caused to joints, the joint sealant material, backer rod, etc. will be repaired or replaced by the Contractor, as directed by the Engineer. No additional payment will be made for the repair work or any reapplication of the pavement marking in the area of the repair.

The bottom of the groove will be uniform and free of loose material. The groove will be flat and of uniform depth for the entire width of the groove.

The grooving will be performed within the following specifications and tolerances:

Description	Specification	Tolerance
Depth of Groove	Marking Thickness + 15 mils	+ 5 mils
Width of 4 inch Groove	4½ inches	± 1/8 inch
Width of 6 inch Groove	6½ inches	± 1/8 inch
Width of 8 inch Groove	8½ inches	±1/8 inch
Width of 12 inch Groove	12½ inches	±1/8 inch
Width of 24 inch Groove	24½ inches	± 1/8 inch
Length of Skip Lines	10 foot 6 inches	± 3 inch
Tapers at ends of lines	6 to 9 inches	
Between Double Lines	4 inches	± 1/2 inch

The grooving alignment and straightness tolerances will be the same as required for the cold applied plastic pavement marking as specified in Section 633.3 A.6.

If the groove is exposed to traffic or adverse weather conditions overnight, the Contractor will sand blast the groove prior to priming and applying tape.

Existing grooves not meeting the required depth will be re-grooved to the required depth. In areas where the existing groove meets the required depth and existing markings are still in place, the Contractor will remove the existing marking by light grinding or sand blasting or both. The grooving, light grinding, and sand blasting operations will provide the surface preparation required for the application of the new cold applied plastic pavement markings.

633.4 METHOD OF MEASUREMENT

A. Cold Applied Plastic Pavement Marking: Cold applied plastic pavement marking, of the width and color specified, will be measured by the foot.

B. Cold Applied Plastic Pavement Marking Arrow: Cold applied plastic pavement marking arrow will be measured by count of each type specified.

C. Cold Applied Plastic Pavement Marking Message: Cold applied plastic pavement marking message will be measured by count of each complete word specified.

D. Cold Applied Plastic Pavement Marking Area: Cold applied plastic pavement marking area, of the color specified, will be measured to the nearest square foot.

E. Pavement Marking Paint, Beads, and Elements: Paint, beads, and elements will be measured by the foot, square foot, each, or gallon of paint depending on the unit designated by the contract quantity.

F. Grooving for Cold Applied Plastic Pavement Marking: Grooving for cold applied plastic pavement marking will be measured to the nearest foot, along the length of the groove for the width of grooving specified in the plans.

G. Grooving for Cold Applied Plastic Pavement Marking Arrow: Grooving for cold applied plastic pavement marking arrow will be measured by the count of each arrow type specified.

H. Grooving for Cold Applied Plastic Pavement Marking Message: Grooving for cold applied plastic pavement marking message will be measured by the count of each complete word specified.

I. Grooving for Cold Applied Plastic Pavement Marking Area: Grooving for cold applied plastic pavement marking area will be measured to the nearest square foot.

633.5 BASIS OF PAYMENT

A. Cold Applied Plastic Pavement Marking: Cold applied plastic pavement marking of each width specified, will be paid for at the contract unit price per foot. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

B. Cold Applied Plastic Pavement Marking Arrow: Cold applied plastic pavement marking arrow of the type specified will be paid for at the contract unit price per each. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

C. Cold Applied Plastic Pavement Marking Message: Cold applied plastic pavement marking message will be paid for at the contract unit price per each word. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

D. Cold Applied Plastic Pavement Marking Area: Cold applied plastic pavement marking area will be paid for at the contract unit price per square foot. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

E. Pavement Marking Paint, Beads, and Elements: Payment for paint, beads, and elements will be by the foot, square foot, each, or gallon for each type of pavement marking. Payment will be full compensation for furnishing paint, beads, and elements (if required) and for labor, equipment, and incidentals necessary.

F. Grooving for Cold Applied Plastic Pavement Marking: Grooving for cold applied plastic pavement marking will be paid for at the contract unit price per foot for the width of groove specified. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

G. Grooving for Cold Applied Plastic Pavement Marking Arrow: Grooving for cold applied plastic pavement marking arrow will be paid for at the contract unit price per arrow type specified. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

H. Grooving for Cold Applied Plastic Pavement Marking Message: Grooving for cold applied plastic pavement marking message will be paid for at the contract unit price per each word specified. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

I. Grooving for Cold Applied Plastic Pavement Marking Area: Grooving for cold applied plastic pavement marking area will be paid for at the contract unit price per each square foot.

Payment will be full compensation for equipment, labor, materials, and all incidentals required.

634 TEMPORARY TRAFFIC CONTROL

634.1 DESCRIPTION

This work consists of furnishing, installing, and maintaining required temporary traffic control devices in accordance with the current edition of the MUTCD.

634.2 MATERIALS

Traffic and traffic control devices will conform to and be maintained in accordance with the requirements of Section 984 and Part 6 of the MUTCD.

Traffic control devices are categorized by their intended use and certification requirements.

- Category I traffic control devices are lightweight devices which may be self-certified by the manufacturer including, but not limited to; cones, drums, and delineators.
- Category II traffic control devices are other lightweight devices which must be certified by individual crash testing including, but not limited to; portable signs and barricades.
- Category III traffic control devices are fixed or other massive devices which must be certified by individual crash testing including, but not limited to; breakaway sign supports, concrete barriers, concrete barrier end protection, crash cushions, truck mounted attenuators, and longitudinal barriers.
- Category IV traffic control devices are trailer mounted devices which are not required to be individually crash tested including, but not limited to; portable changeable message signs, arrow boards, portable temporary traffic signals, and work area lighting.

Category I, II, and III traffic control devices will meet the crashworthy requirements of test level 3 of National Cooperative Highway Research Program (NCHRP) Report 350 or AASHTO Manual for Assessing Safety Hardware (MASH). Category IV traffic control devices will be delineated with retroreflective traffic control devices.

Prior to use, the Contractor will provide documentation for all traffic control devices used. The documentation will show the traffic control devices used meet the applicable NCHRP 350 or MASH requirements.

Retroreflective sheeting material used on traffic control devices will conform to Section 984.

Paint used for temporary pavement marking will be in accordance with Section 980.1 A.

Glass beads will be used to reflectorize the temporary traffic paint. The glass beads will conform to the requirements of Section 981.

Pilot Cars will conform to Section 984.

Temporary pavement marking tape will conform to Section 984.

Signal heads will meet the requirements of Section 985.

Warning lights will meet the requirements of Section 984.

634.3 CONSTRUCTION REQUIREMENTS

A. General: The Contractor will furnish, install, and maintain required traffic control devices and pavement marking material.

1. All traffic control devices will be kept in proper position, clean, and legible at all times. Damaged devices will be replaced within 24 hours, or as directed by the Engineer.

2. Non-applicable traffic control devices will be completely covered or removed during periods of inactivity.

3. Traffic control devices will be immediately removed or covered when the need for such devices no longer exists. When devices are no longer needed, they should be stored off the project or as close to the right-of-way line as possible.

4. Vehicles and equipment will be stored outside the clear zone and as near as possible to the right-of-way line. Contractor's employees should mobilize at a location off the right-of-way and arrive at the work site in a minimum number of vehicles necessary to perform the work.

5. Traffic approaching the project from intersecting roadways, streets, and approaches must be adequately accommodated. Major intersections and large commercial entrances may require additional signing, flaggers, and channelizing devices on a temporary basis until work activities pass these areas.

6. Unless otherwise stated, hours of darkness are defined as 1/2 hour after sunset until 1/2 hour before sunrise.

B. Apparel: All workers within the right of way who are exposed either to traffic (vehicles using the highway for purposes of travel) or to construction equipment within the work area will wear high-visibility safety apparel intended to provide conspicuity during both daytime and nighttime usage, and meeting the Performance Class 2 or 3 requirements of the ANSI/ISEA 107 publication entitled "American National Standard for High-Visibility Safety Apparel and Headwear" or equivalent revisions.

Workers will wear a vest, shirt, or jacket as an outer garment with a background color of fluorescent yellow-green, fluorescent orange-red, or fluorescent red. The retroreflectorized portion of the material will be orange, yellow, white, yellow-green, or silver.

C. Flagging: The Contractor will provide each flagger with a copy of the "Flagger Manual". These manuals are available from the Department. Standards for flaggers and flagging practices will conform to Part 6 of the MUTCD and the flagger manual.

The Contractor will furnish certified flaggers to perform project traffic control. The minimum age for flaggers will be 18 years old. Flagger training and certification is available at some Department Area offices and from the Associated General Contractors (AGC). All flaggers will complete a flagger training course and pass a written test to become certified. Flagger certification is valid for a period of 2 years. All flaggers will be certified in South Dakota prior

to flagging on the project. Flaggers will carry proof of certification while flagging on Department projects.

Flagger workstations will be illuminated during hours of darkness. Flagger workstations will be illuminated with a minimum of 108 lux (10 foot candles) of illumination. The Contractor will perform a drive-through after dark to check for glare from the driver's perspective and make adjustments necessary to eliminate or reduce the glare to the satisfaction of the Engineer.

Flaggers will be equipped with a STOP/SLOW sign for the control of traffic. The sign should be mounted on a staff from 5 to 7 feet long, from the bottom of the sign to the ground. All flagging devices and the use of such devices will comply with Part 6 of the MUTCD, unless otherwise specified.

D. Pilot Car: Pilot cars and pilot car practices will conform to Part 6 of the MUTCD.

E. Traffic Control, Miscellaneous:

On unfinished grades until gravel is in place, the Contractor will place reflectorized devices (cones, drums, or vertical panels back-to-back) defining the outside edge of the road. The Contractor will place the devices at 264 feet maximum spacing on tangents and at 132 feet maximum spacing on curves (greater than 3 degrees). The devices are required at all times during nighttime hours and only at locations where grading work is not active during daytime hours.

1. **Channelizing Devices:** Channelizing devices will be reasonably plumb to the pavement, safely and neatly ballasted as needed, clearly visible, and legible.

   Additional requirements for the use of specific channelizing devices are as follows:

   a. **Cones:** No additional requirements.

   b. **Barricades:**

      1) **Type 1 Barricades:** Type 1 barricades are for use on roads with normal posted speeds of 40 mph or less. Type 1 barricades may also be used on higher speed roads provided the reflective area of the upper rail is at least 2 square feet.

      2) **Type 2 Barricades:** No additional requirements.

   c. **Tubular Markers:** Tubular markers will not be used in lane closure tapers.

   d. **Vertical Panels:** No additional requirements.

   e. **Direction Indicator Barricades:** No additional requirements.

   f. **Drums:** No additional requirements.

2. **Delineators:** Delineators will conform to Section 632.

3. **Warning Lights:** When used in conjunction with signs, barriers, and channelizing devices; the warning light will conform to Part 6 of the MUTCD.

   Vehicles and equipment working in traffic or alongside traffic will be equipped with a flashing amber light visible from all directions at a minimum distance of 1/2 mile. The amber light will be mounted on the uppermost part of the Contractor's vehicle. Lights must flash at 75 ±15 flashes per minute. Vehicle flasher/hazard lights are not acceptable.

4. **Shadow Vehicles:** Shadow vehicles will conform to Part 6 of the MUTCD. Shadow vehicles will be used as specified in the plans and for brooming operations unless otherwise directed. Shadow vehicles will be a four-wheel motor vehicle with a flashing amber light. No separate payment will be made for shadow vehicles and any signs, warning lights, or other items associated with the shadow vehicles.

5. **Inspection:** The Contractor will constantly monitor and maintain all traffic control items. The Contractor is responsible for adjustments of traffic control items when traffic conditions change.

   The Contractor will make weekly inspections after dark to verify the overall traffic control system is adequate and all devices are legible at night. This includes detour route signing. The weekly inspections will begin when the first traffic control sign or device is put into operation and end when the last traffic control sign or device is removed from operation.

   The Contractor will designate an employee whose primary responsibility is the maintenance of traffic and traffic control devices, 24 hours a day, 7 days a week. The person so designated must have training and experience in the field of construction traffic control and be knowledgeable about the MUTCD. The employee selected must be approved by the Engineer. The name, phone number, and location of the person(s) will be provided to the Department, SD Highway Patrol, county sheriff's office, and the local city police department.

   The person so designated will submit a written report weekly to the Engineer. The reports will document the daytime and weekly night time inspections.

F. Type 3 Barricades: Type 3 barricades will conform to Part 6 of the MUTCD.

G. Flexible Delineators: Flexible delineators will be used for delineation required within the outside edge of the finished shoulder. Flexible delineators will match the color of the edge line. Flexible delineators will be 28 inches long.

H. Traffic Control Signs: Traffic control signs will conform to Part 6 of the MUTCD and as specified in the plans.

I. Temporary Traffic Control Signal: Temporary traffic control signals will generally consist of all necessary materials and appurtenances needed to control road user movements at an intersection, bridge, or other site.

1. **General:** The Contractor will furnish, operate, and maintain the temporary traffic control signal. The temporary traffic control signal will reliably and continuously control traffic for all approaches at the specified location. The temporary traffic control signal system will

meet the requirements of the MUTCD, national and local electrical codes, and these specifications.

Existing signal equipment at the site may be salvaged for use in the temporary traffic control signal. Existing traffic signal equipment used on the project will be salvaged or returned to original use as indicated in the plans. All materials furnished by the Contractor will remain the property of the Contractor upon completion of the project.

The temporary traffic control signal will display pedestrian indications if the pedestrian indications previously existed, or if it is anticipated pedestrians will utilize the temporary traffic control signalized intersection.

In the event of system failure, the Contractor will furnish necessary flaggers to safely control traffic until the temporary traffic control signal is operable. The cost of flaggers, signing, and lighting will be incidental to the contract price for temporary traffic control signal.

The Contractor will have a qualified individual responsible for setup and maintenance of the temporary traffic control signal. This person will have received training on installation, setup, and maintenance of the system.

Traffic signal operation or maintenance work is required to be performed by the Contractor when project conditions dictate, lane closures change, traffic flow is impeded, a potential risk to the public exists, or when equipment breaks down or malfunctions. Equipment breakdowns or malfunctions require a high priority response and are to be reacted to within one hour of notification of the event.

2. Temporary Traffic Control Signal Equipment:

a. Short Term Temporary Traffic Control Signal: The short term temporary traffic control signal system will consist of signal heads mounted on span wire supports. Except as required in this section, all traffic signal equipment and materials will meet the requirements of Section 635 and Section 985.

b. Portable Temporary Traffic Control Signal: The portable temporary traffic control signal system will consist of signal heads, controller, and power supply, all mounted on a heavy duty trailer. Except as required in this section, all traffic signal equipment and materials will meet the requirements of Section 635 and Section 985.

One of the signal heads will be mounted a minimum of 17 feet and a maximum of 19 feet above the roadway surface on the mast arm. The other signal head will be mounted at least 8 feet but not more than 15 feet above the roadway surface.

The signal heads will have the ability to be rotated 180 degrees to face in either direction. The signal heads will also have the ability to be rotated in the vertical or horizontal plane so as to have the optimum visibility to the motorist. Signals will be located so as to meet the visibility requirements of the MUTCD.

The portable temporary traffic control signal will be equipped with work zone safety lights located on the back side of the signal heads to alert construction workers of the status of the traffic signal.

3. **Temporary Traffic Control Signal Support:** The support system, with traffic signal heads, will be designed in accordance with the current edition of the AASHTO Standard Specifications for Highway Signs, Luminaires, and Traffic Signals. The design wind velocity will be 90 mph.

   a. **Short Term Temporary Traffic Control Signal:** The Contractor will furnish and install span wire supports. Guy wire anchors will be used as design requires. The Contractor will determine the size of span support wire, span tether wire, pole type, and guy wire required.

      Design and check design calculations for the span wire and support system (span wire, tether wire, poles, arms, connections, guy wires, and anchors, footings, anchor bolts, etc.) will be signed and sealed by a Professional Engineer registered in the state of South Dakota and will be submitted with shop drawings in accordance with Section 985.1 I.3.

      The Contractor will complete tree trimming, as necessary.

   b. **Portable Temporary Traffic Control Signal:** The temporary traffic control signal will be designed to support the signal heads required.

      Signal supports should be located as far as practical from the edge of the traveled way without adversely affecting the visibility of signal indications. Temporary signal trailers are not to be parked in areas or lanes open to traffic.

      The Contractor will adjust the traffic signals as necessary for the various phases of the work and traffic conditions to meet MUTCD criteria for sight distances and sight triangles. This includes the relocation or realignment of traffic signal indications as project conditions require.

      The Contractor will complete tree trimming, as necessary.

4. **Power:**

   a. **Short Term Temporary Traffic Control Signal:** The Contractor will provide power to the temporary traffic control signal system. The monthly fee for power used by the short term temporary traffic control signal system will be paid for by the Contractor.

   b. **Portable Temporary Traffic Control Signal:** The power source for the unit will be one of the following: an engine generator unit, a solar powered unit, or a 110 volt AC power source. Solar powered units will have a solar array charging system capable of operating without external charge for a minimum of 20 days during all seasons. The system will monitor alternator or charging system and battery voltage. The master trailer (controller) will monitor all functions of remote trailers and display all conditions. The remote trailers will also provide the status of all functions for that particular remote trailer. If a low power condition occurs, the controller software will automatically switch

the trailer to a minimum power mode to preserve battery power. The Contractor will be responsible for providing backup power if the main power source fails. The backup power supply will be able to operate the traffic signals for a minimum of 48 hours.

5. **Controller:** The controller will be capable of operating pre-timed, actuated, and by manual control.

   a. **Short Term Temporary Traffic Control Signal:** The short term temporary traffic control signal will operate from a controller at the site. The controller and the controller cabinet will meet the requirements of Section 985 with the following deviations:

      1) Battery backup is not required.

      2) The controller cabinet will be a NEMA Type M enclosure capable of pole mounting with cable conduit opening(s) in the center bottom.

   b. **Portable Temporary Traffic Control Signal:** The portable temporary traffic control signal units will operate from one master controller at a given site. The second controller or additional slave units will be controlled by the master unit.

      The controller will have an operating temperature range from -40 to +120°F.

6. **Vehicle Detection:** The system will be capable of video, loop, microwave, or radar detection.

7. **Traffic Signal Programming:** The Contractor will program the controllers with the traffic signal programming that is provided in the project plans. Should the project plans not specify a traffic signal program, the State will provide the traffic signal programming in writing. As project conditions and traffic needs change, the Contractor will adjust the traffic signal splits and offsets as directed by the Engineer.

J. Arrow Boards: On roads with normal posted speeds of 45 mph and above, Type C units will be used for all operations 24 hours or more in duration and Type B units may be used for operations less than 24 hours in duration. On roads with normal posted speeds less than 45 mph, Type A, B, or C, units may be used for all operations.

Type A: 48 inches x 24 inches, visible for a minimum of 1/2 mile
Type B: 60 inches x 30 inches, visible for a minimum of 3/4 mile
Type C: 98 inches x 48 inches, visible for a minimum of 1 mile

K. Portable Changeable Message Signs: Portable changeable message signs will conform to Part 6 of the MUTCD except the minimum mounting height may be lowered, as approved by the Region Traffic Engineer. The Contractor will furnish, place, operate, and maintain the Portable Changeable Message Signs (PCMS) at the locations shown on the plans. The Contractor will maintain possession of the PCMS upon completion of the project.

L. Temporary Pavement Marking:

1. **General:** Temporary pavement markings will be maintained in good condition until the permanent pavement marking is in place, or until the Area office issues the letter of Acceptance of Field Work.

   All roadways open to traffic (including, but not limited to, newly paved surfaces, cold milled surfaces, asphalt surface treatments, flush seals, fog seals, and tack coats) will have temporary dashed centerline markings, no passing zone markings, and applicable lane lines placed prior to nightfall. For prime coats, the existing signing will remain in place until the prime coat has cured for 72 hours and temporary pavement marking is installed. Following the 72 hour cure period for prime coats, the Contractor will install temporary dashed centerline markings, no passing zone markings, and applicable lane lines prior to nightfall. Interstate highways will also be marked with edge lines prior to nightfall.

   Unless otherwise shown on the plans, centerline and the applicable lane lines may be temporarily marked by temporary pavement marking tape, temporary raised pavement markers, temporary flexible vertical markers (tabs), or temporary pavement marking paint.

   The material used to mark the no passing zones will be the same type of material used to mark the temporary dashed centerline, unless otherwise approved by the Engineer.

   For 2 lane roadways with average daily traffic volumes of 2500 or less, no passing zones may be identified using DO NOT PASS and PASS WITH CARE signs rather than pavement markings. The DO NOT PASS signs will be used to mark the beginning of each no passing zone, and the PASS WITH CARE signs to mark the end of each zone. These may be utilized in place of the pavement markings normally used to identify no passing zones for no longer than 14 calendar days. The placement of the dashed centerline marking, and these signs will be required prior to nightfall.

   The Contractor will take the steps necessary to ensure the temporary markings on the final surface will match the markings on the existing surface.

   The Engineer will determine locations and limits of no passing zones in accordance with Part 3 of the MUTCD.

2. **Materials for Temporary Pavement Marking:** Temporary pavement marking tape, temporary raised pavement markers, temporary flexible vertical markers (tabs), and temporary pavement marking paint will be of the type specified and will meet the following requirements.

   a. **Temporary Pavement Marking Tape:** Temporary pavement marking tape will be applied according to the manufacturer's recommendations. Tape used for dashed centerline marking will be applied in 4 inch widths, 2 feet long with a cycle length of 40 feet. A 2 foot stripe with a cycle length of 20 feet may be used for roadways with severe curvature. Solid stripes will consist of tape applied in 4 inch widths for the length specified.

b. **Temporary Raised Pavement Markers:** Temporary raised pavement markers will be applied according to the manufacturer's recommendations. 4 inch wide reflectorized markers may be used in place of tape or paint.

   If temporary raised pavement markers are used to substitute for dashed centerlines, the dashed centerline will be a 4 foot long line with a cycle length of 40 feet. A 2 foot long line with a cycle length of 20 feet will be used for roadways with severe curvature. Two temporary raised pavement markers will represent the dashed centerline, one at each end of the line. A solid line will be represented by a 5 foot spacing.

c. **Temporary Flexible Vertical Markers (Tabs):** Temporary flexible vertical markers (tabs) will be applied according to the manufacturer's recommendations. 4 inch wide reflectorized markers may be used in place of tape or paint.

   If temporary flexible vertical markers (tabs) are used to substitute for dashed centerlines, the dashed centerline will be a 4 foot long line with a cycle length of 40 feet. A 2 foot long line with a cycle length of 20 feet will be used for roadways with severe curvature. Two temporary flexible vertical markers will represent the dashed centerline, one at each end of the line. A solid line will be represented by a 5 foot spacing.

   When an asphalt surface treatment, fog seal, or flush seal are to be applied, temporary flexible vertical markers (tabs) will not be placed more than 72 hours prior to covering the in place markings on the surface. The protective marker covers will not be removed until after all oil within 2 feet of the markers has been applied and rolling has been completed.

d. **Temporary Pavement Marking Paint:** Temporary pavement marking paint will be applied in accordance with Section 633 except as modified by the following:

   Dashed centerlines will be applied in 4 inch widths 4 feet long at cycle lengths of 40 feet. A 2 foot long line at cycle lengths of 20 feet may be used for roadways with severe curvature. Solid lines will be 4 inches wide for the length specified or required.

   The paint applicator will be a self-propelled pneumatic spraying machine with atomizing nozzles capable of applying a minimum of two lines at one time from 4 to 8 inches wide.

   When only one lane of a two-lane roadway is complete at the end of a day, the temporary marking will be placed near centerline on the unsurfaced portion of the roadway.

M. Removal of Pavement Markings: Pavement markings to be removed will be designated by the Engineer.

Pavement markings will be removed from the pavement by methods that do not damage the surface or texture of the pavement. Pavement markings will be removed before the traffic pattern is changed.

Covering the markings is not acceptable removal.

Sand or other material used for removal will be disposed of as the work progresses. Accumulations of sand or other material, which interferes with drainage or constitutes a hazard to traffic, will not be permitted.

When sand blasting is used for removal of pavement markings or objectionable material, and the removal operation is performed within 10 feet of a lane occupied by the traveling public, the residue including dust, will be removed immediately by a vacuum attachment operating concurrently with the sand blasting operation.

Damage to the pavement surface caused by pavement marking removal will be repaired at the expense of the Contractor.

634.4 METHOD OF MEASUREMENT

A. Flagging: Flagging will be measured to the nearest 0.5 hour a flagger is performing flagging work. A record of the number of flagger hours used will be submitted to the Engineer.

B. Pilot Car: Pilot car will be measured to the nearest 0.5 hour a pilot car is performing pilot car work. A record of the number of pilot car hours used will be submitted to the Engineer.

C. Traffic Control, Miscellaneous: Measurement for traffic control, miscellaneous will not be made.

D. Type 3 Barricades: Type 3 barricades, of the type and length specified, will be measured per each used on the project. Measurement for Type 3 barricades will be made one time even if the Type 3 barricades are moved or replaced. The number of Type 3 barricades measured will be the greatest number of installations in place at any one time, regardless of the number of setups throughout the duration of the project.

E. Flexible Delineators: Flexible delineators will be measure per each used on the project.

F. Traffic Control Signs: Traffic control signs will be measured to the nearest 0.1 foot and the area computed to the nearest 0.1 square foot of the sign face. Deduction will not be made for rounded corners. Measurement for traffic control signs will be made one time even if the traffic control signs are moved or replaced. The amount of traffic control signs measured will be the greatest number of installations in place at any one time, regardless of the number of setups throughout the duration of the project.

G. Temporary Traffic Control Signal:

1. **Short Term Temporary Traffic Control Signal:** Measurement for a short term temporary traffic control signal will be made on a per site basis. One site will be considered to be all signals, overhead span wires, support poles, and other equipment in use at an intersection.

2. **Portable Temporary Traffic Control Signal:** Measurement for a portable temporary traffic control signal will be made on a per each basis. One unit will be considered to be a portable traffic control signal mounted on a trailer.

H. Arrow Board: Arrow boards will be measured on a per each basis of the total number of arrow boards used on the project. Measurement for arrow boards will be made one time even if the arrow boards are moved or replaced. The amount of arrow boards measured will be the greatest number of arrow boards on the project at any one time, regardless of the number of setups throughout the duration of the project.

I. Portable Changeable Message Sign: Portable changeable message signs will be measured on a per each basis of the total number of portable changeable message signs used on the project. Measurement for portable changeable message signs will be made one time even if the portable changeable message signs are moved or replaced. The amount of portable changeable message signs will be the greatest number of portable changeable message signs on the project at any one time, regardless of the number of setups throughout the duration of the project.

J. Temporary Pavement Marking: Measurement for tape, paint, tabs, and raised pavement markers will be made either by the foot or by the mile depending on the unit designated by the contract quantity.

When measurement of temporary pavement marking is made by the mile, a single measurement will be made longitudinally along the centerline of the roadway to the nearest 0.1 mile. The resulting single measured distance will be the quantity used for payment for all temporary pavement markings including, but not limited to, temporary dashed centerline, lane lines, edge lines, gore lines, no passing zone lines, and Do Not Pass and Pass With Care signing (if utilized). Separate measurement and determination of quantity for each individual temporary pavement marking line measured by the mile will not be made.

When measurement of temporary pavement marking is made by the foot, all temporary lane line, centerline, and edge line markings will be measured separately to the nearest foot.

All temporary gore lines, stop bars, and crosswalks will be measured separately as a 4 inch equivalent marking.

All temporary area markings, arrows, and word messages will not be measured, and the accepted quantity will be the 4 inch equivalent marking quantity listed in the plans unless additional work is ordered by the Engineer.

Each surface course or surface treatment receiving temporary pavement marking will be measured to the nearest 0.1 mile increment for payment. If a single set of temporary flexible vertical markers is utilized on multiple surface courses or surface treatments, payment will be made as though each surface course or surface treatment was marked separately.

Temporary pavement markings applied to sections of the roadway due to the application of tack will not be measured for payment. The temporary pavement markings placed near the centerline on the unsurfaced portion of the roadway when only one lane of the final surface course or surface treatment is complete will not be measured for payment.

K. Remove Pavement Marking: Measurement for removal of pavement markings will not be made. The plan quantity will be used for payment unless additional pavement marking removal is ordered by the Engineer.

634.5 BASIS OF PAYMENT

A. Flagging: Flagging will be paid for at the contract unit price per hour. Payment for flagging will include all costs for provided certified flagger, stop/slow paddle, flag, and any nighttime illumination required. The accepted number of flagging hours will be paid for at the rate specified in Section 4.4.

B. Pilot Car: Pilot car will be paid for at the contract unit price per hour. Payment for pilot car will include all cost for provided operator, vehicle, and required sign. The accepted number of pilot car hours will be paid for at the rate specified in Section 4.4.

C. Traffic Control, Miscellaneous: Payment for traffic control, miscellaneous will include all costs for installation, maintenance, and removal of all cones; Type 1 and Type 2 barricades; tubular markers; vertical panels; direction indicator barricades; drums; flashing warning lights; and flags on signs. Payment will include all costs for removing and covering non-applicable traffic control devices, shadow vehicles, traffic control inspections, reporting for traffic control inspections, and the designated traffic control contact person.

D. Type 3 Barricades: Payment for Type 3 barricades will include all cost for installation, maintenance, and removal.

E. Flexible Delineators: Payment for flexible delineators will include all cost for installation, maintenance, and removal.

F. Traffic Control Signs: Traffic control signs will be paid for by the square foot. Payment for traffic control signs will be made following satisfactory installation. Payment will be full compensation for installing, maintaining, relocating, and removing traffic control signs and supports. Hinged signs and signs with tabs, such as right and left signs, will be paid for as one sign. Costs for posts and supports will be included in the contract unit price of the sign.

Additional payment will not be made for any traffic control sign turned away, covered, or temporarily taken out of service and returned to service.

If a fixed location traffic control sign is relocated due to an error in the plans or by the Engineer, an additional 50% of the designated sign rate will be paid.

The Contractor's failure to maintain, relocate, or remove traffic control signs and supports as required will result in a price adjustment assessed to the contract.

G. Temporary Traffic Control Signal:

1. **Short Term Temporary Traffic Control Signal:** Short term temporary traffic control signals will be paid for at the contract unit price per each site. Payment will be full compensation for furnishing, installing, maintaining, tree trimming, and all other incidentals for the short term temporary traffic control signal, which may include using existing controller and signal heads or providing new controller and signal heads, as designated in the plans.

2. **Portable Temporary Traffic Control Signal:** Portable temporary traffic control signals will be paid for at the contract unit price per each unit. Payment will be full compensation

for furnishing, installing, maintaining, relocating, tree trimming, and all other incidentals for the portable temporary traffic control signal.

H. Arrow Board: Arrow boards will be paid for at the contract unit price per each. Payment will be full compensation for labor, equipment, materials, delivery, installation, maintenance, relocation, and removal.

I. Portable Changeable Message Sign: Portable changeable message signs will be paid for at the contract unit price per each. Payment will be full compensation for labor, equipment, materials, delivery, installation, maintenance, relocation, and removal.

J. Temporary Pavement Marking: Payment for temporary pavement marking will be by the mile or foot. Payment will be considered total payment for all required temporary pavement markings, including but not limited to, temporary dashed centerline, lane lines, edge lines, gore lines, no passing zone lines, and Do Not Pass and Pass with Care signing (if utilized). Payment will be full compensation for all costs to furnish, install, and remove (when required) temporary pavement markings including costs to remove and properly dispose of temporary road marker covers, temporary road markers, and temporary pavement marking tape.

K. Remove Pavement Marking: Payment for removal of pavement markings will be by the foot, each, word, or square foot depending on the bid item unit description. Payment will be full compensation for all costs to remove and properly dispose of the pavement markings.

871 ASPHALT CONCRETE CRACK SEALANT

871.1 REQUIREMENTS

A. Asphalt Concrete Crack Sealant Type IV:

The sealant will conform to the requirements of ASTM D6690 Type IV.

The sealant material will not weigh more than 9.35 pounds per gallon.

Only products that meet the above requirements and have performed satisfactorily based on Department analysis may be used. A listing of acceptable products meeting ASTM D6690 Type IV requirements may be obtained from the Department's Approved Products List. Products on the Department's Approved Products List for joint sealant for asphalt over long jointed concrete pavement may also be used.

The blocking medium will be an inert, compressible material which is compatible with the sealant.

B. Asphalt Concrete Crack Sealant Type IV Modified:

The sealant will conform to the requirements of ASTM D6690 Type IV except as modified below.

The sealant material will not weigh more than 9.75 pounds per gallon.

Resilience % will be between 30 – 60%.

Only products that meet the above requirements and have performed satisfactorily based on Department analysis may be used. A listing of acceptable products meeting ASTM D6690 Type IV Modified requirements may be obtained from the Department's Approved Products List. Products on the Department's Approved Products List for joint sealant for asphalt over long jointed concrete pavement may also be used.

The blocking medium will be an inert, compressible material which is compatible with the sealant.

881 AGGREGATES FOR ASPHALT SURFACE TREATMENTS

881.1 GENERAL REQUIREMENTS

The material will conform to the specifications for the particular material required by the contract. The material will be sand, crushed rock or crushed gravel. The material will not contain dirt, clay balls, vegetation or organic debris, paper, metal, glass, and other foreign material.

881.2 SPECIFIC REQUIREMENTS

REQUIREMENTS	TYPE 1		TYPE 2			TYPE 3
	A	B	A	B	C	
Sieve	**Percent Passing**					
5/8 inch						100
1/2 inch					100	
3/8 inch	100	100	100	100	0-100	
1/4 inch	25-70				0-70	
#4	0-25	0-75	0-70	0-60	0-15	10-75
#8	0-5	0-30	0-28	0-18	0-5	0-62
#40	0-4	0-6	0-4	0-4		0-30
#200	0-1.3	0-3.0	0-3.0	0-1.3	0-1.0	0-10.0
Other Properties						
Flakiness Index (max)	30%		30%	30%	30%	30%
Plasticity Index (max)	3	3	3	3	NP	3
LA Abrasion Loss (max)	40%	40%	40%	40%	40%	40%
Soundness Loss (max)	12%	12%	12%	12%	12%	15%
Crushed Particles (min) +#4 Sieve			50% 2-CF	100% 2-CF	50% 2-CF	30% 1-CF
Foot Notes	*1	*1	*1	*1		*1

*1 The plasticity index may be waived if not more than 4% of the material passes the #40 sieve.

881.3 SAMPLING AND TESTING

Sampling ..... SD 201
Gradation ..... SD 202
Plasticity Index ..... SD 207
LA Abrasion Test ..... SD 204
Soundness Test (sodium sulfate solution, five cycles) ..... SD 220
Crushed Particle Test ..... SD 211
Flakiness Index Test ..... SD 203

890 ASPHALT MATERIAL

890.1 GENERAL REQUIREMENTS

Transporting conveyances for asphalt material will be free of contaminating material. A record of material hauled the previous load in truck transport tanks will be furnished as a prerequisite to loading. A determination will be made if the previously hauled material is compatible with the material to be loaded or if cleaning of the tank is required to prevent contamination.

All sampling will be performed in accordance with SD 301.

If the material is to be used prior to testing by the Department, the asphalt material supplier will furnish two copies of a Certificate of Compliance for each tank car, truck tank, or other individual conveyance. The Certificate of Compliance will show all information contained on Form DOT-62 and a properly executed certification statement.

Temperatures to provide kinematic viscosities of 300 centistokes and 150 centistokes for mixing application and 200 centistokes and 50 centistokes for spray application will be furnished with the first load of each type of asphalt material delivered to the project on or along with the Certificate of Compliance.

Upon presentation of a Certificate of Compliance, the Engineer may permit incorporation into the work the asphalt material covered by the certificate. Permission by the Engineer to use asphalt material will not be construed as an acceptance of the material. Acceptance of asphalt material will be based on test results from the samples obtained.

Asphalt material tested and accepted for use on a project and transferred by the Contractor to another project, may be accepted for use in the terminating project on the basis of the test results of the originating project. The Contractor must request and receive from the Engineer of the originating project, prior to transfer, a letter of transfer covering the material. (DOT-70)

890.2 SPECIFIC REQUIREMENTS

A. Rapid Curing Cut-back Asphalt will conform to AASHTO M 81.

B. Medium Curing Cut-back Asphalt will conform to AASHTO M 82.

C. Slow Curing Cut-back Asphalt will conform to the following requirements.

1. The oil will be uniform in appearance and consistency and will show no foaming when heated to the application temperature. The residue of specified penetration will be smooth and homogeneous in appearance.

2. The grade of liquid asphaltic material specified will conform to the requirements shown in the following table.

REQUIREMENT	TEST METHOD	SC-70		SC-250		SC-800		SC-3000	
		Min	Max	Min	Max	Min	Max	Min	Max
Kinematic Viscosity at 140ºF*1, Centistokes	AASHTO T 201	70	140	250	500	800	1600	3000	6000
Flash Point *2 ºF	AASHTO T 79	150		175		200		225	
Asphalt Residue of 100 pen., percent by weight	SD 310	50		60		70		80	
Ductility of 100 pen., residue @77ºF, 5 cm. Per min., cm	AASHTO T 51	100		100		100		100	
Solubility in Trichlorethylene, percent	AASHTO T 44	99.0		99.0		99.0		99.0	
Spot Test*3	AASHTO T 102	Negative for all grades							

*1 As an alternative, Saybolt-Furol viscosities may be specified as follows:

Grade SC-70 .....Furol viscosity at 50ºC .....60 to 120 sec.
Grade SC-250 .....Furol viscosity at 60ºC .....125 to 250 sec.
Grade SC-800 .....Furol viscosity at 82.2ºC .....100 to 200 sec.
Grade SC-3000 .....Furol viscosity at 82.2ºC .....300 to 600 sec.

*2 If flash point is anticipated to be above 200ºF test will be performed in accordance with AASHTO T 48.

*3 The use of the spot test is optional. When specified, the Engineer will indicate whether the standard naphtha solvent, the naphtha xylene solvent, or the heptane xylene solvent will be used in determining compliance with the requirement and in the case of xylene solvent, the percentage of xylene to be used.

D. Performance Graded Asphalt Binder will conform to AASHTO M 320 and the Combined State Binder Group Method of Acceptance for Asphalt Binders available from the Department's Bituminous Engineer.

The asphalt binder will, if necessary, be blended at the terminal with permissible additives styrene-butadiene styrene (SBS) or styrene-butadiene rubber (SBR) necessary to meet the specifications. The supplier will assign the modifying process with a unique name and type of modification and will provide the actual modifier, modifying process, and unique name to the Department's Bituminous Engineer and the Department's Certification Engineer for tracking and monitoring purposes. The unique name of the modifying process will then be listed on the Certificate of Compliance. Air blown asphalts, acid modifiers, and other modifiers will not be allowed unless approved by the Department's Bituminous Engineer.

SHRP Performance Graded Asphalt Binders PG 58-34, PG 64-28, PG 64-34, PG 70-28, and PG 70-34 will also meet the following requirements:

Test	Specification	Test Method
Elastic Recovery, RTFO Residue, 77ºF, %	Min 60	AASHTO T 301

E. Emulsified Asphalt will conform to AASHTO M 140 with the following exceptions. When SS-1h emulsified asphalt is specified for tack or flush seal coat, the cement mixing test requirement is waived. The sieve test requirement on representative samples will be waived unless requested by the Engineer.

	AE150S		AE150L		AE200S		AE300	
	Min	Max	Min	Max	Min	Max	Min	Max
TESTS ON EMULSIONS:								
Viscosity, Saybolt Furol at 122ºF, s	35	150	35	150	35	150	35	150
Sieve test, %		0.30		0.30		0.30		0.30
Oil Portion, %	0.5	3			1	6		8
Residue by distillation, %	62		65*1		62		65	
TESTS ON RESIDUE FROM DISTILLATION TESTS								
Penetration, 77ºF, 100 g, 5s	140	225	140	225	250		300	
Ductility, 77ºF, 5 cm/min, cm	40		30		40		40	
Ash Content, %	1.0		1.0		1.0		1.0	
Float test, 140ºF, s	1200		1200		1200		1200	

*1 Distillation as described in T 59 with the following modifications: Material will be brought to a temperature of 350ºF ± 10ºF for a period of 20 minutes. Total time to distill, including the 20-minute hold period, will not exceed 60 minutes.

F. Cationic Emulsified Asphalt will conform to AASHTO M 208 with the following exceptions. When CSS-1h is specified for tack or flush seal coat, the cement mixing test requirement is waived. The sieve test will have a maximum percentage of 0.30 for samples taken at point of use. The sieve test requirement on representative samples will be waived unless requested by the Engineer. The demulsibility test will be made within 30 days from the date of shipment.

G. Polymer Modified Emulsified Asphalt will conform to AASHTO M 316, with the following exceptions. The sieve test requirement on representative samples will be waived unless requested by the Engineer. If requested, a maximum percentage of 0.30% is acceptable for samples taken at the point of use.

The distillation test for CRS-2P emulsion will be in accordance with AASHTO T 59, except the distillation temperature will be the temperature recommended by the emulsion manufacturer.

	HFMS-2P		HFRS-2P		CRS-2P	
	Min	Max	Min	Max	Min	Max
TESTS ON EMULSIONS:						
Viscosity, Saybolt Furol @ 122ºF	50	400	50	400	100	400
Classification test					Passes	
Particle charge test					Positive	
Sieve (%)*1		0.10		0.10		0.10
Demulsibility 50ml 0.10 N $CaCl_2$, %	40					
Demulsibility 50ml 0.02 N $CaCl_2$, %			30			
Demulsibility 35ml 0.8% Sodium dioctylsulfosucinate, %					40	
Oil Distillate by Volume of Emulsion,%*2		3.0		3.0		1.0
Residue by Distillation, %	65		65		65	

	HFMS-2P		HFRS-2P		CRS-2P	
	Min	Max	Min	Max	Min	Max
TESTS ON RESIDUE FROM DISTILLATION TESTS:						
Penetration @ 77ºF	100	200	100	200	100	175
Ductility @ 39ºF 5cm/min., cm	30		30		30	
Softening Point (R&B) ºF	100		100		100	
Elastic Recovery @ 50ºF*3	55		55		55	
Float Test @ 140ºF, sec	1200		1200			
Solubility in trichloroethylene, %					97.5	

*1 A maximum percentage of 0.30% is acceptable for samples taken at the point of use.

*2 The distillation test for CRS-2P emulsion will be in accordance with AASHTO T 59, except that the distillation temperature will be what the emulsion manufacturer recommends.

*3 The Elastic Recovery test will be in accordance with AASHTO T 301, except that the residue will be obtained by distillation, not oven evaporation. The distillation temperature will be as recommended by the emulsion manufacturer.

H. Petroleum Resin-Oil Base Emulsion will conform to the following requirements:

TEST	LIMITS		TEST METHOD
	MIN	MAX	
TESTS ON EMULSIONS:			
Saybolt-Furol viscosity at 77ºF (seconds)	15	40	AASHTO T 59
Miscibility	No coagulation		AASHTO T 59*1
Sieve Test		.30	AASHTO T 59*2
Partial Charge	Positive		
Residue Percent	60		AASHTO T 59*3
TESTS ON RESIDUE FROM DISTILLATION TESTS:			
Kinematic Viscosity at 140ºF (centistokes)	100	200	AASHTO T 201

*1 Test procedure identical with AASHTO T 59, except Normal Calcium Chloride solution will be used in place of distilled water.

*2 Test procedure identical with AASHTO T 59, except distilled water will be used in place of 2% Sodium Oleate solution.

*3 AASHTO T 59 residue by evaporation test for percent residue is made by heating a 50 gram sample to 300ºF (149º C) until foaming ceases, then immediately cooled and results calculated.

The material will have the capability of increasing the ductility and penetration of the asphalt binder in an asphalt concrete surface when applied at the specified rate.

Diluted petroleum resin-oil based emulsion will be diluted with potable water in the ratio of approximately two parts emulsion to one part water by volume. The diluted emulsion will have a minimum residue of 40%.

980 PAINT

980.1 TRAFFIC PAINT

The finished paint will be smooth and homogeneous, free of coarse particles, skins, or any other foreign materials detrimental to the use or appearance of the paint.

High build waterborne paint will meet the requirements of Section 980.1 B.

The manufacturer will submit a "Certificate of Compliance" for each batch of paint produced for use under this specification. The certification will contain the manufacturer's code number and batch number along with the test results of each batch for weight per gallon, viscosity, drying time, percent pigment, percent vehicle, and fineness of grind.

A. Waterborne Paint: The paint will use 100% acrylic polymer such as Dow FASTRACKTM 3427, Arkema DT 250, or an approved equal.

1. Quantitative Requirements: The finished paint will meet the following quantitative requirements:

	WHITE	YELLOW
Lead, parts per million ASTM D3335 or X-ray fluorescence	100	100
Pigment, percent by weight Tested in accordance with ASTM D3723	60.0 - 62.5	56.1 - 58.6
Titanium Dioxide, pounds/gallon, min ASTM D 476 Type II Rutile 92% min. $Ti0_2$ tested in accordance with ASTM D1394 or ASTM D4764	1.00	0.20
Total Solids, percent by weight, min Tested in accordance with ASTM D3723	77.0	76.1
Non-volatile Vehicle, percent by weight, min Tested in accordance with NIST 141C (Method 4051.1)	42.5	42.5
Consistency (Viscosity), KU Krebs-Stormer, equivalent units, shearing rate 200 rpm. When tested in accordance with ASTM D562, the consistency of the paint will be within the stated specification when determined a minimum of 48 hours after packaging the material.	80 to 90	80 to 95
Weight per Gallon, pounds, min Tested in accordance with ASTM D1475. In addition to compliance with the minimum, the weight per gallon will not vary more than ± 0.3 pounds/gallon between batches.		
Dow FASTRACK™ 3427	13.85	13.30
Arkema DT 250	13.75	13.20
Fineness of Dispersion, Hegman Scale, min Tested in accordance with ASTM D1210 "B" Cleanliness"	2	2

Drying Time, No Pick-Up, minutes, max 12 12
Tested in accordance with ASTM D711, except the wet film thickness will be 12.5 ± 0.5 mils.

Drying Time, Dry-through, minutes, max 120 120
Tested in accordance with ASTM D1640, except the wet film thickness will be 12.5 ± 0.5 mils. A reference control paint will be run in conjunction with the candidate paint. Dow FASTRACK™ 3427 formulation will be the referenced-control paint. If either the candidate or reference-control paint exceeds the 120 minute maximum, then the candidate paint will not exceed the dry time of the reference-control paint by more than 15 minutes.

Directional Reflectance, min 85 50
When applied at a wet film thickness of 15 mils and when tested in accordance with ASTM E1347 using the 45/0 illumination.

pH, min 9.80 9.80
Tested in accordance with ASTM E70

Dry Opacity, Contrast ratio, min 0.95 0.88
When applied at a wet film thickness of 6 to 7 mils and when tested in accordance with ASTM D2805

Volatile Organic Content (VOC), grams/liter, max 115 115
Tested in accordance with ASTM D3960

Color: The paint will meet the color specification limits and luminance factors listed in Tables 1 & 2 when tested in accordance with ASTM E1347 or ASTM E1349. The paint will not discolor in sunlight and will maintain the colors and luminance factors throughout the life of the paint.

Table 1*[1]

Color	Chromaticity Coordinates (corner points)								Min. Luminance Factor (Y %)
	1		2		3		4		
	X	Y	X	Y	X	Y	X	Y	
White	0.355	0.355	0.305	0.305	0.285	0.325	0.335	0.375	35
Yellow	0.560	0.440	0.490	0.510	0.420	0.440	0.460	0.400	25

*[1] Daytime Color Specification Limits and Luminance Factors for Pavement Markings Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65

Table 2*[2]

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.480	0.410	0.430	0.380	0.405	0.405	0.455	0.435
Yellow	0.575	0.425	0.508	0.415	0.473	0.453	0.510	0.490

*[2] Nighttime Color Specification Limits for Pavement Marking Retroreflective Material With CIE 2° Standard Observer, Observation Angle = 1.05°, Entrance Angle + 88.76° and CIE Standard Illuminant A.

2. **Qualitative Requirements:** The finished paint will meet the following qualitative requirements:

Condition in Container - Storage Stability. Within a period of 12 months from the time of delivery and when examined in accordance with Federal Specification TT-P-1952F 4.3.2, the paint will not show excessive settling in a freshly opened full can and will be easily redispersed with a paddle to a smooth homogeneous state. The paint will show no undesirable characteristics to include curdling, livering, caking, gelling, or thixotropic properties, lumps, skins, or color separation. The consistency will not change more than 5 Kreb Units from that of the original sample, the degree of settling will have a rating of 6 or better per ASTM D869, and the drying time will be as specified.

Skinning. The paint will not skin within 48 hours in a three-quarter filled, tightly closed container when examined in accordance with Federal Specification TT-P-1952F 4.3.14.

Flexibility and Adhesion. The paint will show no cracking, flaking, or chipping when tested as specified. Apply a wet film thickness of 0.005 inches with a film applicator to a 3 inch x 5 inch tin panel weighing 0.39 to 0.51 pounds per square foot, previously cleaned with benzene and lightly buffed with steel wool. Dry the paint film at 70 to 80ºF in a horizontal position for 18 hours, then bake in an oven at 122 ± 4ºF for two hours, and cool to room temperature for at least 1/2 hour. Bend over a 1/2 inch diameter rod and examine, without magnification, in accordance with ASTM D522 Test Method B.

Water Resistance. The paint will show no softening, blistering, loss of adhesion or other evidence of deterioration, other than a slight loss in gloss when tested as specified. Apply a wet film thickness of 0.015 inches with a film applicator to a clean glass plate. Dry the paint film at 70 to 80ºF in a horizontal position for 72 hours. Immerse one-half of the painted plate in distilled water in a vertical position at room temperature (70 to 80ºF) for 18 hours in accordance with ASTM D870. Remove the painted plate from the immersion liquid, allow to air dry for 2 hours, and then examine.

Dilution Stability. The paint will be capable of dilution with water with no separation, curdling or precipitation observed when examined in accordance with NIST 141D (Method 4203.2), such that the wet paint can be readily cleanable with only water.

Spraying Properties. The paint as received will have satisfactory spraying and hiding properties when applied by either airless or air-assisted type traffic stripers to glass or metal plates at a wet film thickness of 0.015 inches.

Bleeding. The paint will have a minimum bleeding ratio of 0.97 when tested in accordance with ASTM D868. The asphalt saturated felt will conform to ASTM D 226 (Type I).

Freeze-Thaw Stability. The paint will show no coagulation or change in consistency greater than 5 Kreb Units when tested in accordance with Federal Specification TT-P-1952 F 4.3.8.

Heat Stability. The paint will show no gelling, signs of instability, or change in consistency greater than 5 Kreb Units when tested in accordance with Federal Specification TT-P-1952 F 4.3.13.

Abrasion Resistance. No less than 190 Liters of sand will be required for removal of the paint film when tested in accordance with Federal Specification TT-P-1952 F 4.3.7.

B. High Build Waterborne Paint: The paint will be a durable high build, low VOC, fast drying, waterborne traffic paint using 100% acrylic polymer Dow FASTRACKTM HD-21A or an approved equal.

1. Quantitative Requirements: The finished paint will meet the following quantitative requirements:

	WHITE	YELLOW
Lead, parts per million, max ASTM D3335 or X-ray fluorescence	100	100
Pigment, percent by weight Tested in accordance with ASTM D3723	60.0 - 62.0	58.0 - 62.0
Titanium Dioxide, pounds/gallon, min ASTM D476 Type II-IV Rutile 92% min. $Ti0_2$ tested in accordance with ASTM D1394 or ASTM D4764	1.00	0.20
Total Solids, percent by weight, min Tested in accordance with ASTM D2369	77.0	76.0
Non-volatile Vehicle, percent by weight, min Tested in accordance with NIST 141C (Method 4051.1)	42.5	42.5
Consistency (Viscosity), KU Krebs-Stormer, equivalent units, shearing rate 200 rpm. When tested in accordance with ASTM D562, the consistency of the paint will be within the stated specification when determined a minimum 48 hours after packaging the material.	80 to 95	80 to 95
Weight per Gallon, pounds, min Tested in accordance with ASTM D1475. In addition to compliance with the minimum, the weight per gallon will not vary more than ± 0.3 pounds/gallon between batches.	13.50	13.00
Fineness of Dispersion, Hegman Scale, min Tested in accordance with ASTM D1210 “B” cleanliness	2	2
Drying Time, No Pick-Up, minutes, max Tested in accordance with ASTM D711, except the wet film thickness will be 12.5 ± 0.5 mils.	12	12
Drying Time, Dry-through, minutes, max Tested in accordance with ASTM D1640, except the wet film thickness will be 12.5 ± 0.5 mils. A reference control paint will be run in conjunction with the candidate paint. Dow FASTRACK™ HD-21A formulation will be the referenced-control paint. If either the candidate or reference-control paint exceeds the 120 minute maximum, then the candidate paint will not exceed the dry time of the reference-control paint by more than 15 minutes.	120	120
Directional Reflectance, min	85	50

When applied at a wet film thickness of 15 mils and when tested in accordance with ASTM E1347 using the 45/0 illumination.

pH, min	9.6	9.6
Tested in accordance with ASTM E70		
Dry Opacity, Contrast ratio, min	0.95	0.88
When applied at a wet film thickness of 6 to 7 mils and when tested in accordance with ASTM D2805.		
Volatile Organic Content (VOC), grams/liter, max	115	115
Tested in accordance with ASTM D3960		

Color: The paint will meet the color specification limits and luminance factors listed in Tables 1 & 2 when tested in accordance with ASTM E1347 or ASTM E1349. The paint will not discolor in sunlight and will maintain the colors and luminance factors throughout the life of the paint.

Table 1*[1]

Color	Chromaticity Coordinates (corner points)								Min. Luminance Factor (Y %)
	1		2		3		4		
	X	Y	X	Y	X	Y	X	Y	
White	0.355	0.355	0.305	0.305	0.285	0.325	0.335	0.375	35
Yellow	0.560	0.440	0.490	0.510	0.420	0.440	0.460	0.400	25

*[1] Daytime Color Specification Limits and Luminance Factors for Pavement Markings Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65

Table 2*[2]

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.480	0.410	0.430	0.380	0.405	0.405	0.455	0.435
Yellow	0.575	0.425	0.508	0.415	0.473	0.453	0.510	0.490

*[2] Nighttime Color Specification Limits for Pavement Marking Retroreflective Material With CIE 2° Standard Observer, Observation Angle = 1.05°, Entrance Angle + 88.76° and CIE Standard Illuminant A.

2. **Qualitative Requirements:** The finished paint will meet the following requirements:

Condition in Container – Storage Stability. Within a period of 12 months from the time of delivery and when examined in accordance with Federal Specification TT-P-1952F 4.3.2, the paint will not show excessive settling in a freshly-opened full can and will be easily redispersed with a paddle to a smooth homogeneous state. The paint will show no undesirable characteristics to include curdling, livering, caking, gelling, or thixotropic properties, lumps, skins, or color separation. The consistency will not change more than 5 Kreb Units from that of the original sample, the degree of settling will have a rating of 6 or better per ASTM D869, and the drying time will be as specified.

Skinning. The paint will not skin within 48 hours in a three-quarter filled, tightly closed container when examined in accordance with Federal Specification TT-P-1952F 4.3.14.

Flexibility and Adhesion. The paint will show no cracking, flaking, or chipping when tested as specified. Apply a wet film thickness of 0.005 inches with a film applicator to a 3 inch x 5 inch tin panel weighing 0.39 to 0.51 pounds per square foot, previously cleaned with benzene and lightly buffed with steel wool. Dry the paint film at 70 to 80ºF in a horizontal position for 18 hours, then bake in an oven at 122 ± 4ºF for two hours, and cool to room temperature for at least 1/2 hour. Bend over a 1/2 inch diameter rod and examine, without magnification, in accordance with ASTM D522 Test Method B.

Water Resistance. The paint will show no softening, blistering, loss of adhesion or other evidence of deterioration, other than a slight loss in gloss when tested as specified. Apply a wet film thickness of 0.015 inches with a film applicator to a clean glass plate. Dry the paint film at 70 to 80ºF in a horizontal position for 72 hours. Immerse one-half of the painted plate in distilled water in a vertical position at room temperature (70 to 80ºF) for 18 hours in accordance with ASTM D870. Remove the painted plate from the immersion liquid, allow to air dry for 2 hours, and then examine.

Dilution Stability. The paint will be capable of dilution with water with no separation, curdling or precipitation observed when examined in accordance with NIST 141D (Method 4203.2), such that the wet paint can be readily cleanable with only water.

Spraying Properties. The paint as received will have satisfactory spraying and hiding properties when applied by either airless or air-assisted type traffic stripers to glass or metal plates at a wet film thickness of 0.015 inches.

Bleeding. The paint will have a minimum bleeding ratio of 0.97 when tested in accordance with ASTM D868. The asphalt saturated felt will conform to ASTM D 226 (Type I).

Freeze-Thaw Stability. The paint will show no coagulation or change in consistency greater than 5 Kreb Units when tested in accordance with Federal Specification TT-P-1952 F 4.3.8.

Heat-Shear Stability. The paint will show no gelling, signs of instability, or change in consistency greater than 5 Kreb Units when tested in accordance with Federal Specification TT-P-1952 F 4.3.13.

Abrasion Resistance. No less than 190 Liters of sand will be required for removal of the paint film when tested in accordance with Federal Specification TT-P-1952 F 4.3.7.

981 GLASS BEADS

981.1 GENERAL REQUIREMENTS

Glass beads for use with pavement marking paint will be moisture resistant and will meet the requirements of AASHTO M 247, Type II. The glass beads will be without floatation properties. The glass beads will have dual surface treatment consisting of a moisture resistant silicone treatment, and silane adherence surface treatment. The glass beads will have a minimum of 80% true spheres. Roundness will be tested in accordance with SD 510.