400.00 CONSTRUCTION SURFACE COURSES AND PAVEMENT

The traveling public judges an overall project by the smoothness and appearance of surface courses and pavements. The quality of the construction will determine the serviceability, durability, strength, and riding quality of the project.

The table in the specification shows the application temperatures for the various grades and types of asphalt. The following also must be considered regarding asphalt:

- Loading certificates should be checked carefully to assure that the asphalt is of the grade and type specified. When anti-stripping additive is required, the percentage and type of additive must also be shown on the loading certificate.

- Changes in asphalt grade should be carefully reviewed before being made. A change in specification change order is always required to change the grade for plantmix asphalt. The Engineer may change the asphalt grade one-step without a change order for other applications.

- The Department's Quality Assurance Program requirements.

Construction diary entries should include the following information unless recorded or filed elsewhere:

- Loading certificate number.
- Sample numbers.
- Air and application temperatures.
- Placement.
- Comparison of quantities used and planned quantities.
- A record of occasional tanker weights to verify certified weights. This may be achieved by weighing loaded and unloaded tanker on approved scales.
- Explanation of any material deductions.
- Discussions with the Contractor prior to and during production.
- Calculations for quantities both weight and volume.
- Yield calculations, depth checks and smoothness tests.
- Scale checks and equipment inspections.
- Application rates of asphalt, CCM, rolling, maintenance, brooming, etc.
- Results of field tests.
- Any other information pertaining to construction (e.g. application rate of curing compound, the installation of load transfer devices and dowel bars, joint sawing and sealing operations) and reasons for material deductions (with reference to deduction tickets).

Whenever material is wasted or it becomes necessary to make deductions from pay quantities, documentation should be prepared on the day the deduction occurs and be **clearly identified** as a deduction.

The asphalt content of wasted or unacceptable loads of plantmix is computed from the asphalt content of the mix. Show computations on the ticket or diary. Asphalt deduction tickets shall cover variations in delivery loading certificate weights. Separate tickets must be used for plant mix and asphalt if each is a separate pay item.

Compute quantities and report to the nearest whole unit.

401.00 TACK COAT

The tack coat is an application of liquid asphalt on an existing pavement, CRABs, or base course surface, and is used as an aid in bonding a new pavement surface to the existing pavement surface. Any pavement surface exposed to the elements or traffic even for short periods will develop a film that cannot be removed by ordinary cleaning methods, and may prevent or reduce bonding. The tack coat, as the name implies, is intended only to provide a "tacky" surface between the surfaces. An excess of asphalt may act as a lubricant and create a slippage plane between the surfaces, or it may be absorbed and cause the new pavement surface to "flush".

The three essential requirements of a tack coat are:

- Correct application rate.
- It must uniformly cover the entire surface of the area to be paved.
- It must wet the old surface so the new surface will adhere.

The type and grade of asphalt is specified in the contract. The Engineer is allowed to change the grade by one step without a change order and with no change in the unit price. See the table in Section 400. Diluted emulsified tack coat requires equal volumes of water and emulsified asphalt to be mixed together by the supplier prior to application.

Tack must be placed on a clean surface. Material accumulations on the existing surface may interfere with the adhesion of the tack. Accumulated materials include dust, loose aggregate, soil, leaves and pieces or lumps of other foreign materials deposited on the surface. Ensure that cleaning includes the edges of any existing pavement adjacent to new pavement.

Application should be limited to the area that can be covered before traffic or dust nullifies the effect. Any areas of tack coat that are thus affected should be retacked. Reapplication of tack must be carefully controlled to avoid an excess of asphalt. Keep all traffic not essential to the work off the tack coat.

Tack coat should be sprayed uniformly on the surface at the specified application rate. If streaking is occurring the Contractor should be required to adjust the distributor. Streaking is caused by faulty distributor adjustment or operation, resulting in the material being placed in ridges. These ridges will not flow together and will result in insufficient material available for bonding between these ridges.

In places where the distributor spray bars cannot reach, it is necessary to apply the tack coat with a hand spray attachment or by hand. It is very important that vertical edges of longitudinal and transverse joints be adequately coated to aid in bonding.

The tack coat must "break over" (i.e. the water must have all evaporated into the atmosphere) before pavement is placed or water will be trapped and create a slip plane.

402.00 PRIME COAT

The purpose of the prime coat is to protect and stabilize the base material and provide a uniform, firm working floor for the next course. The surface to be primed must conform to the typical section and have reasonably uniform compaction. The surface should be tight and in a surface dry condition. Excess float rock should be bladed off or rolled in prior to priming. Excess or insufficient moisture both tend to prevent penetration of the asphalt. A dusty, dry surface may require a light application of water to bring it to the desired moisture condition. Water should be applied only with a spray bar to obtain uniformity and prevent wet spots.

The type and grade of asphalt is specified in the contract. The Engineer is allowed to change the grade by one step without a change order and with no change in the unit price. See the table in Section 400.

After the asphalt has been applied, some time must be allowed for the asphalt to penetrate prior to blotting. The ideal situation is to apply no blotter at all. The second choice would be to have time necessary for maximum penetration. However, traffic conditions and several other factors usually influence the amount of time available. The bulk of the penetration will occur quite rapidly within the first 30-60 minutes. If rain occurs, apply blotter material and prohibit traffic if at all possible. If not possible, a cleaning system for vehicles may need to be established.

Blotter material should be applied sparingly in those areas where necessary to prevent picking up the prime. Excess blotter material creates a hazard for traffic. Excess blotter must be removed prior to the next phase of construction.

403.00 SEAL COAT

A seal coat consists of an application of liquid asphalt immediately covered with an application of aggregate (cover coat). Generally, seal coats are applied to an existing asphalt surface to:

- Seal out moisture and air.
- Rejuvenate a dry or weathered surface.
- Improve skid resistance.
- Improve visibility of delineation.
- Improve riding quality.

Seal coat construction is a fast-moving operation and requires correct timing of the sequence of steps: surface preparation, asphalt application, aggregate application and traffic control. All needed equipment must be on-site and in good working order before the work starts. Equipment used in seal coating includes power broom; asphalt distributor; self-propelled aggregate spreader, dump trucks and self-propelled pneumatic tired rollers. Dust control and blotter application equipment may also be needed.

Surface preparation is extremely important to any seal coat. The surface must be clean, dustfree and dry to obtain proper adhesion of the seal coat. All defective areas and broken edges should be repaired. The old surface should be brought to a reasonable degree of uniformity by correcting flushed or dry areas. Scrub coats, leveling courses, or patching material containing cutback emulsified asphalt should cure at least 10 days before sealing. It is important that vegetation overhanging the roadway be moved prior to seal coating.

The asphalt distributor is the most important piece of equipment on a seal coat project. Its purpose is to uniformly apply asphalt to a surface at a specified rate and to maintain this application rate. Verify that the distributors have been prequalified by the Contractor. Asphalt should be applied as outlined in Section 400 with special attention given to uniformity of spread and temperature of the asphalt and pavement.

Immediately prior to starting an application of asphalt, require the Contractor to test the spray bar and nozzles to verify that the asphalt will be sprayed properly. The distributor should be placed with the spray bar over the building paper and the nozzles opened so that the spray may be checked visually for non-uniformity.

After initial approval, maintain a close inspection to assure continuing equipment compliance and proper operation. Practically all problems involving distributor application of asphalt are the result of an uneven application of asphalt. If any streaked areas develop require the Contractor to stop and adjust the distributor. The development of ridges is usually the result of low asphalt temperature, improper pump pressure, uneven bar pressure, spray bar at improper height, interference between spray nozzles, improper nozzle sizes or a combination of these.

- Rough or bleeding transverse joints are the direct result of poor joint construction, either improper papering, a bad start with the distributor, or poor cutoff at the end of a shot.

- Poor longitudinal joints are the result of an improper lap.

- Transverse corrugations are the result of pressure fluctuations or uneven travel speeds.

A distributor operation must be balanced. Changes in any factor affect all other factors and must be compensated for. Changes in asphalt type or spread ratio may require a change in pressure, nozzle size or angle, bar heights, etc., as well as travel speed. Some distributors must be chained or blocked to prevent excessive change in bar height during unloading, thus affecting the spray lap. Observe the end of each distributor shot to verify the proper rate of asphalt is being applied. If the distributor shoots until it is fully off-loaded the last of the application may be light or non-uniform. New pavements may require a slight increase in asphalt application rates.

The time lapse between the distribution of asphalt and the application of cover coat material is critical. The application of seal coat asphalt shall not be started until there are sufficient trucks loaded with cover coat material at the job site ready for immediate use. If the cover coat is dusty, the material should be moistened at least 24 hours prior to intended use.

Asphalt shall not be applied to more roadways than can be covered with aggregate within two to three minutes. The Asphalt Institute recommends two minutes; however, in some instances,

three minutes or more may be successful. If an emulsion is used, it must be covered before it starts to break.

Each asphalt shot shall be started on building paper at least 1 m (3 ft) wide and longer than the spread width. This is to prevent buildup at the joint, assure a matching joint, and allow the distributor to be traveling at the proper speed. Paper may be required at the end of the shot as well if the shut-off is not positive. Verify that bridge joints are papered or covered with duct tape prior to applying asphalt.

The aggregate spreader should be checked carefully for compliance with specifications. The spreader must be capable of providing a uniform spread at the desired rate without segregation. Proper control of the spread rate is essential. Since aggregate cannot stick more than one particle thick, any excess will be wasted. Excess material will also have a tendency to displace and loosen material embedded in the asphalt. Immediately after material placement, verify that any areas with a deficiency or surplus of material are corrected.

Verify that the cover coat is applied so that the tires of the spreader or trucks coming to the spreader never contact the uncovered asphalt. Empty trucks may cross the uncovered longitudinal joint leaving the spreader; but this should not be allowed if any of the asphalt will be tracked onto a fresh seal coat. In this case, the joint should be covered with aggregate where the truck is crossing and then the material swept off the roadway.

The "meet-line" or longitudinal joint is very critical. The lap must be correct to provide the required asphalt. Cover coat must not be applied to the joint until the abutting spread is made. If the joint is covered on the first spread, not enough asphalt is present to hold the chip. If the second spread of asphalt and aggregate laps the joint too far, a ridge will occur and usually the joint will bleed and cause tracking.

Only pneumatic tire rollers are allowed for seal coats. Rolling should start immediately behind the spreader and not be allowed to lag behind the spreading operation. Verify that the rollers are operating at a speed slow enough to prevent the tires from displacing or picking up the aggregate. The purpose of rolling is to seat the aggregate in the asphalt and thus, promote the bond. The speed of the aggregate spreading operation should be geared to the speed of the rolling.

Embedment of the cover coat must be watched carefully. The largest stones should be embedded approximately 40 percent. Care must be exercised at all times to prevent scuffing or pickup of the new seal coat. Any damage should be repaired immediately. Bleeding areas should be blotted immediately.

Any loose aggregate particles are swept up using a power broom the morning following the previous day's application unless the Contractor is otherwise directed. Brooming reduces the danger of flying rock and prevents the loose material from prying loose the embedded chips. A light application of water may be needed to reduce dust during the brooming operation.

403.01 TRAFFIC CONTROL

Traffic control through the seal coat is extremely important to both the success of the job and public relations. The seal coat must be protected from the traffic until the material is firmly embedded, and the seal coat has cured sufficiently to prevent pick up or displacement and until the chips are firmly embedded.

Traffic control is usually accomplished during the initial curing with flaggers and pilot cars; later it may be handled by signing. Traffic should be piloted through the work at speeds low enough to prevent damage to the surface and to vehicles from loose chips. Normally, this speed will be less than 35 mph (55 km/h). Following an unexpected rainstorm, traffic should, if possible, be kept off of the roadway until covercoat aggregate has become dry. If this is not possible, extremely slow convoying of the traffic will be necessary and rolling continued until danger of dislodging aggregate has passed.

Pilot car traffic control should be maintained during that portion of the day when damage could occur to traffic due to flying rocks or to the seal coat because of weather conditions. It may even be necessary to pilot during the second day. The pilot car should vary travel paths to help seat the aggregate.

The length of time that traffic should be controlled over the project depends in part on the weather and the type of asphalt applied. During cool, damp, cloudy, or humid weather, it may be necessary to pilot longer than during a time when the weather is warm, dry, and sunny. This is because the cool, damp weather delays the evaporation of the moisture contained in the aggregate and the setting rates of the asphalt cutback or emulsion. During very hot weather, traffic should be controlled longer than normal if there is a possibility of chips rolling and picking up.

Care must be exercised to prevent sudden starts or stops of the traffic. When stopping traffic on a new seal coat, it may be necessary to provide additional cover coat or other material to blanket the area where the traffic will park. This will prevent pick up and tracking.

Sufficient pilot cars should be provided and the work should be arranged to handle the traffic with a minimum of delay. Most extended delays, exposure of the traffic to unnecessary hazard or other inconvenience to traffic, as well as damage to the seal coat, are a direct result of poor planning for traffic control. Never pilot traffic by a distributor in the process of applying asphalt if there is a possibility of asphalt getting on vehicles.

Special traffic control considerations are required for four-lane interstate and other multi-lane highways. Stopping of traffic on these highways should be avoided if feasible and unless approved by the Engineer. Recirculating pace cars are normally used to control speed during the critical cure periods and during placement operations.

403.02 WEATHER LIMITATIONS FOR SEAL COATS

1. Seal coats should be undertaken only when pavement temperature is above specified minimum. Seal coating should not be attempted during damp weather or when the weather appears threatening. In general, high pavement temperatures between 120°F and 140°F

2. (49°C and 60°C) will be considered cause for tracking and bleeding and reason for ceasing the operation should they become evident.
3. Air temperature should desirably be between 80°F and 95°F (27°C and 35°C). Seal coat operations should be avoided at air temperatures over 100°F (38°C), especially if high ADT's and grades are present. Be sure and check temperatures in shady areas to verify that specifications are being met.
4. Satisfactory bond is dependent upon good wetting action by the asphalt and involves the viscosity of the asphalt and evaporation rate of the diluents. Generally, RC asphalts are more suitable for use when the pavement temperature is above 90°F (32°C) and MC asphalts are recommended when the pavement temperature is below 80°F (27°C). The asphalts are about equal when the pavement temperatures are between 80°F and 90°F (27°C and 32°C).
5. If feasible, stop asphalt application at the edge of shaded areas until the aggregate spreader catches up and can follow immediately behind the distributor through the shaded areas.
6. Raise the asphalt temperature to its upper limits for colder pavement and weather conditions and shady areas. Then cover with chips immediately.
7. When windy, take special care to protect the traveling public. Do not seal in strong winds. Direct crosswinds are most critical for disturbing the flow of the fan edges. Specifications do not allow sealing if wind velocity exceeds 15 mph (24 km/h) unless approved by the engineer.

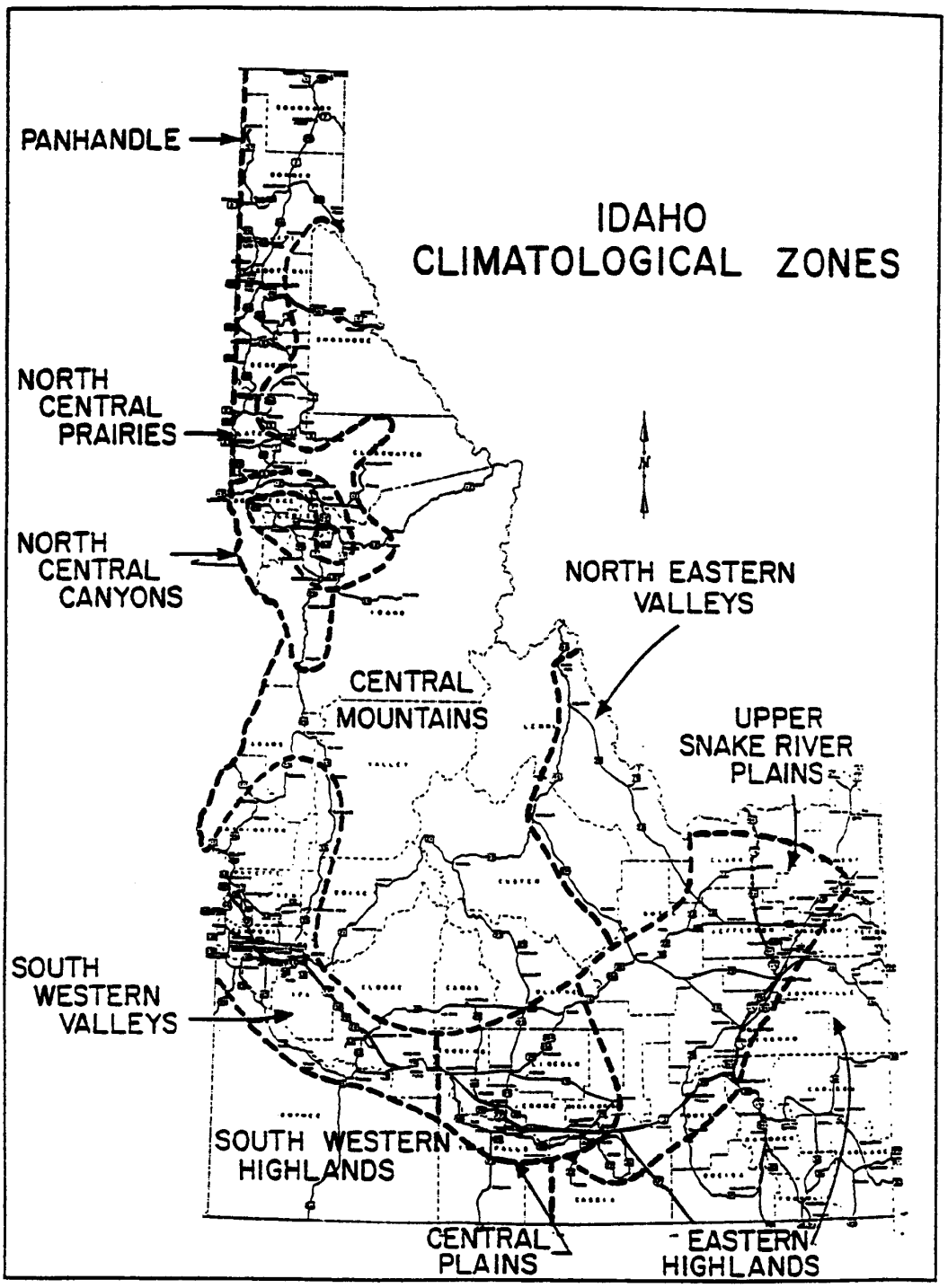
403.03 PRECIPITATION PATTERNS AS AN AID IN SEAL COATING

Exhibits 1 and 2 contain state maps divided into climatic zones and graphs of average temperature and percent probability of dry weather expected during the seal coating season for these zones.

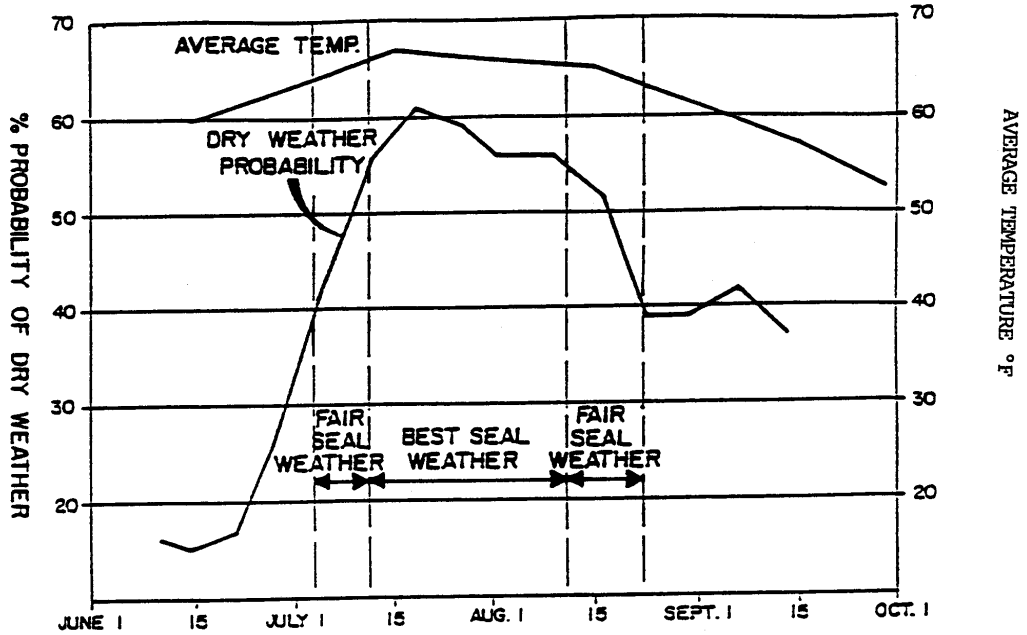
Information was gathered from the U.S. Department of Agriculture, U.S. Department of Commerce, and the University of Nevada Agricultural Experiment Station publications. A 30-year study base, 1931-1960, was used to predict the precipitation patterns. The average temperatures come from the annual summary of climate data published by the U.S. Department of Commerce.

The curves should be used as a guide to determine the best time to perform seal coating in a particular area. Better seal coats should result by avoiding the marginal sealing weather periods.

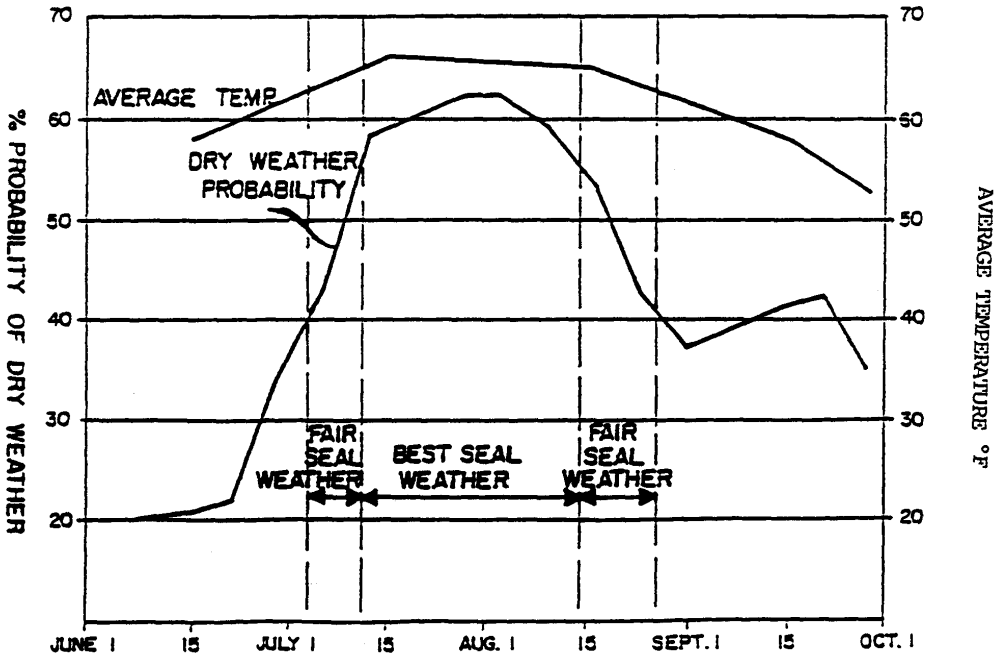
403.04 CONSTRUCTION SEAL COAT EXHIBIT 1



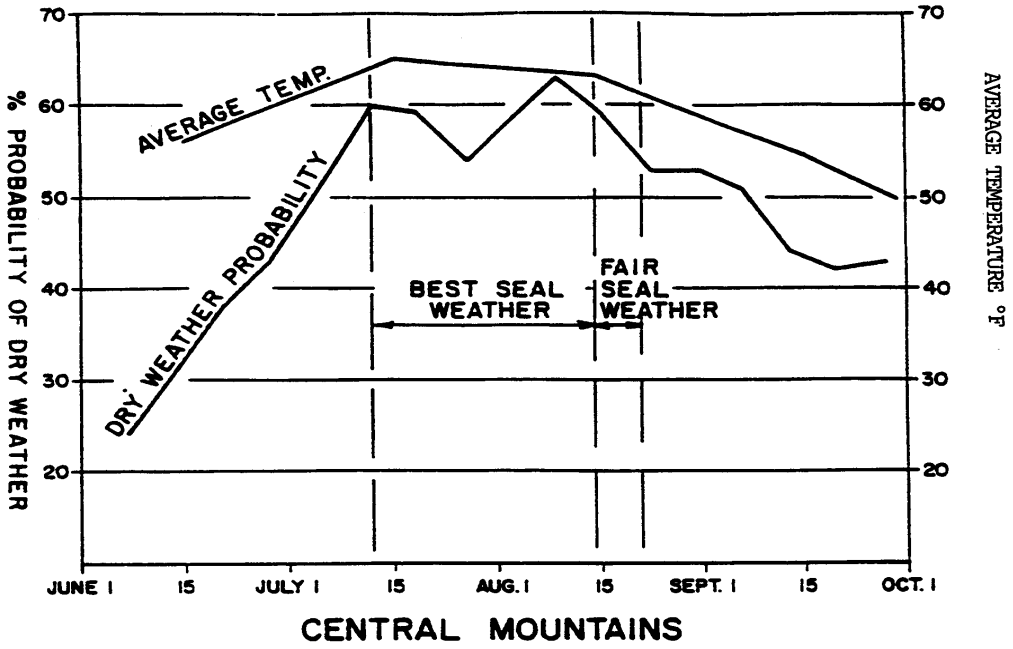
403.05 CONSTRUCTION SEAL COAT EXHIBIT 2



PANHANDLE



NORTH CENTRAL PRAIRIES AND
NORTH CENTRAL CANYONS


% PROBABILITY OF DRY WEATHER
AVERAGE TEMPERATURE °F
AVERAGE TEMP.
DRY WEATHER PROBABILITY
BEST SEAL WEATHER
FAIR SEAL WEATHER
70
60
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JUNE 1
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JULY 1
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AUG. 1
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SEPT. 1
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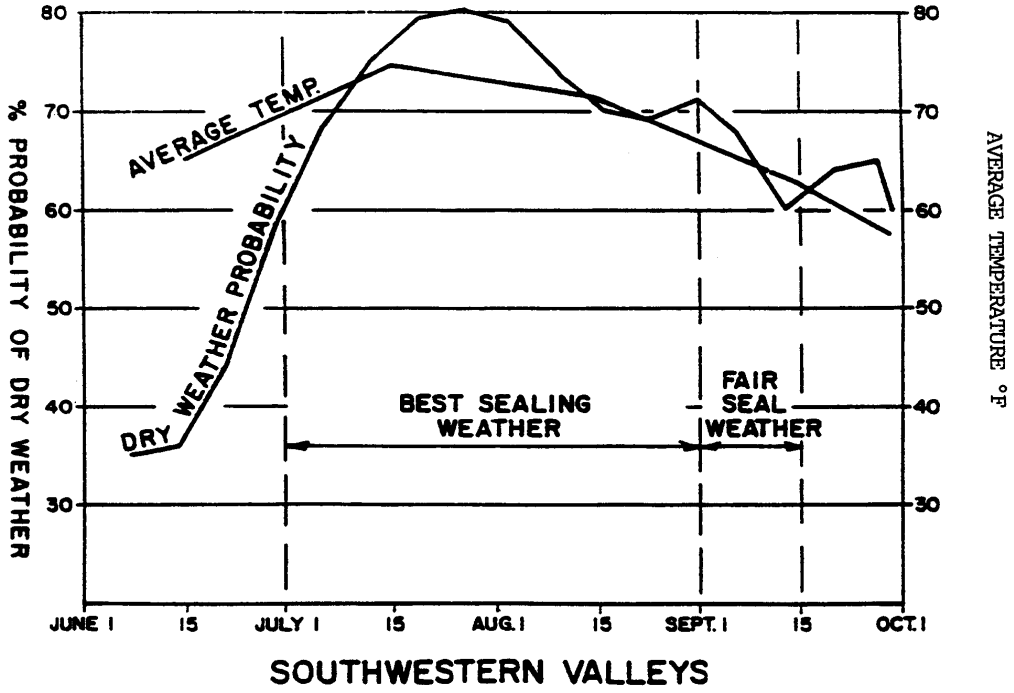
OCT. 1
CENTRAL MOUNTAINS


% PROBABILITY OF DRY WEATHER
AVERAGE TEMPERATURE °F
AVERAGE TEMP.
DRY WEATHER PROBABILITY
BEST SEALING WEATHER
FAIR SEAL WEATHER
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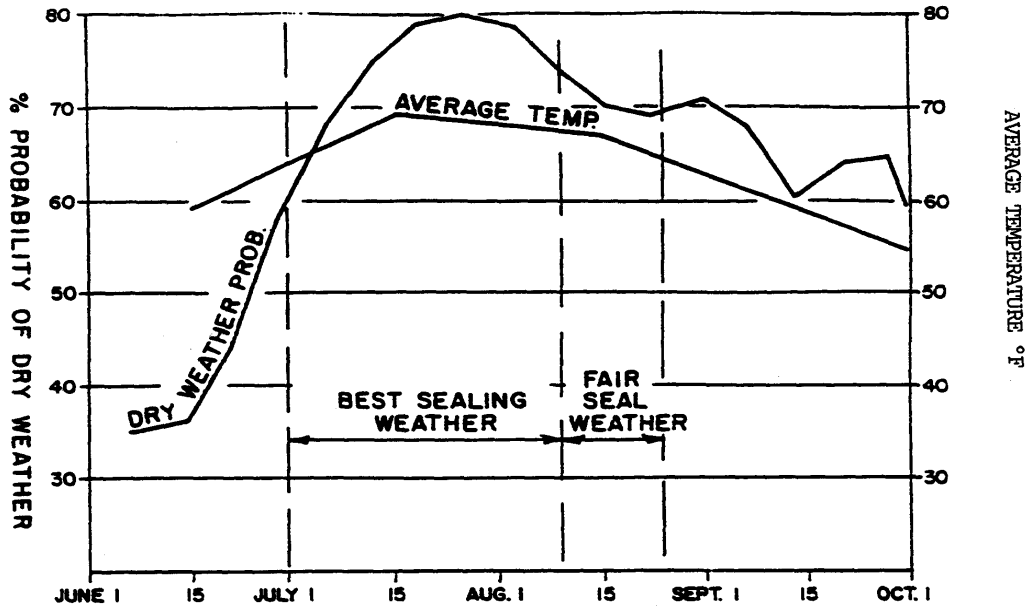
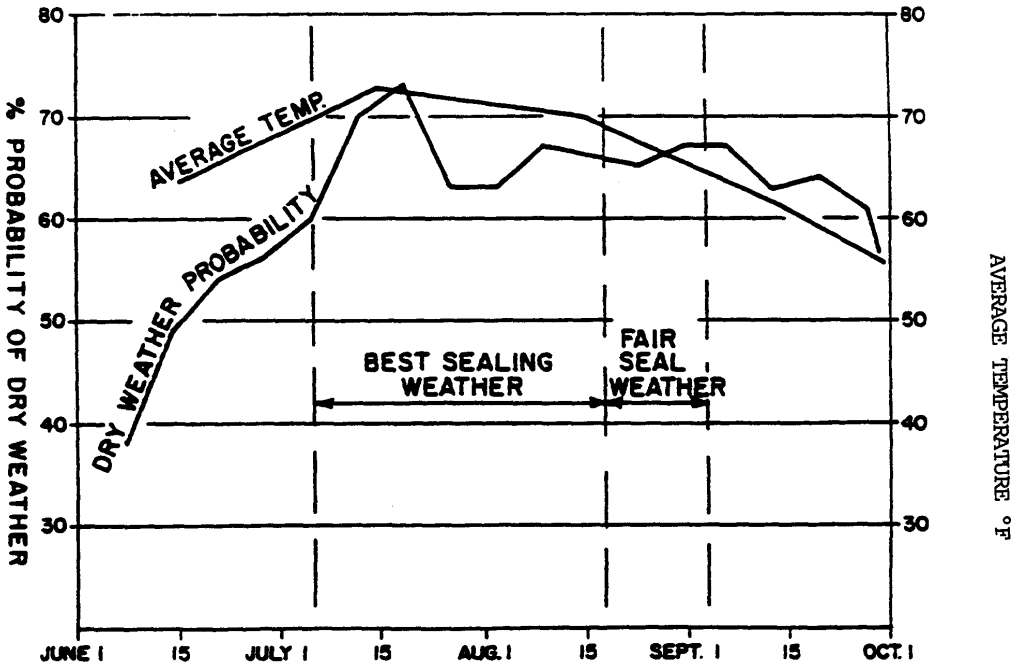
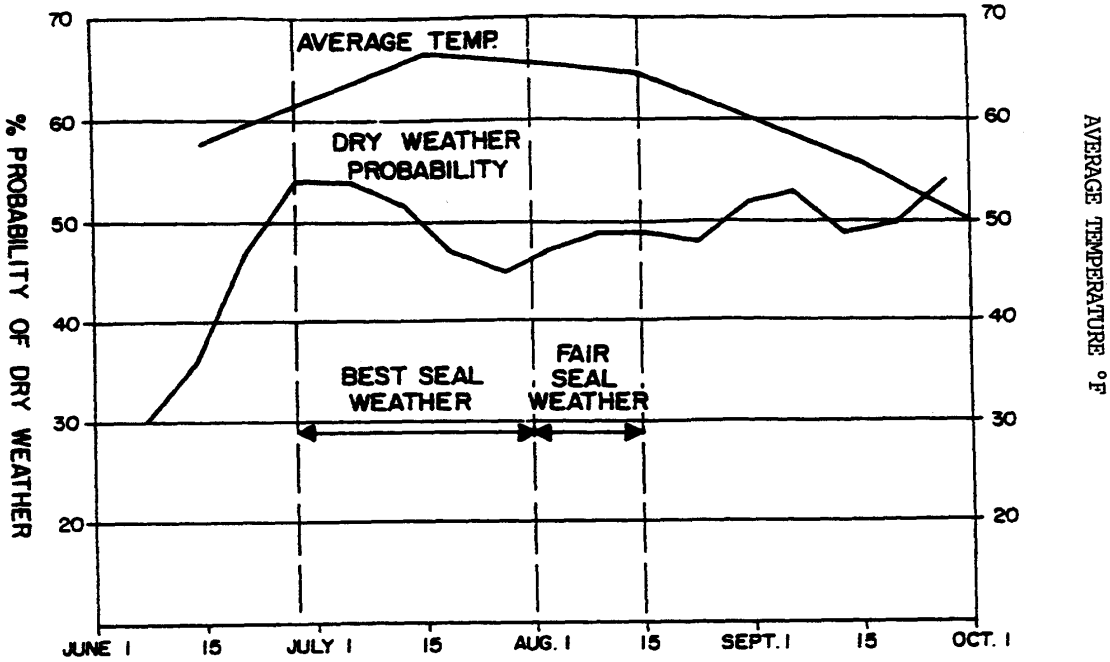
SOUTHWESTERN VALLEYS



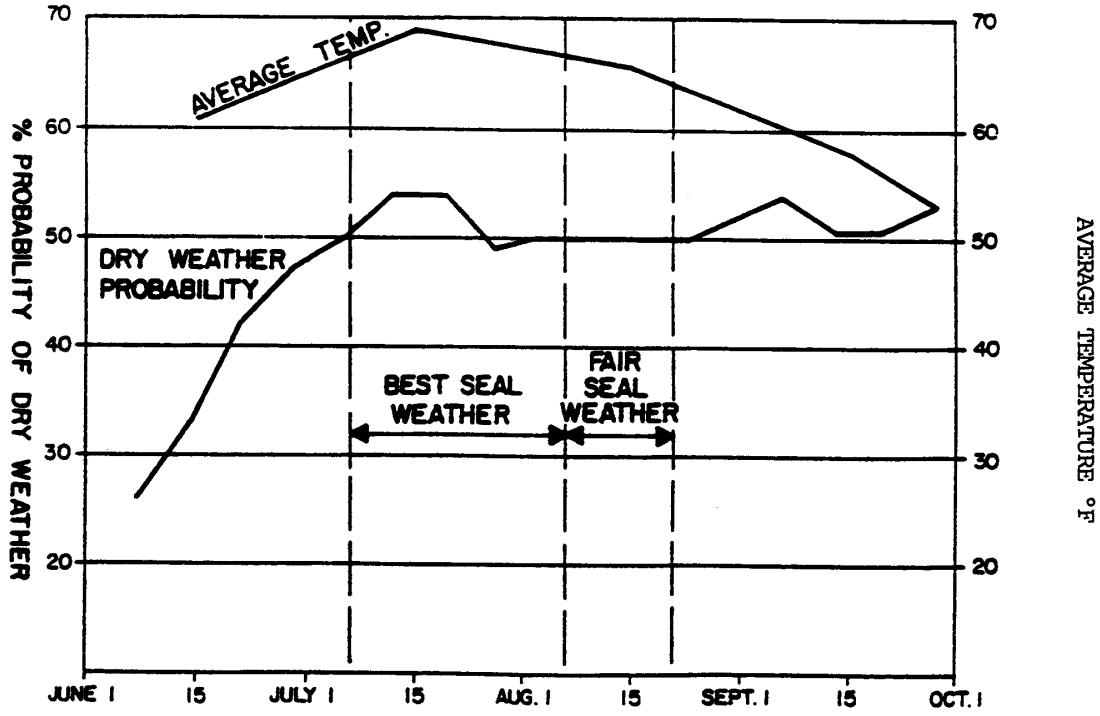
SOUTHWESTERN HIGHLANDS



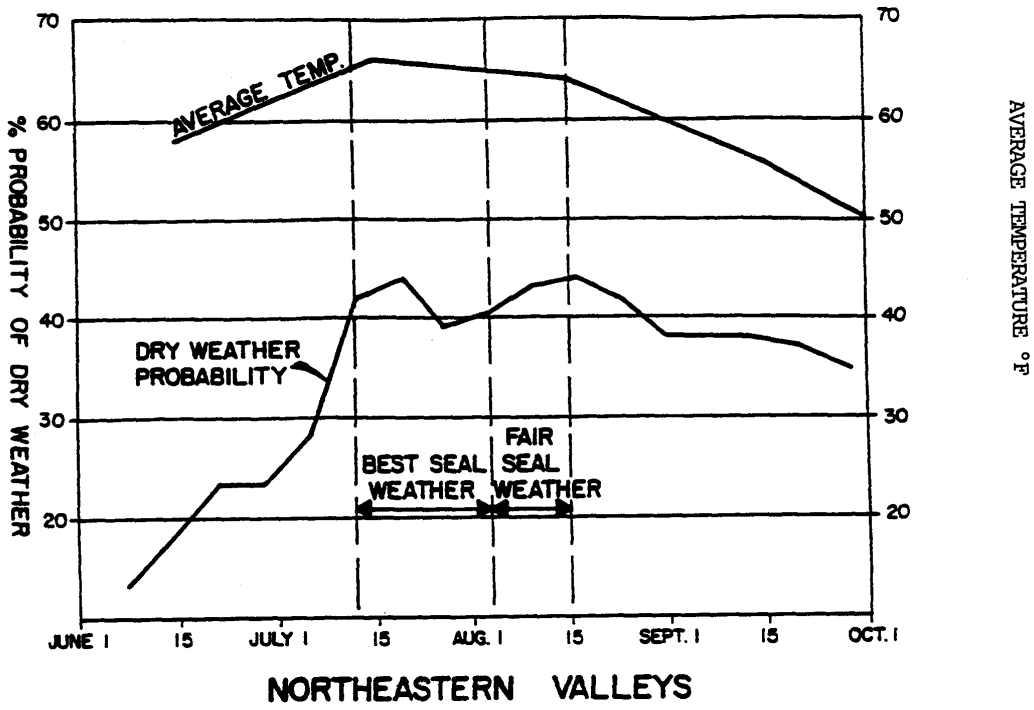
CENTRAL PLAINS



EASTERN HIGHLANDS



UPPER SNAKE RIVER PLAINS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% PROBABILITY OF DRY WEATHER
AVERAGE TEMP.
DRY WEATHER PROBABILITY
BEST SEAL WEATHER
FAIR SEAL WEATHER
JUNE 1
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JULY 1
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AUG. 1
15
SEPT. 1
15
OCT. 1
AVERAGE TEMPERATURE °F
NORTHEASTERN VALLEYS

404.00 SURFACE TREATMENT

Surface treatment construction is a combination of prime and/or seal coats as specified and the applicable sections apply to each operation.

405.00 PLANT MIX PAVEMENT

405.01 Description

Plant mix production and pavement construction requires extremely careful inspection. Pavement that does not meet all specifications will not perform satisfactorily and will result in high maintenance costs. An oversight or omission may result in an inadequate pavement that is not only unsightly and rough but may materially affect the useful life of the project.

Plant mix is a mixture of aggregate and asphalt binder. Because of the high viscosity of asphalt binders at normal temperature, it is necessary to heat the aggregate and asphalt binder to permit mixing, placing and compacting. Plant mix is produced in a central proportioning and mixing plant (hot plant). At the hot plant, the aggregate is dried and heated to the mixing temperature and then mixed with the specified asphalt binder. On completion of mixing, the mixture is discharged into trucks and conveyed to the roadway. The plant mix is then placed by mechanical spreaders (paving machines or blade laid by a dozer) and then the pavement is compacted using compaction equipment before it cools and becomes unworkable.

The Special Provisions usually require a pre-operational conference be conducted prior to paving. The intent of the conference is to discuss:

- The mix design to be used and the asphalt content starting point.
- The procedures to follow if the mix design is modified.
- Acceptance test strip construction procedures including testing and notification procedures.
- Nuclear density gauge calibration for correlation factors.
- Communication procedures to be used for weather shut downs and other potential construction issues.
- Procedures to follow if equipment breakdowns occur.
- What will be done regarding segregation of material.
- Use of tack – application rates, pickup problems and problems with rain.
- Testing: who, what, where, when and how; re-testing criteria; random sampling procedures; test result turn-around time; dispute resolution.
- QC/QA 0.75 and 0.85 pay factor decision criteria. Below 0.85 production must stop and adjustments made. Below 0.75 material is rejected.
- Traffic control procedures and lines of communication.
- Other factors specific to Contract.

405.02 Materials

See the specifications for materials and the test methods to be used. Idaho T-40, Asphalt Content Correction Factor, is no longer required.

405.03 Construction Requirements

A. Mix Design

Plant mix is specified in the plans by a specific class (Class I, II, III or IV) and aggregate nominal size 1 ½, 1, ¾, ½, 3/8 in (37.5, 25, 19, 12.5 or 9.5 mm). Subsection 405.02 of the Standard Specifications gives the material specification parameters for the various classes of mix and the tests used in determining specification conformance. These are the parameters that the Contractor's mix design must meet to produce the job mix formula (JMF) that will be used for the project. The Contractor must submit the proposed JMF including copies of all test reports, data and worksheets at least 5 calendar days before the start of paving.

Materials must also meet the applicable requirements of Section 700 for asphalt binder, anti-stripping additive and aggregates. Subsection 703.05 specifically addresses requirements for stockpiles; fine and coarse aggregates; and aggregate fracturing, thinness and elongation.

B. Weather Limitations

Subsection 405.03 B specifies the conditions that plant mix may not be placed. Be aware that thin mats, low ambient temperatures, wind, low base temperatures, moisture, and cloudy days all have a significant effect on decreasing the temperature of the mix. There must be sufficient time from placement of the plant mix until the mix reaches about 175°F (80°C) for the rollers to adequately compact the mix to obtain the required density. Discuss with the Contractor how the above factors will be taken into consideration when applicable to assure that compaction requirements will be met, and document.

Surface temperature measurements are taken using the following procedures:

- When taking a reading in the sun, place the thermometer on the pavement and then shade it for three minutes before reading. The intent is to prevent a false reading due to the sun's direct exposure.
- Take the surface temperature in an area representative of conditions for the project. Take a new temperature when conditions change for any reason.

C. Mixing Plant

C-1. Mixing Plant Types

Most portable mixing plants are now dryer-drum mixers. The increase in use of dryer-drum mixers for the production of asphalt concrete is primarily because of the method's simplicity and economy.

The fundamental components of the dryer-drum plant are:

- Aggregate cold-feed bins
- Aggregate conveyor
- Asphalt storage tanks
- Dryer-drum mixer

- Hot mix conveyor
- Hot mix storage silo

There are no screens, hot aggregate bins, or pugmill mixers as there are for batch mixing plants. Aggregate gradation control is achieved in the crushing and stockpiling operations. Accurately controlled feeders proportion the aggregate as it leaves the cold bins. Since mix gradation and uniformity are almost entirely dependent on the cold feed system, proper care must be exercised in the production and stockpiling of aggregates. Multiple aggregate stockpiles must not be mixed or contaminated prior to entry in the cold feed bins.

If reclaimed asphalt pavement is allowed, a reject screen must be installed as required in the specifications.

Positive separation of cold feed bins such as dividers between bins must be used to prevent spillover. Cold aggregate bins should be equipped with feed units having interlocking controls to maintain a constant ratio between the relative quantities of each size of aggregate at varying plant production rates. The conveyor that delivers the combined aggregates to the drum should be fitted with a mechanical or electronic belt weighing device, linked directly to the asphalt metering pump with the appropriate time delay to ensure that the desired asphalt content is maintained at varying production rates.

Belt scales that continuously weigh and monitor the combined aggregates are interlocked with a metering asphalt pump to maintain a constant aggregate-to-asphalt ratio. Asphalt is added at various locations generally midway in the drum. The burner is located at the aggregate-entry end of the drum. This means that there is a parallel flow of burner gasses and asphalt-aggregate mixture toward the discharge end of the drum. An indicator for checking the quantity or rate of flow of the asphalt to the mixer should be provided.

When proportioning the asphalt at the plant, the moisture in the aggregate must be considered. The Contractor should correct the wet aggregate weight back to dry weight. The intended asphalt content is based on the dry weight. The Contractor should also monitor moisture content during production, since changes in stockpile moisture may affect not only asphalt content, but variables such as compaction and mix temperature.

Controls and monitoring devices for feeders, aggregate conveyors, weigh belts, asphalt pump, burner, mix temperature and conveyors are usually housed in a control van with good visibility of the entire operation.

Although the combustion rate of the burner fuel is independently controlled, there should be a provision for automatic shutdown of the burner if there is an interruption in the flow of any of the mix components.

Diesel, natural gas, or propane fuels are commonly used in the burner. Be aware that contamination of the mix with unburned fuel may result if plant or burner output is pushed beyond recommended capacity when using diesel or heavier burner oils.

The benefits of hot-mix surge silos for both plant and paving operations are well known. The dryer drum mixing plant is designed for nearly continuous operation; however, the flow of haul trucks may be intermittent. The surge bin is the important link between a steady flow of asphalt mixture and the sometimes sporadic movements of haul trucks. Specifications require that the

material in the silo not drop below the top level of the cone except at the end of the day's production.

Dryer-drum mixed asphalt concrete can be produced over a wide range of temperatures. Conditions such as stockpile moisture, aggregate characteristics, asphalt viscosity, weather, use of reclaimed pavement, and rate of production all have an effect on the mixing temperature. A thermometric instrument should be installed in the discharge chute of the drum to provide the plant operator with an easily visible indication of the mix temperature.

C-2. Mixing Plant Inspection and Calibration

The Contractor is responsible for calibrating the mixing plant and checking for accuracy. Observe the calibration whenever possible and always obtain a copy of all calibration data to verify that adequate information is available for making adjustment when indicated for project files. Document any deficiencies and corrective actions taken.

Calibration must be completed prior to production of plant mix to ensure that the asphalt pump, weigh belt, and cold bin feeders are operating properly. The cold feed aggregate bins are equipped with variable speed belt feeders and gates. Calibration charts are completed for each bin using the various aggregates to be included in the mix. These charts are used to adjust the mixing plant controls so that the proper mixture of aggregates is incorporated into the mix.

Prior to paving, verify that the mixing plant meets Subsection 405.03 requirements. Report any deficiencies to the Contractor immediately and document including the corrective actions taken. At a minimum, verify the following:

- Hot Plant equipment foundations are stable.
- Sampling locations are safe and convenient.
- Positively controlled gates on the cold feed(s).
- Aggregate Sampler installed and working properly (See Subsection 106.11).
- Dust collection system in proper working order.
- Thermometers installed properly at the proper locations and calibrated.
- Scales in proper working order and accuracy within specified limits.
- Discharge gates open and close fully and quickly.
- For batch plants, pug mill paddles and liner in good condition with no excessive clearance (see manufacturer's recommendation).
- Asphalt storage adequate; tanks clean and equipped with a recirculating and heating system to provide constant temperature.
- Method of measuring asphalt in tanks adequate and properly calibrated.
- Plant has been calibrated by the contractor.

D. Hauling Equipment

Verify that the Contractor is using trucks and release agents that meet Subsection 405.03. Diesel fuel or other petroleum products are not to be used as a release agent. The release agent may be used to lightly coat the inside of each truck bed. Prior to production, assure that each

truck is identified by a unique number. The contractor may cover the truck beds during hauling to maintain mix temperatures.

During production, hauling equipment should be inspected to assure they are clean and that excess release agent is discharged before loading plant mix.

E. Paver

Paving machines may be mounted on track or rubber tires, with tamping, vibrating or oscillating - vibrating screeds. Before allowing the use of any machine verify that:

- Screed and compacting mechanisms are in adjustment and fully operable.
- Drive mechanisms are properly adjusted, as loose racks or drive chains or improper or uneven tire pressures may result in a poor paving job.
- Automatic screed controls are in good working order.

After operations are started, the Contractor may need to adjust the feed from the hopper to provide as near as possible continuous operation of the augers. This will provide a constant depth of material in front of the screed. Fluctuation of this depth of material will change the pressure on the screed causing it to raise or lower, resulting in thickness variations and a poor ride.

The forward speed of the paver should be regulated to provide a balanced operation with the hot plant, trucks and rollers. Pavers should be operated at as slow a pace as possible. Watch for excessive paver speed.

F. Mixing

The Contractor is responsible for providing a mixture that meets the specification tolerances specified in this Subsection and the control point minimum and maximum ranges specified in Subsection 703.05. These tolerances and the control point ranges are used to establish the upper and lower specification limits used in the QC/QA Special Provisions Quality Analysis.

Minimum testing requirements for aggregate coating and moisture content are specified in the Department's Field Test manual. The State is required to conduct these tests.

G. Acceptance Test Strip

An acceptance test strip is constructed by the contractor using the JMF prior to the start of production paving to establish that the mix design parameters specified in Subsection 405.02 are met and that density may be achieved by the equipment and construction methods used. Multiple test sections must be constructed if more than one target asphalt content is proposed. However, the contractor must select only one JMF to be used on the project. Test methods to be used are as specified in Subsection 405.02

Acceptance of the test strip is based on the results of sampling and testing for mix design parameters, aggregate gradation and density. Sample locations and number and test methods are as specified. Responsibility for sampling and testing is as specified in the contract.

All samples obtained by the Contractor to be tested by the State must immediately be turned over to the State. The State has a specified time frame to complete testing based on the number of test sections. See specification for requirements. Acceptance criteria are as specified. Based on the acceptance criteria the acceptance test strip is either accepted, rejected and

removed, or rejected and allowed to remain in place with a 50 percent unit price reduction. A change order may be required if the test strip is allowed to remain in place.

Density correction factors for equipment correlations are also determined during acceptance test strip construction.

H. Tack

See Section 401.00 for requirements.

I. Spreading and Finishing

Spreading and finishing requires observation and inspection of the methods and practices employed by the contractor to:

- Assure that these methods are producing the intended result, and
- To require corrective measures when unsatisfactory results are obtained.

The intended result is a pavement that is constructed to the correct depth and cross-section, and with a surface texture density and riding surface as specified.

The following conditions must be watched closely and documented in the construction diary including corrective actions taken, if necessary:

- Uniformity of the mixture and any evidence of segregation. Look for the accumulation of coarse aggregate in "pockets".
- Surface texture of the mixture. Look for streaks of differing texture and pulling or tearing of the mixture
- Temperature of the mixture. Take frequent measurements at both the plant and the roadway to verify specification requirements are being met.
- Yield, cross-slope and smoothness of the pavement. Verify contract requirements are met by:
  - Calculating yield once per day based on the actual tonnage placed and the actual area (length and widths) paved.
  - Verifying paver is adjusted correctly and checking the cross-slope frequently with a straight-edge.
  - Reviewing the smoothness profilograph each day.
- Paver speed – is every effort is being made to keep the paver moving continuously and at an appropriate speed (i.e. contractor is matching delivery of material to paver speed; enough haul trucks are being used to continuously supply the paver).
- Rolling operation – verifying the rolling pattern established during the acceptance test strip is being followed.

Check for difficulties when trucks are being used to load material into the paver hopper. Trucks must not be allowed to back into the spreader so that they bump it or bear against the machine.

By observing the surface texture and depth behind the machine, and checking the surface with a straightedge, a malfunction in the paver or non-uniformity of mixture may be detected. Some of the most common difficulties encountered together with possible causes include (see table on next page):

FAULT	CAUSE
Dragging (Displacement of plant mix in a longitudinal direction)	Cold mix Improper gradation Aggregate too large for depth of lay (lift thickness should be 2 ½ to 3 times the maximum aggregate size)
Tearing (Pulling of plant mix under the paver)	Build-up on screed Worn screed Worn tampers Improper tamper adjustment Improper amount of material in augers (usually too high) Improper "lead crown" in screed o Tearing in center, add lead crown o Tearing on edge, take out lead crown [ordinarily the leading edge of the screed will have 1/8-3/16 in (3-5 mm) more crown than the back] Insufficient asphalt
Segregation (Separation of the coarse aggregate from the rest of the plant mix)	Segregated in trucks (improper handling, insufficient mixing) Segregation in hopper Feed from hopper too low Worn augers
Wavy Surface (short choppy waves)	The amount of material on auger is causing compaction under auger (auger shadow) Worn tampers Worn augers Truck driver setting brakes too tightly. Pickup machine set too close to ground Uneven buildup or wear on truck Automatic controls hunting Running screed too empty with oscillating-vibrating screeds Excessive paver speed
Wavy surface (long waves)	Too much variation in amount of material in front of screed Over controlling screed Worn auger

(cont.) Wavy surface (long waves)	Variation in machine travel speed Improper mounting of windrow pickup device Sudden stops and starts of machine Sag in erected string line for automatic control Ski or beam brackets binding on automatic controls Variation in material temperature Variation in material moisture content Variation in asphalt content Variation in gradation Variation in uncompacted material thickness On pneumatic machines the weight of the material on the conveyors from hopper to screed is carried by the pneumatic tires; running this conveyor empty will cause the machine to rise Roller operating too fast
Irregular rough spots on pavement:	Roller standing on fresh surface; Abrupt reversing of roller; Trucks backing into paver; Poor workmanship at transverse joints.
Miscellaneous Bumps	Pivot points on screed binding Screed adjustment screw loose or binding Paver setting too long on mat, allowing screed to settle Bumping or uneven push on trucks Flat spots on rollers Wear in kingpin or axle bearing or rollers Running over spilled material Parking or turning rollers
SURFACE TEXTURE	
Excessively open	Improper adjustment of strike-off Screed plat rough or galled Excessive paving machine speed Cyclic open texture is primarily caused by the machine operator allowing the head of material to fall below the top of the augers or by dumping the wings of the paver when the hopper is low on material.

Varying **Varying (cont.)**	Insufficient mixing Trucks being loaded improperly at the plant Segregation of mix at the plant Poor gradation control at the mixer Screed not uniform across paving machine.
Streaked:	Insufficient mixing Segregation of mix in trucks Worn or damaged screed plate
Bleeding patches:	Asphalt not uniformly mixed Excessive moisture in mix.
Crooked or irregular longitudinal joint lines	Careless machine operation.

J. Compaction

The primary purpose of all rolling is to obtain compaction while also providing a satisfactory surface. Compaction rolling begins while the mix is still at the highest temperature that will allow rolling without damage to the surface or affecting smoothness. All compaction rolling must be completed prior to the cooling below 175 degrees Fahrenheit (80 degrees Centigrade). Verify throughout that Section 306 requirements are being followed.

Verify that the rolling equipment is the same type and weight as was used on the acceptance test strip. During production verify the rolling equipment is following the pattern established during construction of the acceptance test strip. If the contractor is experiencing difficulty in obtaining compaction, monitor and documents the efforts the contractor is making to obtain the specified compaction. The rolling should be done in compliance with the temperature parameters supplied by the asphalt manufacturer. Poor mix compaction may occur because of the following:

- Improper rolling operation.
- Reversing or turning too fast of rollers.
- Parking roller on hot mat.
- Improper mix design
- Moisture in mix.
- Variation in mix temperatures.
- Cold mix temperature.

If pick-up of material is occurring on the roller wheels, check that they are being properly moistened.

Traffic should not be allowed upon the new pavement until it cools to the temperature recommended by the asphalt manufacturer.

K. Joints

Joints, both longitudinal and transverse, have a great effect on the riding quality of a job. On transverse joints, the previously laid material must be cut back to expose the full depth of the new lift thickness. Use of a straight edge is very important to determine the distance to cut the existing material back.

Ensure the contractor is immediately testing the joint for smoothness and correcting defects before the material temperature drops below the minimum rolling temperature.

L. Plant Mix Leveling Course

Plant mix leveling course may be either machine or blade laid. See the specifications for requirements.

M. Surface Smoothness

Surface smoothness testing is to be done by the Contractor using both a 10 ft (3 m) straight edge and a profilograph. The State must verify the Contractor's profilograph using the following procedure:

> For all profilographs, verification requires that a verification block be used at least once per each profilograph run. The verification block is to be ¾ inch thick, 75 inches in length placed longitudinally in the profilograph path by the State. Approximate station(s) of the block placement are then noted in the construction diary. The block will present a "spike" with vertical edges approximately ¾ inch high by ¼ inch in length on the profilogram. The "spike" must be manually subtracted from the Profile Index for the run to obtain the actual Profile Index. The actual Profile Index is then used to determine "must grind" areas and surface smoothness.
>
> For manual profilographs (those using a pen plotter linked directly to the wheel), the profilogram must be initialed by the State at either the beginning or end of the run, and at the location(s) where the verification block was placed. For all other profilograghs, a documentation point shall be inserted in the file at the location of the verification block. For electronic profilographs a preliminary copy of the profilogram must be submitted to the State immediately at the end of the run. The evaluated profilograms are required to be submitted no later than the next working day.
>
> The State must witness vertical and horizontal calibration of all profilographs and document in the construction diary.

The intent is to check the pavement for surface smoothness as soon as possible after final rolling. The profilograph must be run no later than the next working day following placement. The graph chart produced by the profilograph is to be evaluated by the Contractor in accordance with Idaho T-140 and then given to the State for review and retention. Pavement surfaces not meeting the required smoothness specification will have to be ground to specification values. If pavement smoothness is outside specification limits, it is most imperative that the Contractor determine the cause and it be corrected to ensure a smooth pavement meeting specifications. Require the contractor to follow specifications to analyze and submit by the next calendar day.

If grinding is necessary, observe roadway temperatures do not become excessive. If temperatures become to hot, the equipment may pull aggregates right out of the pavement. Stop operations until the pavement has sufficiently cooled down.

406.00 ROAD MIX PAVEMENT

Three methods are generally used to produce road mix pavement:

- Travel plant mixing
- Stationary plant mixing
- Road grader mixing

The specifications will allow the use, under certain conditions, of any of these or may specify the method to be used. Regardless of the mixing method used, one of the major problems is the inherent lack of control of asphalt content. Variation in windrow or aggregate feed, minor segregation of material and distributor operation can and do create fat or lean spots with the resultant flushing, pushing, and raveling problems. These variations are not always apparent by visual inspection. Therefore, every effort should be made to control, as closely as possible, the factors that may affect asphalt content.

Aggregate windrows must be of uniform size throughout the section to be mixed and the quantity of material must be known to calculate asphalt required. When placing material through a windrow sizer, the load on the sizing gates should be constant, as this will affect the density of the material and thereby, affect the asphalt content.

When mixing in a stationary plant, the materials must be fed in such a manner to assure proper proportions. The material must be dry and any areas showing segregation must be corrected prior to mixing.

When mixing with road graders, the asphalt must be added in several shots as specified. This not only assures more uniform application but will also facilitate mixing. Too much asphalt per shot will form balls of free asphalt and fines that are very difficult to break down.

Mixing must be continued until all particles are coated and no free asphalt remains. Since road mix pavements are ordinarily made with cutback asphalts, continued manipulation of the mix will allow the volatiles to evaporate and produce a dry material that is very difficult to place and compact. When the mix is to be left for any length of time, it should be placed in a tight windrow to cut down volatile loss.

A tack coat is not ordinarily necessary with road mix pavements when any mixing is done on the road.

Blade laying the material requires good operators and equipment. Patrols and rollers should be inspected carefully, and worn or defective equipment replaced. Patrols used for laying should be equipped with smooth or well-worn tires. This will facilitate the removal of tire marks from the surface. Care must be exercised during the laying and rolling to ensure sufficient and uniform compaction of the mat. The laying pattern of the patrol naturally provides additional compaction in some areas. If the compaction of the adjacent pavement is not sufficient, ruts and wheel path depressions may develop under traffic.

Any unsatisfactory areas of pavement must be repaired before the asphalt is cured. This may require picking up the processed material, remixing, and relaying it. Overlaying rough spots or depressions with thin patches will not ordinarily provide a satisfactory repair.

Seal coats should not be applied to a road mix pavement until it is thoroughly cured. A minimum cure time of 10 days is required after placement.

406.01 EMULSIFIED ASPHALT ROAD MIXES

Emulsified asphalt is an emulsion of asphalt cement and water that contains a small amount of emulsifying agent. It is a heterogeneous system containing two normally immiscible phases (asphalt and water) in which the water generally forms the continuous phase and the minute globules of asphalt, the discontinuous phase.

Both medium setting (MS) and slow setting (SS) emulsified asphalts are used in emulsified asphalt base mixes. They may be either of two types: Cationic (AASHTO M 208) or anionic (AASHTO M 140).

406.02 STORAGE AND TRANSFER OF EMULSIFIED ASPHALTS

The storage and transfer of emulsified asphalts requires close adherence to the following guidelines:

- Anionic and cationic asphalts should never be mixed. Storage tanks should be emptied and flushed with water before switching from cationic, and vice versa.
- Emulsified asphalts should not be stored at temperatures below 50°F (10°C).
- Should it be necessary to heat emulsified asphalts, the heat should be applied very slowly while the emulsion is gently circulated. The temperature of the material should never exceed 160°F (70°C).
- When emulsified asphalts are stored for any length of time, they should be gently circulated once or twice a week to prevent settlement.
- During the transfer of emulsified asphalts, foaming (caused by air entrapment) should be avoided. To this end, storage-tank inlet pipes should be positioned within a few inches of the tank bottom. This provides for nonturbulent entry beneath the free liquid surface of the emulsion into the receiving tank.

406.03 MIXING

There are two basic methods of mixing:

- Central plant
- Mixed-in-place.

The choice of method depends on such factors as anticipated traffic loadings, aggregate source, project size, and available equipment. Regardless of the mixing method, 100 percent coating of the coarse aggregate particles is not always achieved and neither is it necessary. Mixing procedures should aim at achieving a uniform dispersion of the emulsified asphalt with a complete coating of the finer aggregate fractions. Toward achieving uniform dispersion of the emulsified asphalt, it is generally necessary to moisten the aggregate before application of the

emulsion. The minimum amount of water needed for this purpose is that sufficient to merely darken the aggregate, however, the appropriate volume of water should be determined by means of the mix design.

Central Plant Mixing

Central plant mixing generally is accomplished away from the road site, frequently at the aggregate source. Conventional pugmill and dryer-drum hotmix plants may be used to produce emulsified mix. However, more frequently for these mixes, the central plant consists only of a mixer and certain auxiliary equipment for feeding the asphalt, water, aggregate, and additives (if needed) to the mixer. The emulsified mix plant generally has no dryer or screens other than a scalping screen to remove oversize aggregate. It is, therefore, readily transported and easily erected.

Any type of plant that can produce an asphalt mixture conforming to the specifications may be used. But, as a minimum, it should be equipped with meters to control accurately the emulsified asphalt and the water being applied, and controlled feeders for the accurate proportioning of aggregates and additives. The asphalt and the water pumps should be interlocked with the aggregate flow in order to produce a mixture with consistent predetermined percentages.

Although not always a plant component, a surge hopper at the discharge end of the plant allows a more continuous mixing operation resulting in better mix uniformity.

Emulsion mixes require a shorter mixing time than asphalt concrete mixes. The tendency is to overmix emulsified asphalt mixes. Overmixing has the effect of scrubbing the emulsified asphalt from the coarse aggregate particles. It also may result in the premature breaking* of the emulsified asphalt, causing overly stiff mixtures. *(An emulsified asphalt is said to break when the asphalt and water phases separate. This is indicated by a marked color change from brown to black).* A less common problem is undermixing which results in insufficient coating of the aggregate.

Mixing times can be varied in a continuous pugmill plant by changing the arrangement of the paddles, by varying the height of the end gate, or by changing the location of the asphalt spray bar. With a dryer-drum plant, mixing time is controlled by varying the slope of the drum, rotation speed, or by changing the location of the asphalt inlet pipe within the drum.

In-Place Mixing

Three types of in-place mixing are commonly used: **Travel plant, rotary cross-shaft**, **and blade mixing.**

- **Travel Plant**: The pick-up type of plant moves through a prepared aggregate windrow on the roadbed, adding and mixing the emulsified asphalt supplied from a transport truck and discharging to the rear a mixed windrow ready for aeration and spreading.

  The hopper type of travel plant combines aggregate that has been deposited in its hopper, with asphalt from a self-contained tank, and spreads the mix to the rear in one pass.

- **Rotary Cross-Shaft**: Rotary cross-shaft mixing employs a mobile mixing chamber which, depending on the model, is either self-propelled or towed by a tractor.

  The mixing chamber, usually a full lane wide, 2 to 3 ft (0.60 to 1 m) high, and open at the bottom, contains one or more shafts, transverse to the roadbed, upon which mixing blades or tines are mounted. As the shafts rotate rapidly, the mixing tines thoroughly

agitate the material in the roadbed. The machine, moving forward, strikes off a uniform course of asphalt-aggregate mixture.

Some rotary mixers are equipped with a system that adds water and asphalt by means of spray bars in the mixing chamber. Other machines, however, must be used in conjunction with a water truck and an asphalt distributor that spray water and emulsified asphalt onto aggregate immediately ahead of the mobile mixer. The depth of treatment can be varied and is controlled by the height of the mixing shaft within the chamber.

Prior to mixing, in-place aggregate should be scarified to the full depth of the proposed treatment to loosen the material and remove any localized hard spots. After scarification, the surface should be shaped to the desired cross section in preparation for the mixing pass.

One pass of the rotary cross-shaft mixer may prove sufficient to achieve uniform asphalt dispersion. However, should additional passes be necessary, it must be verified that the mixing tines are reaching the previous depth of treatment, since there may be a tendency to "ride up" on the partially stabilized aggregate.

- **Blade Mixing**: The third (and least precise) method of in-place mixing is with a blade grader. The first step in the operation is to shape the aggregate into a uniform flattened windrow of a known volume by means of a spreader box, windrow spreader, or grader. This allows for the most accurate application of mix water and emulsified asphalt. After windrowing, fillers or additives, if specified, should be applied. Mix water is then added at a predetermined rate by means of a distributor truck straddling the flattened windrow. The water is then blended with the aggregate by blading the windrow to achieve a rolling action off of the moldboard.

  After the mix water is thoroughly blended with the aggregate, and the flattened windrow reshaped with the grader, the emulsified asphalt is applied; usually in two or three passes. After each pass, the emulsified asphalt and aggregate are mixed by the same technique used to blend the mix water with the aggregate. The grader should fold the aggregate around the applied asphalt, working the mixture back and forth across the entire roadway surface. This mixing is continued until the asphalt is uniformly distributed throughout the aggregate.

  After each asphalt application and its subsequent mixing, the mixture is reshaped into a windrow for the next application. During mixing, extra material must not be taken from the mixing table and incorporated into the windrow. None of the windrow should be lost over the edge of the mixing table or left on the mixing table without being processed.

  In most cases, the mixture will be suitable for lay-down and compaction immediately after blade mixing. Occasionally, however, additional aeration is required. In this event, the motor grader should continue to blade the mixture until the additional dehydration has occurred.

406.04 MAINTENANCE OF UNIFORM ASPHALT CONTENT

In order to maintain uniform asphalt content when using any one of the three mixed-in-place methods, three essential variables must be kept in equilibrium. They are:

- The travel speed of the equipment applying the asphalt,
- The volume of aggregate being treated, and
- The flow rate (volume per unit time) of emulsified asphalt being applied.

The three variables must interact so that if one changes, the others are adjusted to maintain the predetermined asphalt content. However, when an asphalt distributor is used to apply asphalt to a windrow, or when mobile mixers or travel plants without synchronization are used, the operator must constantly monitor and adjust to changes in these three important variables.

406.05 SPREADING THE MIX

Emulsified asphalt mixes gain stability as the fluids (mainly water) that have made the mix workable, evaporate. It is important not to hinder this process. Therefore, lift thickness may be limited by the rate at which the mixture loses its fluids. The most important factors affecting this dehydration or curing are the type of emulsified asphalt, the mix water content, the gradation and temperature of the aggregate, wind velocity, ambient temperature, and humidity.

Although each job has its own particular combination of these factors, experience has shown that under the best conditions, dense-graded mixes should be placed in compacted thickness no greater than 3 in (75 mm).

Open-graded mixes, since they allow quicker evaporation, have higher early stability under traffic, and may be placed in thicknesses of up to 5 in (125 mm) under good curing conditions.

When multiple lifts are required, some curing time must be allowed between successive lifts. The length of this curing time is a function of the rate of evaporation, and this varies.

However, an existing lift may normally be overlaid 2 to 5 days later, under good curing conditions.

406.06 COMPACTION

Unlike asphalt concrete, which requires immediate breakdown rolling, a delay in initial rolling is often necessary with emulsified asphalt mixes, especially dense-graded mixes. Rolling seals the pavement as it reduces the voids in the mix. If done prematurely, it retards dehydration of the excess water required to facilitate mixing, and thereby greatly extends the time required for the mix to reach design strength. It also is necessary that the mix be allowed to develop strength sufficient to support the rollers. Nonetheless, if it is too long delayed, compaction is rendered difficult and, in some cases, the developing asphalt-aggregate bond will be irreversibly broken.

Proper timing is of utmost importance. Experience has shown that breakdown rolling should begin immediately before or at the same time as the mixture starts to break. About this time, the moisture content of the mixture is sufficient to act as a lubricant between the aggregate particles, but is reduced to the point where it does not fill the void spaces and prevent their reduction under the compaction force. Also, by this time, the mixture should be able to support the roller without undue displacement.

TYPES OF ROLLERS FOR COMPACTION OF EMULSFIED ASPHALT MIXES			
Type of Emulsified Asphalt Mixes	Stage of Compaction		
	Breakdown Rolling	Intermediate Rolling	Finish Rolling
Dense-Graded	Steel Wheeled Pneumatic-Tired Vibratory	Steel Wheeled Pneumatic-Tired Vibratory	Steel Wheeled
Open-Graded	Steel Wheeled*	Steel Wheeled Vibratory Pneumatic-Tired**	Steel Wheeled

**Breakdown rolling of open-graded emulsified asphalt mixes is often facilitated by adding a small amount of detergent to the sprinkler system water to prevent pickup.*

***If intermediate rolling of an open-graded emulsified asphalt mix is to be with a pneumatic-tired roller, or if traffic must use a recently placed mix, a choker stone application of from 4-6 lb/y^2 (2-3 kg/m^2) of suitable aggregate should be applied. Stone screenings from a crushing operation or concrete sand are among those suitable.*

406.07 TRAFFIC CONTROL

If possible, traffic should not be allowed on the mix until the mix will support vehicles without undue displacement. Under favorable conditions, thin lifts with low moisture content may handle traffic within 3 hours after rolling. However, it is often not possible to close a road completely. In this event, traffic control requiring reduced vehicle speeds is necessary. In most cases, a motor grader may be used to reshape any surface irregularities caused by early traffic. If there is a problem with asphalt pickup, a light sand cover will generally eliminate the problem.

406.08 WEATHER

The preceding paragraphs have discussed the relationship between dehydration and the strength gain of the emulsified asphalt mix. The key to this dehydration process is suitable weather conditions during construction and throughout the curing period.

Construction should not continue during rainfall, and should not begin when rain is expected. Also, the emulsified asphalt mix should not be placed if the ambient temperature is below 50°F (10°C).

407.00 SCRUB COAT

A scrub coat is a preparation course for existing roadway surfaces that accomplishes crack filling and minor leveling of surface irregularities prior to the placement of subsequent courses or seal coats. It may be mixed on the roadway, in a traveling plant, or in a stationary plant depending on specification requirements. Plant mixing is the superior method, provided that sufficient aeration of the material is accomplished during the placement or scrubbing operation.

Scrub coats shall not be used for the purpose of major leveling. In general, the maximum depth of scrub coats should not exceed approximately 1 in (25 mm). Roadways requiring courses of greater depth for purposes such as filling deep ruts and depressions and building up of super elevations should be corrected using plantmix leveling courses.

Excessively deep scrub coat courses tend to entrap the low volatility diluents in the liquid asphalt aggregate mixture creating an unstable layer of material. The material is sized and windrowed on the roadway and spread with patrols. The patrols perform a tight blade on the material, scrubbing the fines into the cracks. The patrols should apply enough pressure so that some aggregate is broken in the application process. Pneumatic rolling is accomplished during the tight blading operation to compact the material in the cracks. The crack filling is best accomplished by blading the material from one shoulder to the other and then back to the original shoulder. The remaining material is then spread and compacted for leveling purposes. Excess course material may have to be wasted.

A standard tack is generally applied to the existing mat in amounts applicable to the surface condition. However, when a road mixing is specified, the same liquid asphalt as the scrub coat is used. This sticks dry fines in the initial blade mixing and provides sufficient asphalt for tight blading into the cracks.

When applying a seal coat, the asphalt application rate is generally less than normal to account for chip penetration into the soft scrub coat. A minimum of 10 days is needed for the scrub coat to cure prior to placing a subsequent surface treatment such as a seal, etc.

408.00 FOG COAT

A fog coat or fog seal is a single shot of asphalt material in a very light application, generally 0.10 gal./yd^2 (0.45 L/m^2) or less without a sand cover. This seal is used in the preparation for heavier applications of asphalt and cover material where the pavement surface has deteriorated to the extent that too much asphalt would be absorbed by the dry pavement and cause failure of the final seal coat. It is also used to provide a seal on a permeable pavement where a regular seal coat is not always desirable. It has been used to seal the surface of plant mix pavements constructed late in the fall where inadequate compaction is sometimes responsible for a slight raveling during the following winter.

Fog seals must be used with discretion and caution. They are used only to correct defects in existing pavements. Application of fog seals consists mainly of careful control of the distributor (Section 403). Verify that the distributor does not exceed 35 mph (50 km/hr). Application rate should be based on the amount of asphalt that will readily penetrate the mat without leaving an excess on the surface. Surface voids should be sealed but not filled, since this would cause slick or fat spots. Generally, the surface texture of the mat should show little change after application. The initial visual effect should be that of a light paint job.

The rate of application should be determined by short test sections. Normally, it will be from 0.05 to 0.10 gal./yd ^{2} (0.23 to 0.45 L/m^2) for dilute SS-1. More asphalt may be required for open textured or dry old pavements. Diluted emulsion resin runs about 0.10 to 0.12 gal./yd ^{2} (0.45 to 0.54 L/m^2).

409.00 PORTLAND CEMENT AND CONCRETE PAVEMENT

The construction of high quality concrete pavement is a function of the Contractor's workmanship. The State's role is to ensure and enforce that the contractor is following all contract requirements. All sampling, testing, and reporting shall be in accordance with procedures and frequencies outlined in the Department's *Field Test Manual*.

Convene a pre-paving operational meeting prior to paving to discuss materials handling, plant site, equipment, method of operation and contract requirements.

409.01 Description

A. Mix Design

The Contractor is responsible for the mix design. The State reviews and confirms the mix design for compliance with the specified basic mix design parameters and proportioning. Subsection 409.03 Proportioning specifies the information and materials that the Contractor must submit as well as additional mix design criteria. Do not allow production to start until the Central Materials Laboratory has confirmed the mix design. The Materials Manual contains the procedures used by the Central Materials Laboratory to confirm the mix design.

B. Acceptance

Concrete acceptance during production is based on the basic mix design parameters and strength as required by the specifications. Concrete that does not meet the basic mix design parameters as determined by field testing is rejected. The specifications provide the criteria to be followed if minimum 28 day compressive strength tests are not attained. The minimum testing requirements, including testing frequencies and independent assurance (that the State must perform) are contained in the Department's Field Test Manual – Part II Quality Assurance Program.

409.02 Materials

See the specifications for materials and the test methods to be used.

409.03 Construction Requirements

A. Proportioning

See mix design discussion in 409.01.

B. Equipment

Verify that all equipment is in compliance with the specifications prior to work start.

B-1. Mixers and Hauling Equipment

Mixing blades should not be worn excessively. A worn blade will show more wear at the center with relatively little at the ends. The amount of wear may be measure using a string line or straight-edge. Blades with more than one inch of wear should be replaced.

The size of batch, speed of rotation, and mixing cycle must comply with the specifications. The batch counter or timer must be checked prior to discharge to assure that the material has received the full specified mixing.

The mixer must have the manufacturer's nameplate attached setting forth recommendations for its use. No equipment should be operated in excess of the manufacturer's recommendation.

Verify the water meter calibration to ensure that the correct water quantity is being attained. Verify that no water lines or valves are leaking.

All hard concrete or other foreign material must be removed from the mixers or truck beds.

B-2 Paving Equipment

The slip form paving equipment must be self-propelled and capable of placing, spreading, consolidating, screeding and finishing the freshly placed concrete to the proper pavement elevation and cross-section within the specified tolerances using string lines established by the contractor. The concrete is vibrated with internal vibrators. See the specification for rates and measuring device requirements.

Critical features to verify are in good operating condition include checking all screeds with a string line to ensure a true plane or crown, checking the height of the finished pavement elevation, checking vibrating frequency of the vibrators and screeds, checking the feelers or sensors for sensitivity and the related string line for tightness to ensure adequate control. Finally, verify that the paver may accomplish the desired crown break section and any transition adjustments.

Slip form paving machines are equipped to receive concrete either in a receiving hopper or on the subgrade within an extension of the attached side forms. The concrete should not be dropped more than 1.5 m (5 ft). A greater free fall will induce segregation of the mix and a surge of concrete under the screed.

When provided, the hopper serves the purpose of providing for lateral distribution of the concrete to the main screed. Operation of the receiving hopper should be controlled to provide a uniform amount of concrete at the main screed. When concrete is placed on the subgrade in advance of the paver, the pattern of distribution of the batches becomes very important. Alternating wet and dry batches produce irregularities in the finished surface. The wet batches slump excessively at the edges; and dry batches result in high spots and cause difficulties in operating the machine. The paver should be equipped with an initial strike-off blade that distributes the concrete for the full paving width in front of the main screed.

B-3 Concrete Sawing Equipment

Sawing equipment is generally equipped with guide, blade guards, water cooling systems, and cut depth controls. Adequate and extra equipment and parts as specified must be on the job prior to placing concrete and during sawing operations. Verify that the gang saws are in alignment. Sufficient lighting must be provided so that sawing may be performed at night when necessary.

C. Handling, Measuring and Batching Materials

It is important that the aggregate be well graded and remain so throughout the job.

Segregation and contamination are two of the main problems associated with the stockpiling and handling of aggregates. Specifications regarding stockpile construction are outlined in Subsection 106.11 of the Standard Specifications. Under no circumstances should equipment being used to construct stockpiles be allowed to track mud into the stockpile site. Stockpiles of concrete aggregate must be physically separated by distance or by a bulkhead to prevent contamination.

The ideal moisture content for both the coarse and fine aggregate is that of a saturated surface dry condition. Aggregates that have been washed or taken from a wet source should not be used until the free water has drained off. Uniformity of moisture is probably the most important factor in achieving a consistent slump. Aggregates that have been washed must be drained at least 12 hours prior to use.

Particular attention should be given to the storage and handling of cement. The cement must be protected from the elements until it is incorporated in the mix. A considerable loss of cement may occur when it is exposed to the wind.

Concrete additives, such as air entraining admixtures, set retarding admixtures, water reducing admixtures, etc., may be used subject to approval of the engineer. Verify that only approved admixtures are being used and are dispensed accurately and appropriately into the batch. The dispenser should be checked daily to see that it is functioning properly and accurately.

Any source of water approved for culinary use may be used for concrete. Nonpotable water must be approved before use. Water should be cool particularly in hot weather so that the temperature of the mix does not exceed 80°F (27°C). In cold weather, it may be necessary to heat the water or aggregate or both. However, the 80°F (27°C) maximum temperature for the mix at the time of placing must not be exceeded.

The water meter should be checked at the start of each job and occasionally during the progress of the job by diverting water into a drum and weighing for various settings of the gauge. Leaky lines or valves are not permitted.

Materials must be accurately weighed into batches. Before starting the job and at frequent intervals thereafter, the batching equipment should be carefully inspected and checked. All batch weighing equipment should be supported on stable footings and checked for accuracy before work begins. The scales should be checked throughout their working range. All calibration readings should be made a part of the project records.

During the progress of the work, the scales should be checked for zero balance daily and recalibrated when necessary.

If beam scales are used, the set screws holding the counterweights on the beam arm must be firmly tightened. Vibration tends to move these weights which will cause incorrect batch weights. Scales must be kept level at all times. Fulcrums, clevises, knife edges, and other working parts must be kept clean and free from accumulations of dirt and cement dust.

D. Mixing and Delivering

Concrete may be delivered and mixed a variety of ways. See the specifications for requirements of the various methods including mixing and delivery time constraints.

E. Conditioning of Subgrade or Base Course

The subgrade must be shaped and thoroughly compacted prior to concrete placement, and kept in this condition. Verify that the subgrade surface is firm and unyielding. Require that soft spots be removed and backfilled with suitable material.

Verify that the subgrade is at the correct elevation including the crown and any super transitions.

F. Temperature Limitations and Cutoff Dates

See the specifications for when concrete may be placed and concrete temperature and evaporation constraints.

Concrete may be placed after October 1 and before May 1 only with the Engineer's approval.

G. Hand Placing Concrete

Hand placing is permitted under very limited circumstances. See the specifications for when hand placing is allowed and requirements.

H. Joints

H-1. Tie Bars and Load Transfer Devices

Tie bars are deformed steel bars used at the longitudinal joint to help hold the longitudinal lanes of concrete together. Tie bars are placed to the depth and spacing shown on the plans.

Load transfer devices are smooth steel bars used at the transverse joint locations to transfer load from one slab to the next under traffic loading. It is imperative that the dowel bars be installed parallel to centerline of the concrete roadway and parallel to the surface of the roadway. The locations of the dowel bars must be positively marked so that the transverse saw cut will follow the center of the dowel bar installation across the roadway. The dowel bars should be properly lubricated before installation.

H-2. Transverse and Longitudinal Joints

The purpose of joints is to control the location of cracks in the pavement. Joint spacing, skew, depth and width of the joint to be sawn are shown on the plans. Stress relief saw cuts must be made as soon as the concrete has hardened sufficiently to allow sawing. It is necessary to make this relief cut to the depth indicated on the plans or random cracks may develop outside the planned longitudinal and transverse joint system.

Joints should be sawn as soon as the concrete has hardened sufficiently to permit sawing without damaging the pavement surface or concrete adjacent to the joint. All joints shall be sawn before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on both during the day and night, regardless of weather conditions. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. If dowel bars are

being used for load transfer, refer to the specifications for corrective action to take should a pavement crack occur at any location other than the load transfer device.

H-3. Construction Joints

Whenever paving operations are discontinued at the end of the day, or at any time for more than thirty minutes, a construction joint shall be constructed at right angles to the center line of the pavement. A header board should be cut to the slab section and firmly staked so that the board conforms to the proper elevation and section. The board should be a minimum of 1 5/8 in (41 mm) thick and have a metal strip or board strip fastened to it of the size and shape specified to form a key-way in the end of the slab. Load transfer devices will be constructed as shown on the plans.

H-4. Construction Sealant Reservoir

After 72 hours, the joints will be sawed to the width and depth shown on the plans for placement of sealant. Verify that the reservoir is cleaned and prepared according to the specifications before any sealant is placed. Joint preparation and sealant placement are very critical operations and if the specifications and good workmanship are not followed, the sealant will more than likely experience premature failure. The serviceability and life of the concrete pavement depends heavily on the sealant keeping the water out of the pavement system. Ensure the Contractor is protecting the joints prior to sealing.

When a concrete pavement slab is placed next to an adjacent slab, require the Contractor to make every effort to line up the transverse joints.

I. Tolerance in Pavement Thickness

This subsection outlines the requirements for thickness determinations and provides price adjustment criteria when prescribed tolerances are not met. Ensure that thickness tests are obtained at the prescribed frequencies and results recorded in the construction diary.

J. Final Finish

The surface of the pavement shall be finished as required by the specification. Timing is critical. The texturing must be done while the concrete is wet enough to allow proper texturing but not so dry as to cause tearing of the surface. Verify that depth tolerances are being followed in accordance with the specifications, ensure corrective action are made immediately when necessary and record results on the proper form.

K. Surface Test

The specifications require that the pavement surface be tested with a 10 ft (3 m) straightedge and a profilograph. Deviations in the form of high spots may only be corrected by grinding after the concrete has hardened. It is recommended that after the floating has been completed and any excess water and mortar removed, but while the concrete is still plastic, that the surface be tested for trueness. High spots may be cut down and refinished. Any depressions found should be immediately filled with fresh concrete, struck off, consolidated, and refinished. Special attention shall be given to assure that the surface across joints meets the requirements for smoothness. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and the slab conforms to the required grade and cross-section.

The profilograph is run after the concrete has hardened sufficiently to allow its use. Pavement outside specification limits will be corrected accordingly. See Section 405.03 M for profilograph verification procedures.

L. Curing

Curing compound is intended to protect the concrete against drying too rapidly and to prevent heat buildup from radiant solar heating. Effective curing assists the chemical action between the cement and the water and protects the concrete against shrinkage until such time as it gains sufficient strength to resist the imposed tensile stresses.

In order to be effective, the curing must be prompt and must be complete in its coverage.

Damaging loss of water occurs in concrete immediately after it starts to set if no protection is afforded to prevent evaporation from the surface. A delayed cure may also result in hair checking and random cracking. The sides of the slab must be covered with the curing compound as well as the surface.

Verify that the compound has been sampled, tested and approved in accordance with the specifications prior to use.

Ensure that the use of any evaporation retardants are only in accordance with manufacturer recommendations.

M. Cold Weather Concreting

The Contractor is responsible for protecting the concrete during cold weather. See the specifications for requirements. Verify that the recording thermometers are operating correctly.

N. Sealing Joints

Do not allow the Contractor to seal joints below the specified minimum temperatures. See the specifications for requirements.

O. Multiple Lane Construction

See the specifications for requirements.

P. Protection of Pavement

Verify that the Contractor has on hand adequate materials for protection.

Q. Opening to Traffic

When the pavement has developed a compressive strength as specified, the roadway may be opened to traffic if approved by the Engineer and after the pavement has been cleaned.

411.00 URBAN CONCRETE PAVEMENT

411.01 Description

The requirements of Section 409 apply with exceptions as specified in Section 411.

411.02 Materials

See Section 409.02 for material requirements.

411.03 Construction Requirements

The requirements of Subsection 409.03 apply for:

- Mixers and Hauling Equipment
- Mixing and Delivering
- Slip Form Paving
- Weather and Temperature Limitations
- Sawed Joints
- Curing

The requirements of Subsection 502.03 apply for Handling, Measuring and Batching materials.

The requirements of 405.03 apply with exceptions specified in Section 412 for:

- Proportioning
- Surface Test

For joints see the specification for requirements and also refer to Section 409.03 for additional joint discussion.

Section 411 requirements apply to the following:

- Strike-Off, Consolidation and Finishing - See the specification for requirements.
- Forms - See the specification for requirements.
- Edging - See the specification for requirements. Verify that the Contractor is doing the edging at the proper time.
- Final Surface Finish -See the specification for requirements. Verify that depth tolerances are being followed in accordance with the specifications and record results in the construction diary.
- Surface Test - Use of a profilograph is not required. See the specification for requirements.
- Multiple Lane Construction - See specification for requirements.
- Protection of Pavement - Verify Contractor has enough protective materials on hand and are put to use when rain appears imminent. See specification for requirements.
- Opening Pavement to Traffic - See specification for requirements

412.00 PLANT MIX SEAL

412.01 Description

The requirements of Standard Specification Section 405 apply with exceptions as specified in Section 412.

412.02 Materials

See the specification for material requirements. Tests are to be made in accordance with the applicable methods listed in Subsection 405.02. The Contractor is responsible for the mix design.

412.03 Construction Requirements

The requirements of Subsection 405.03 apply for:

- Mixing plant
- Hauling equipment
- Paver
- Mix Design
- Miscellaneous Pavement

The requirements of Subsection 403 apply for tack coat. The requirements of 405.03 apply with exceptions specified in Section 412 for:

- Rollers – verify that Section 412 rolling operations criteria are being followed.
- Mixing – verify that Section 412 temperature requirements are being followed.
- Spreading and Finishing – ensure that the mixture is being placed directly into the paver hopper unless otherwise approved. If approved verify that specification requirements are being followed and revoke approval if necessary based on observation of segregation or other reasons.
- Weather Limitations - verify that Section 412 temperature requirements are being followed
- Joints - verify that Section 412 joint criteria are being followed.
- Compaction – verify that Section 412 Compaction requirements are being followed.

An acceptance test strip is not required. Minimum testing requirements are as specified in the Department's Field Test Manual.