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## 100 CRUSHER RUN SURFACE COURSE (Two Course)

100-1.1 Description. This item shall consist of two courses, composed ofe either crusher run stone or crusher run gravel, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

-2.1 Materials. Crusher run stone shall be crushed from sound, tough, durable rock, and shall be uniform in quality and grading. Crusher run gravel shall consist of sound, tough, durable pebbles with natural filler, crushed and graded to size. All suitable oversize material in pits or quarries shall be crushed to meet the required grading. Sand may be added to the crusher run product to supply any deficiency in the 10-mesh size and dust or earth filler may be added to supply any deficiency in the 200-mesh material. Filler shall possess satisfactory cohesive and low shrinkage characteristics.

All material when tested by laboratory methods using sieves with square openings shall meet the following grading requirements:

| | Percent |
|---|---|
| Passing 1 inch sieve | 100 |
| Passing No. 4 sieve | 35-60 |
| Passing No. 10 sieve | 30-55e |
| Passing No. 200 sieve | 5-10e |

-3.1 Construction Methods. In handling and placing all graded materialse for this work, care shall be taken to prevent separation of the fine from the coarse materials and such separation shall be cause for rejection in the discretion of the engineer.

The bottom course shall be spread in a uniform layer on the prepared subgrade to the loose depth shown on the plans. The surfacing shall then be thoroughly mixed by alternately blading the material into windrows in the middle, and back to the edges of the subgrade until the mixture becomes uniform throughout. A heavy tightly-articulated grader with at least an 8-foot blade pulled by adequate mechanical power shall be used for this operation. When uniform the mixture shall again be carefully spread over the subgrade. Hauling shall be done over the surfacing material already deposited to compact it, accompanied by constant blading and dragging; care shall be taken to fill all ruts caused by hauling, to prevent formation of corrugations and waves in the longitudinal profile of the surface course, and to avoid segregation of the material into nonumiform layers or into patches of coarse or fine material. The hauling shall be distributed so far as practicable in order to produce uniform and thorough compaction of the surfacing material.

-3.2 Watering. During compaction water shall be applied as the engineer shall direct. The normal amount, unless otherwise directed, shall be a total of 60 gallons per cubic yard of materials.

-3.3 Rolling. When required, rolling shall be done with a roller of thee self-propelled type, having a weight of at least 400 pounds per linear inch of tire. A roller shall not be furnished on a project until authorized in writing. Rolling shall begin at the sides and progress toward the center line, overlapping at each succeeding passage.

When the bottom course is satisfactorily compacted, in the opinion of the engineer, the top course material shall be similarly spread, watered, bonded ande compacted in two layers, and each layer treated as previously described. Supplemental crushed material meeting the specifications shall be deposited in piles along the roadway as directed by the engineer.e

After the top course has been completed in the manner specified, the contractor shall shape and finish the entire roadbed, including gutters and shoulders,e so as to produce a uniformly crowned cross section as shown on the plans ande strictly conforming to the profile grade. The gutters shall be cleaned and alle excess material, loose stones and rock fragments that may be dragged to the surfacee or loosened shall be deposited on the embankment slopes or as directed by thee engineer. Until final acceptance the whole surface shall be bladed and dragged as often as necessary to assist in thorough compaction and to maintain it smooth and true to grade and cross sections.

-4.1 Method of Measurement. The quantities to be paid for under thise item shall be the number of tons of bottom course and top course crusher rune material, weighed separately, incorporated in the work and accepted, the tons of supplemental crushed rock and crushed gravel accepted in roadside piles and, when ordered, the amount of watering in thousand gallon units and roller operation ine days. The material shall be weighed on scales furnished by and at the expense ofe the contractor if local material or material not shipped by rail is used. Thee scales shall be satisfactory to the engineer and shall be "sealed" at the expensee of the contractor as often as the engineer may deem necessary to insure their accuracy. If material is shipped by rail the car weights will be accepted providede that actual weight of material only shall be paid for and not "minimum car weight" used for assessing freight tariff. No allowance will be made for materials placed outside of the lines indicated on the plans or ordered by the engineer. Rollere operation shall be for the days actually operated as ordered, including operator, oil, gas, coal, etc.e

-5.1 Basis of Payment. The quantities, determined as provided above, shalle be paid for at the contract unit prices bid for "Crusher Run Bottom Course," "Crusher Run Top Course," "Supplemental Crushed Stone," "Supplemental Crushed Gravel," per ton, "Watering," per thousand gallon unit or "Roller Operation," per day as the case may be, which prices and payments shall be full compensation for furnishing, hauling and placing all material, and for all labor, equipment, toolse and incidentals necessary to complete the item except furnishing roller on job and furnishing all water plants for project, which will be paid for at thee respective lump sums bid for "Furnishing Roller," and for "Water Plant or Plants for Project."e

## 101 CRUSHER RUN SURFACE COURSE
(One Course)

101-1.1 Description. This item shall consist of one course, composed ofe either crusher run stone or crusher run gravel, constructed on the prepared subgrade in accordance with these specifications and in conformity with the lines, grades, and typical cross section shown on the plans.

-2.1 Material. All material shall meet all requirements for "Material"e prescribed for "Crusher Run Surface Course, (Two Course)."

-3.1 Construction Methods. This surfacing course shall be built ande finished as required for the top course of "Crusher Run Surface Course, (Two Course)."

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-4.1 Method of Measurement. The work shall be measured as provided for "Crusher Run Surface Course (Two Course)."

-5.1 Basis of Payment. The quantities, measured as provided above, shall be paid for at the contract unit prices bid for "Crusher Run Top Course," "Supplemental Crushed Stone," "Supplemental Crushed Gravel," per ton, "Watering" per thousand gallon unit, and "Roller Operation" per day, as the case may be, which prices and payments shall be full compensation for furnishing, hauling, and placing all material, for all labor, equipment, tools and incidentals necessary to complete the item except furnishing roller on job and furnishing all water plants for project which will be paid for at the respective lump sums bid for "Furnishing Roller" and for "Water Plant or Plants for Project."

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## GRAVEL SURFACE COURSE

102-1.1 Description. )
-2.1 Materials. )
-3.1 Construction Methods.) This item shall consist of work and material conforming to all the requirements for the work and material of the "Crusher Run Surface Course (Two Course)," save that the material for gravel surface may be natural or uncrushed material. The finished work shall conform to the lines, grades and typical cross section shown on the plans.

-4.1 Method of Measurement. The work shall be measured as provided for "Crusher Run Surface Course (Two Course)."

-5.1 Basis of Payment. The quantities, determined as provided above, shall be paid for at the contract unit prices bid for "Gravel Bottom Course," "Gravel Top Course," and "Supplemental Gravel," per ton, "Watering" per thousand gallon unit, or "Roller Operation" per day, as the case may be, which prices and payments shall be full compensation for furnishing, hauling and placing all material, for all labor, equipment, tools and incidentals necessary to complete the item except furnishing roller on job and furnishing all water plants for project which will be paid for at the respective lump sums bid for "Furnishing Roller" and for "Water Plant or Plants for Project."

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## 110 BITUMINOUS PRIME COAT

110-1.1 Description. This item shall consist of an application of bituminous material on a previously prepared base or road surface in accordance with this specification and at the rate of application ordered by the engineer and to a width at least one foot wider than the proposed bituminous wearing or other course to be superimposed. The bituminous material shall meet one of the following sets of requirements. The type required selected from the following tables will be stated in the Bid Schedule. The particular grade shall be selected by the engineer from the tables given hereinbelow save in the case of emulsified asphalt the right is reserved to specify other grades and kinds of emulsified asphalt which, in the judgment of the engineer, will better produce the desired result.

-2.1 Materials. The bituminous road material shall be homogeneous.

Cutback Asphalts

| Designation | A.A.S.H.O. | MC-1 | | MC-2 | |
|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. |
| Flash point, °F. | T-48 | | | 150 | |
| Viscosity, Saybolt | T-72 | | | | |
| Furol at 77°F., sec. | | 40 | 150 | | |
| 140°F., sec. | | | | 150 | 250 |
| Total distillate | T-78 | | | | |
| (% by vol.) to 437°F. | | | 10 | | 2 |
| 600°F. | | 25 | | 10 | 20 |
| 680°F | | | 50 | | 27 |
| Pene. of residue | T-49 | 70 | 300 | 100 | 300 |
| Duct. of residue, 77°F. | T-51 | 60 | | 60 | |
| Sol. of residue $CS_2$ | T-44 | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 70 | 100 | 135 | 165 |

Refined Tars

| Designation | A.A.S.H.O. | TC-1 | TC-2 | TC-3 |
|---|---|---|---|---|
| Sp. gr. 77°F. not less than | T-43 | 1.090 | 1.090 | 1.100 |
| Sp. vis. 104°F. | T-54 | 8-13 | 13-18 | 18-25 |
| Total distillate by wt. | T-52 | | | |
| to 338°F. not more than | | 7% | 5% | 5% |
| to 518°F. not more than | | 32% | 30% | 30% |
| to 572°F. not more than | | 42% | 40% | 40% |
| Soft. pt. res. not more than | T-53 | 140°F | 140°F. | 140°F. |
| Bitumen $CS_2$ not less than | T-44 | 90% | 90% | 90% |
| Water, not more than | T-55 | 2% | 2% | 2% |
| Temp. of application °F. | | 80-150 | 80-150 | 80-150 |

Emulsified Asphalt

The emulsified asphalt shall be homogeneous and shall show no separation of asphalt at the time of use, provided that separation has not been caused by freezing after delivery, and provided further that this requirement shall not apply if the material is held more than 30 days and when tested in accordance with A.A.S.H.O. method T-59 shall meet the following requirements:

| | Minimum | Maximum |
|---|---|---|
| Viscosity, Furol, 77°F. | 20 | 100 |
| Residue by distillation | 55% | 60% |
| Settlement, 5-day | | 3% |
| Demulsibility, using 35 milliliters, 0.02 N.$CaCl_2$ solution | 50% | 100% |
| Sieve test | | 0.20% |

Tests on Residue from Distillation Test

| | | |
|---|---|---|
| Penetration at 77°F., 100 grams, 5 secs. | 100 | 200 |
| Soluble in carbon disulphide | 95% | |
| Ash | | 2% |
| Ductility at 77°F., centimeters | 40 | |
| Specific Gravity at 77°F. | 1.00 | |
| Temp. of application °F. | 60 | 120 |

-3.1 Construction Methods. Immediately before applying the prime coat, if the surface is sufficiently bonded, the full width of surface to be primed shall be swept with a power broom. In any case care shall be taken to remove all loose dirt and clay or other loose and objectionable material and, if not swept, the surface shall be cleaned by appropriate blowing equipment and any dust coating removed.

Where suitable loose "float" metal is available on the road and it is so directed by the engineer, a portion of the "float" shall be bladed to the sides in two small windrows (of a combined area of not more than one square foot) using only enough material to "blot" and protect the prime. Unless otherwise directed, this material shall be used to cover the prime.

After the operation of removing the dust has been completed and prior to the application of the prime coat an inspection shall be made of the base to determine its fitness to receive the bituminous priming material. That portion of the base proposed for immediate treatment must be dry and altogether in a satisfactory condition. Where traffic is carried around the work by detours, the full width to be treated may be primed in continuous operations but where detours are not available and traffic must be carried over the road being improved, only half the roadway shall be primed at one time, the other half being kept clear and open to traffic under one way control as provided herein under "Traffic Control."

In cases where the center portion of the roadway, due to its additional compaction by traffic, is more impervious than the outer edges of the roadway to be treated, the engineer may require an additional application of bituminous priming material on such outer edges and, if required, such work shall be done when and as directed by the engineer and shall be accomplished with a minimum of interference to traffic.

The application of the bituminous priming material shall be by means of a pressure distributor of approved type at the temperature for application of bituminous materials as contained in these specifications, and shall be applied at the pressure and in amounts as directed by the engineer. The usual amount to be applied will be from one-fourth to one-half gallon per square yard.

After the bituminous asphalt has penetrated the surface, not less than 4 hours after application, the treated area shall be covered where ordered by the engineer with the windrowed surfacing material (where available), sand or other approved material in just sufficient quantity to absorb any excess liquid bituminous material and prevent picking up by passing vehicles.

Following the application, the primed surface shall be allowed to dry for a period of not less than 48 hours without being disturbed, or for such additional period of time as may be necessary to permit the drying of the prime coat, which period shall be determined by the engineer. The surface shall then be opened to traffic if so ordered by the engineer and shall be maintained by the contractor until the surfacing or next course has been placed. Suitable precautions shall be taken by the contractor to protect the primed surface against damage during this interval, including any sand necessary to blot up excess bituminous material for the convenience of traffic.

The bituminous material shall not be applied at such a rate as will cause it to flow off the road surface, even though it may be necessary to subdivide any prescribed application into two applications. In such case no additional compensation shall accrue to the contractor.

No bituminous material for priming shall be applied when the atmospheric temperature in the shade and away from artificial heat is below 60°F. and falling or below 50°F. and rising, or when in the opinion of the engineer weather conditions are otherwise unfavorable.

If believed advisable in order to secure the surface condition necessary immediately prior to the construction of the work to be superimposed, an additional application shall be made at that time in the amount ordered by the engineer of the appropriate bituminous material called for in the Bid Schedule.

-3.2 Traffic Control. When satisfactory detours are not available or when so ordered by the engineer, the contractor shall be required to perform the work while the road involved is in use by traffic. This work shall be performed on only half the roadway at a time, the other half being kept clear and in otherwise good condition for traffic without the splashing of bituminous materials. Also the work shall be conducted so that all portions of the roadway that are limited to half width use at any one time, shall be confined within the limits of highway not to exceed two miles in length. On the unit of highway not exceeding two miles in length within which are located portions of the roadway that are limited to half width use, traffic shall be limited to one direction at a time, the traffic being flagged through, first in one direction and then in the opposite direction at intervals of time not exceeding 15 minutes. The contractor shall be required to furnish flagmen and patrolmen to control traffic at points of danger. The contractor shall also be required to furnish a pilot car and drivers to direct traffic through portions of the road under one way control. After working hours, flagging and piloting will not be required if the contractor leaves the work in such condition that it can be traveled over without damage to the work and without danger to traffic, and will provide an adequate system of signs, lights, barricades, etc. The engineer shall be the judge as to whether or not these conditions are satisfactorily complied with, and as to whether or not flagging and piloting can be dispensed with after working hours. The responsibility for both protection of the work and traffic rests solely with the contractor, and he shall be solely liable for damage and injury that is in any way chargeable to construction operations, or to any circumstances,

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conditions, action or negligence therewith. The contractor shall furnish the necessary warning signs, direction signs, lights, barricades, pilot cars and drivers, flagmen, and patrolmen for the proper protection of the work and guidance of traffic, at his expense.

-4.1 Method of Measurement. The gallonage of bituminous material to be paid for shall be the number of gallons of the material used as ordered in the work, corrected to gallons at 60°F. in accordance with A.S.T.M. Specification D 208-34; provided, however, that the measurement shall be in tons (2,000 pounds) in cases where the Bid Schedule calls for tons of bituminous material.

-5.1 Basis of Payment. The gallonage, determined as provided above, shall be paid for at the contract unit price per gallon bid for "Refined Tar for Prime Coat," "Cutback Asphalt for Prime Coat" or "Emulsified Asphalt for Prime Coat" as the case may be, which price and payment shall be full compensation for the furnishing of all materials, for windrowing the blotter material and/or securing sand for necessary "blotting" and spreading same, and for all labor, equipment, tools and incidentals necessary to complete the item.

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## 111 BITUMINOUS TACK COAT

111-1.1 Description. This item shall consist of an application of bituminous material on a previously prepared bonded and bituminized base or road surface, or concrete base or surface, in accordance with this specification and at the rate of application ordered by the engineer, and to the full width of the proposed bituminous wearing or other course to be superimposed. The bituminous material shall meet one of the following sets of requirements. The type required, selected from the following tables, will be stated in the Bid Schedule.

-2.1 Materials. The bituminous material shall be homogeneous.

Cutback Asphalts

| Designation | A.A.S.H.O | RC-2 | | RC-3 | |
|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. |
| Flash point, °F. | T-48 | 80 | | 80 | |
| Viscosity, Saybolt | T-72 | | | | |
| Furol at 122°F., sec. | | 200 | 400 | | |
| 140°F., sec. | | | | 275 | 400 |
| Total distillate | T-78 | | | | |
| (% by vol.) to 437°F. | | 10 | | 3 | |
| 600°F. | | 20 | | 14 | |
| 680°F. | | | 35 | | 30 |
| Pene. of residue, | T-49 | 60 | 120 | 60 | 120 |
| Duct. of residue, 77°F. | T-51 | 60 | | 60 | |
| Sol. of residue $CS_2$ | T-44 | 99.5% | | 99.5% | |
| Temp. of application °F. | | 125 | 155 | 145 | 175 |

Emulsified Asphalt

Emulsified asphalt shall meet the same requirements as emulsified asphalt for Bituminous Prime Coat.

Asphalt Cement

| Designation | A.A.S.H.O. | AP-1 | |
|---|---|---|---|
| | | Min. | Max. |
| Specific gravity at 77°F. | T-43 | 1.000 | |
| Flash point, °F. | T-48 | 347 | |
| Softening point, °F. | T-53 | 95 | 131 |
| Penetration, 77°F. | T-49 | 120 | 150 |
| Loss at 325°F. 5 hrs. | T-47 | | 1% |
| Penetration drop | T-49 | | 40% |
| Bitumen (Sol. $CS_2$) | T-44 | 99.5% | |
| Organic insols. | | 0.2% | |
| Temp. of application, °F. | | 325 | 375 |

Refined Tars

TC-2 or TC-3 meeting the respective requirements for TC-2 and TC-3 under Bituminous Prime Coat.

-3.1 Construction Methods. Immediately before applying the tack coat, the full width of surface to be treated shall be thoroughly swept with a power broom, care being taken to remove all loose dirt and clay or other loose and objectionable material. The brooming shall continue until the surface of the aggregate is exposed but not loosened. In the event the power broom causes loosening of the aggregate, the sweeping shall be done with hand brooms.

After the sweeping has been completed and prior to the application of the tack coat an inspection shall be made of the base to determine its fitness to receive the bituminous material. That portion of the base proposed for immediate treatment must be free from loose material, must be dry and altogether in a satisfactory condition.

The application of the bituminous material shall be by means of a pressure distributor of approved type and shall be applied at the pressure and in amounts as directed by the engineer. The usual amount to be applied will be from 0.1 to 0.25 gallon per square yard. Following this application, the surface shall be allowed to dry until in proper condition of tackiness to receive the surface course. Suitable precautions shall be taken by the contractor to protect the tack coat against damage during this interval.

-4.1 Method of Measurement. The gallonage of bituminous material to be paid for shall be the number of gallons of the material used as ordered in the work, corrected to gallons at 60°F. in accordance with A.S.T.M. Specification D 208-34; provided, however, that the measurement shall be in tons (2,000 pounds) in cases where the Bid Schedule calls for tons of bituminous material.

-5.1 Basis of Payment. The gallonage, determined as provided above, shall be paid for at the contract unit price per gallon bid for "Refined Tar for Tack Coat," "Cutback Asphalt for Tack Coat," "Emulsified Asphalt for Tack Coat" or "Asphalt Cement for Tack Coat" as the case may be, which price and payment shall be full compensation for the furnishing of all materials, and for all labor, equipment, tools and incidentals necessary to complete the item.

Class A Bituminous Pavements

112 BITUMINOUS TREATMENT - 35-POUND COVER

112-1.1 Description. This item shall consist of a 35-pound spreading or layer ofa aggregate bonded to the road surface by an application of selected bituminous material. It shall be constructed in accordance with these specifications on a road surface which complies with the profile and cross section crown shown on the plans and has been prepared for bituminizing under the item "Reconditioning of Used Roadbed" or on an approved newly constructed base or surfacing, and which in any case immediately prior to placing this proposed treatment has been treated as prescribed under the item "Bituminous Prime Coat," or under the item "Bituminous Tack Coat."

-1.2 The sequence of operations and the approximate amounts of material per square yard of road surface treated shall be in accordance with the following tables, Table I giving amounts per square yard when liquid asphalt or tar is used and Table II when emulsified asphalt is used.

Table I

Liquid Asphalt or Tar
(Including cut-back, 95/ and OH-1 liquid asphalt and tar)

| | Bituminous materials (Gal.) | Grading A | Grading B |
|---|---|---|---|
| On Treated Surface (Prime or Tack) | | | |
| Application | a.35a | | |
| Spreading | | 35 lb. | 35 lb. |

Table II

Emulsified Asphalt

| | Bituminous materials (Gal.) | Split Methoda: Coarse Aggregate | Split Methoda: Chips | Single Method Grading A | Single Method Grading B |
|---|---|---|---|---|---|
| On Treated Surface (Prime or Tack) | | | | | |
| Spreading | | 25 lb. | | | |
| Application | .45 | | | | |
| Spreading | | | 10 lb. | 35 lb. | 35 lb. |

The amounts given in Tables I and II are approximate. After the particular job materials have been tested and approved for use, the engineer will set the exact amounts to be used in each "Application" and "Spreading." He may vary the amount of bituminous material per square yard from that called for in the table to better suit the conditions, but the 35-pound total for aggregate shall not be changed save that the engineer may order, in writing, some of the apportionment for stockpiling used on the road at once if deemed advantageous. The actual rate of distribution of bituminous material on each square yard of surface shall not vary from the rate ordered by the engineer by more than 5 percent.

aWhen the Bid Schedule and Award call for cut-back asphalt, 95/ liquid asphalt,a OH-1 liquid asphalt, or for tar, aggregate of grading A or grading B, whichever is called for in the Bid Schedule, shall be furnished. When the Bid Schedule and Award call for emulsified asphalt the split method with its pertinent sizings shall be used unless the single method is stipulated in the Bid Schedule, in which case the latter method with aggregate of grading A or B as called for shall be used.

-2.1 Materials. The aggregate shall be crushed gravel, stone or slag graded asa provided for grading A or grading B in Table III when liquid asphalt or tar is used as binder, and similarly as provided in Table IV when emulsified asphalt is used as binder, using A.A.S.H.O. Method T-27.

Table III

Liquid Asphalt or Tars

| | Grading A | Grading B |
|---|---|---|
| Square Openings | Percent Passing | |
| 3/4 inch | 100 | |
| 1/2 inch | 90-100 | 100 |
| 3/8 inch | 20- 55 | 90-100 |
| No. 4 | | 0- 25 |
| No. 8 | 0- 5 | 0- 5 |

Table IV

Emulsified Asphalt

| | Split Method | | Single Method | |
|---|---|---|---|---|
| | Coarse Aggregate | Chips | Grading A | Grading B |
| Square Openings | Percent Passing | | | |
| 3/4 inch | 100 | | 100 | |
| 1/2 inch | 90-100 | | 90-100 | 100 |
| 3/8 inch | | | 25- 55 | 90-100 |
| No. 4 | 0- 10 | 90-100 | 0- 10 | 20- 40 |
| No. 8 | | | | 0- 10 |
| No. 10 | | 0- 10 | | |

-2.2 Crushed gravel shall consist of clean, hard, tough, sound and durable stone fragments and shall be the product obtained by scalping the quarry material on a screen which will remove and waste sufficient of the fine fractions so that the material scalped, when tested by laboratory methods, shall be retained on a 1½-inch sieve with square openings. The portion thus retained on the scalping screen shall then be crushed to provide the mineral aggregate. The finer fractions passing the scalping screen shall be discarded and not used in this item.

-2.3 Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft, or disintegrated pieces, dirt, or other objectionable matter.

-2.4 Crushed slag shall be air-cooled blast furnace slag and shall consist of angular fragments reasonably uniform in density and quality and reasonably free from thin elongated or glassy pieces, dirt, or other objectionable matter.

-2.5 Crushed stone shall show a percent of wear of not more than 7, slag a percent of wear of not more than 15 and gravel a percent of wear of not more than 15 for uncrushed and not more than 25 for crushed pieces using A.A.S.H.O. Method T-3 or T-4. Slag shall have a weight of not less than 70 pounds per cubic foot.

-2.6 The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

-2.7 Bituminous Materials. The bituminous material shall be cut-back asphalt, 95/ liquid asphalt, OH-1 liquid asphalt, tar or emulsified asphalt, whichever is called for in the Bid Schedule and the Award. Liquid asphalts shall be homogeneous and free from water. Refined tars shall be homogeneous. The emulsified asphalt shall be homogeneous and shall meet the requirements herein prescribed using A.A.S.H.O. Method T-59. It shall show no separation of asphalt at the time of use, provided that separation has not been caused by freezing after delivery, and provided further that this requirement shall not apply if the material is held more than 30 days. If a cut-back asphalt or tar is to be used, the particular grade shall be selected by the engineer from the tables hereinbelow and shall meet the respective requirements set out in the table for that grade.

Cut-back Asphalts

| Designation | A.A.S.H.O. | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point, °F. | T-48 | 80 | | 80 | | 80 | |
| Viscosity, Furol | T-72 | | | | | | |
| at 122°F., sec. | | 200 | 400 | | | | |
| 140°F., sec. | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78 | | | | | | |
| (% by vol.) | | | | | | | |
| to 437°F. | | 10 | | 3 | | 0.5 | |
| 600°F. | | 20 | | 14 | | 7 | |
| 680°F. | | | 35 | | 30 | | 25 |
| Pene. of Residue | T-49 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. of Residue | T-51 | 60 | | 60 | | 60 | |
| Sol. Residue ($CS_2$) | T-44 | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 125 | 155 | 145 | 175 | 170 | 200 |

95% Liquid Asphalt

| Designation | A.A.S.H.O. | Min. | Max. |
|---|---|---|---|
| Water | T-55 | | 0.5% |
| Sediment | T-55 | | 1% |
| Flash Point °F. | T-48 | 400 | |
| Float Test 122°F. sec. | T-50 | 250 | |
| Residue of 80 Pene. | T-56 | 95% | |
| Percent of Residue | | | |
| Sol. in $CS_2$ | T-44 | 99.5% | |
| Pene. of Residue after | | | |
| loss on heating 325°F. | | | |
| 5 hr. | T-49 | 125 | |
| Temp. of Application °F. | | 325 | 375 |

OH-1 Liquid Asphalt

| Designation | A.A.S.H.O. | Min. | Max. |
|---|---|---|---|
| Specific Gravity | T-43 | 0.97 | |
| Flash Point | T-48 | 176°F. | |
| Specific Viscosity 212°F. | T-54 | | 60 |
| Float Test 89.6°F. sec. | T-50 | 60 | |
| Bitumen (Sol. $CS_2$) | T-44 | 99.5% | |
| Percent Bitumen | | | |
| insol. 86° Be. naphtha | T-46 | 6% | |
| Loss at 325°F. | T-47 | | 10% |
| (a) Float Test on Residue | | | |
| at 122°F. sec. | T-50 | 60 | |
| Temp. of Application °F. | | 225 | 300 |

Refined Tars

| Designation | A.A.S.H.O. | TC-3 | | TC-4 | | R-T-131 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Specific Gravity | T-43e | 1.10e | | 1.10 | 1.18 | 1.14 | |
| Specific Viscosity 104°F. | T-54e | 18 | 25 | 25 | 35 | | |
| Float Test 89.6°F. sec. | T-50e | | | | | 60 | 150 |
| Bitumen (Sol. $CS_2$)e | T-44e | 90%e | | 90% | | 85% | |
| Water | T-55e | | 2% | | 2% | | 0 |
| Total Distillate by weight | T-52e | | | | | | |
| to 338°F. | | | 5% | | 3% | | 1% |
| 518°F. | | | 30% | | 30% | | 15% |
| 572°F. | | | 40% | | 40% | | 25% |
| Soft. pt. Residue °F. | T-53e | | 140 | | 140 | | 149 |
| Temp. of Application °F. | | 80 | 150 | 80 | 150 | 170 | 225 |

Emulsified Asphalt

| | Minimum | Maximum |
|---|---|---|
| Viscosity, Furol at 77°F. | 20 | 100 |
| Settlement, 5-day | | 3% |
| Demulsibility, using 35 ml. | | |
| 0.02 N $CaCl_2$ solution | 50% | 100% |
| Sieve Test | | 0.20% |
| Residue by Distillation | 55% | 60% |
| Pene. of Residue | 100 | 200 |
| Soluble Residue ($CS_2$)e | 95% | |
| Ash | | 2% |
| Ductility of Residue | 40 | |
| Specific Gravity | 1.00 | |
| Temp. of Application °F. | 60 | 120 |

-2.8 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed. Sampling, testing, shipment, reports and inspections at delivery shall be as required for "Heavy Armor Coat."

-3.1 Construction Methods. The methods employed in performing the work and alle equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of suitable units, including long base maintainer, broom-dragging equipment, distributor, powered roller weighing not less than 5 tons and aggregate spreading equipment with positive control, adjustable to spread accurately the given amount per square yard of road surface. The contractor shall also provide a power revolving broom or a power blower. The broom-dragging equipment, consisting essentially of non-revolving brooms, may be either an independent unit or an accessory attachment on the roller or other equipment. The spreading equipment shall preferably be a power spreader, but the contractor may use trucks equipped to distribute the aggregate in a thin uniform sheet over a one-lane strip.

Distributors shall be equipped with pneumatic tires of sufficient width and design so that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire.

Distributors shall be equipped with suitable manifold and appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heat and temperature at all times, including thermometers reading temperature of tank contents. The distributor shall be so designed as to maintain a constant and uniform pressure upon the bituminous material as it passes through the nozzles. Sufficient and proper screens shall be installed between the tank and the nozzles and the same shall be cleaned frequently to prevent clogging of the nozzles.

Distributors shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface under the operating conditions, and with tachometers reading speeds in feet per minute. The capacity of the distributor shall be .05 to 2.0 gallons per square yard, 25 to 75 pounds pressure, and variable width up to 15 feet.

-3.2 Application of Bituminous Material. After the prime coat or tack coat has been completed and is in proper condition in the judgment of the engineer, an application of the bituminous binder called for shall be made on the prepared surface in the amount determined by the engineer as indicated in Article -1.2 herein.

The particular grade of liquid asphalt or tar to be used shall be designated by the engineer for the application. The material shall be applied only when the prepared surface is firm and intact and free from moisture.

Where the Bid Schedule calls for emulsified asphalt and the split method the application directly on the prepared surface as prescribed above with liquid asphalts or tar shall be omitted.

-3.3 First Spreading of Aggregate. After the application of the bituminous material, or in the case of emulsified asphalt when the surface to be treated has been duly prepared, aggregate in the amount determined by the engineer as indicated in Article -1.2 shall be spread uniformly with the spreading equipment hereinbefore indicated. Dumping en masse on the road shall not be permitted. If the rock segregates into sizes in handling, it shall be mixed until it presents a uniform appearance prior to being spread. In the case of emulsified asphalt where the split method is called for and indicated the above spreading shall be of coarse aggregate.

After the aggregate has been spread, it shall be brought to a smooth and even surface by means of the long base maintainer, or drag, and the entire surface shall then be rolled and broom-dragged as directed. In the case where emulsion is used with the "Split Method" it shall be rolled once over only, but need not be broom-dragged.

-3.4 Application of Bituminous Material. In the case of emulsified asphalt with the "Split Method," after the rolling, the bituminous material shall be applied in the amount set by the engineer for the application as indicated in Article -1.2.

-3.5 Spreading of Chips. If the split method is used, immediately following the above application the bituminous material shall be covered with chips in the amount set by the engineer as indicated in Article -1.2. The surface shall then be rolled and broom-dragged. While this operation is in progress additional chips, if necessary to prevent picking up by the roller, shall be added as directed. The operation shall be continued until the aggregate is thoroughly set in the bituminous binder.

-3.6 Supplemental Aggregate. Chips meeting the requirements therefor in Table IV shall be furnished and stockpiled in the average total amount of 30 tons per mile at such places and in piles of such forms and quantities as the engineer may direct in writing. Prior to stockpiling the material, the sites selected shall be cleared and leveled as directed by the engineer and at the expense of the contractor.

-3.7 If during any application any spots are missed, bituminous material shall be applied to those spots by some means which will insure that the spot will be bituminized at the required rate.

During the application, the surface of all structures, guard rails and trees shall be protected in a satisfactory manner so as to prevent their being spattered or marred. Discharging the bituminous material into borrow pits or gutters will not be permitted.

In order to secure uniform distribution at the junction of two applications, the distribution shall be stopped promptly when the uniform flow decreases, indicating the tank is about empty. The distributor shall be equipped with a trough under the sprays, properly

arranged to be swung out of the way after the sprayers are operating in a uniform manner at the desired pressure, or building paper shall be spread over the treated surface for a sufficient length back so that the sprayers are operating properly when the uncovered surface is reached. The building paper shall then be removed and burned. The contractor shall furnish, and keep on the work at all times, an accurate thermometer suitable for measuring the temperature of the material being applied.

All bituminous material shall be applied under 25 to 75 pounds pressure. Bituminous materials shall be applied only when the atmospheric temperature is 50°F., or above, only between April 1st and November 1st and only when the degree of dryness of the base and aggregates meet the approval of the engineer. The temperature and seasonal requirements given above may be waived, but only when so directed by the engineer. The application temperatures shall conform to the requirements given in the specifications of bituminous materials.

Where detours are not available, bituminous surface treatment shall be applied to but one-half the width of the roadbed at a time, confining traffic under one-way control to the other half of the roadway. The contractor shall provide flagmen and a light car and driver to conduct public traffic through portions of the roadway under one-way traffic control.

-4.1 Method of Measurement. The tonnage of aggregate to be paid for shall be the number of tons of aggregate actually used in the accepted work and shall include the tonnage placed in stockpiles as ordered in writing. The aggregate shall be weighed on scales furnished by and at the expense of the contractor. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous materials to be paid for shall be the number of gallons, measured at 60°F., or converted to this temperature in accordance with A.S.T.M. D-208-34, actually used as ordered in the accepted work. When so called for in the Bid Schedule the unit for measuring bituminous material shall be the ton of 2,000 pounds.

Any aggregate or bituminous material used for repairing damage due to contractor's operations shall not be included in the pay measurement, but all such expense shall be borne by the contractor.

-5.1 Basis of Payment. The tonnage of aggregate and gallonage of bituminous material (or tonnage when so called for in the Bid Schedule), determined as provided above, shall be paid for at the respective contract unit prices per ton and per gallon bid for "Cover (Class A Pavement) - Grading A," "Cover (Class A Pavement) Grading B," or "Cover (Class A Pavement) - Split Method," and for "Cut-back Asphalt for Class A Pavement," "95/ Liquid Asphalt for Class A Pavement," "OH-1 Liquid Asphalt for Class A Pavement," "Tar for Class A Pavement," or "Emulsified Asphalt for Class A Pavement," as the cases may be, which prices and payments shall be full compensation for furnishing, preparing, handling, delivery and placing or application of all materials, for all conditioning of the roadway shoulders and ditches not covered under "Bituminous Prime Coat," or "Bituminous Tack Coat" for all blading, brooming and compacting, including rolling, for the construction or repairing of roads to make the source of materials available, for clearing and stripping of the quarry and for pit clean-up, for the handling and disposal of unsuitable material encountered in quarry or pit operations, for clearing and leveling stockpile sites, for furnishing and sealing scales, including the weigh house, for traffic control, and for all labor, equipment, tools and incidentals necessary to complete the item.

Class A Bituminous Pavements

## 113 BITUMINOUS SEAL AND DOUBLE COVER

113-1.1 Description. This item shall consist of a 50-pound double or triple layer of aggregate bonded to the road surface and sealed with asphalt or tar. It shall be constructed in accordance with these specifications on an approved newly constructed base or surfacing, and which in any case immediately prior to placing this proposed treatment has been treated as prescribed under the item "Bituminous Prime Coat" or under the item "Bituminous Tack Coat."

-1.2 The sequence of operations and the approximate amounts of material per square yard of road surface treated shall be in accordance with the following tables, Table I giving amounts per square yard when liquid asphalt or tar is used and Table II when emulsified asphalt is used.

Table I

Liquid Asphalt or Tar
(Including cut-back, 95/ and OH-1 liquid asphalt and tar)

| | Bituminous material (Gal.) | Coarse Aggregate A or B | Chips A or B |
|---|---|---|---|
| On Treated Surface (Prime or Tack) | | | |
| Application | .25 | | |
| Spreading | | 35 lb. | |
| Application | .25 | | |
| Spreading | | | 15 lb. |
| Totals | .50 | | 50 lb. |

Table II

Emulsified Asphalt

| | Bituminous material (Gal.) | Coarse Aggregate A or B | Chips A or B |
|---|---|---|---|
| On Treated Surface (Prime or Tack) | | | |
| Spreading | | 30 lb. | |
| Application | .35 | | |
| Spreading | | | 10 lb. |
| Application | .25 | | |
| Spreading | | | 10 lb. |
| Totals | .60 | | 50 lb. |

The amounts given in Tables I and II are approximate. After the particular job materials have been tested and approved for use the engineer will set the exact amounts to be used in each "Application" and "Spreading." He may vary the amount of bituminous material per square yard from that called for in the table to better suit the conditions, but the 50-pound total for aggregate shall not be changed save that the engineer may order, in writing, some of the apportionment for stockpiling used on the road at once if deemed advantageous. The actual rate of distribution of bituminous material on each square yard of surface shall not vary from the rate ordered by the engineer by more than 5 percent.

When the Bid Schedule and Award call for liquid asphalt or tar, aggregate of grading A or grading B, whichever is called for in the Bid Schedule, shall be furnished. When the Bid Schedule and Award call for emulsified asphalt, aggregate of grading A or grading B, whichever is called for in the Bid Schedule, shall be furnished.

-2.1 Materials. The aggregate shall be crushed gravel, stone or slag graded as provided in Table III when liquid asphalt or tar is used as binder, and as provided in Table IV when emulsified asphalt is used as binder, using A.A.S.H.O. Method T-27.

Table III

Liquid Asphalt or Tars

| | Grading A | | Grading B | |
|---|---|---|---|---|
| | Coarse Aggregate | Chips | Coarse Aggregate | Chips |
| | Square Openings - Percent Passing | | | |
| 3/4 inch | 100 | | | |
| 1/2 inch | 90-100e | | 100 | |
| 3/8 inch | 20- 55e | 100 | | |
| No. 4 | 0- 10e | | 0-10e | 90-100e |
| No. 8 | | | | 0- 25e |
| No. 10 | | 0-10 | | |
| No. 200 | | | | 0- 5e |

Table IV

Emulsified Asphalt

| | Grading A | | Grading B | |
|---|---|---|---|---|
| | Coarse Aggregate | Chips | Coarse Aggregate | Chips |
| | Square Openings - Percent Passing | | | |
| 3/4 inch | 100 | | | |
| 1/2 inch | 90-100e | | 100 | |
| 3/8 inch | | 100 | 90-100e | |
| No. 4 | 0- 10e | 90-100e | 0- 25e | 90-100e |
| No. 8 | | | 0- 5e | |
| No. 10 | | 0- 10 | | 0- 25e |
| No. 200 | | | | 0- 5e |

-2.2 Crushed gravel shall consist of clean, hard, tough, sound and durable stonee fragments and shall be the product obtained by scalping the quarry materials on a screen which will remove and waste sufficient of the fine fractions so that the material scalped, when tested by laboratory methods, shall be retained on ael½-inch sieve with square openings. The portion thus retained on the scalping screen shall then be crushed to provide the mineral aggregate. The finer fractions passing the scalping screen shall be discarded and not used in this item except that, if so desired, the fraction meeting the requirements for "Chips" may be used therefor.

-2.3 Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft, or disintegrated pieces, dirt or other objectionable matter.

-2.4 Crushed slag shall be air-cooled blast furnace slag and shall consist of angular fragments reasonably uniform in density and quality and reasonably free from thin elongated, or glassy pieces, dirt, or other objectionable matter.

-2.5 Crushed stone shall show a percent of wear of not more than 7, slag a percent of wear of not more than 15 and gravel a percent of wear of not more than 15 for uncrushed and not more than 25 for crushed pieces, using A.A.S.H.O. Method T-3 or T-4. Slag shall have a weight of not less than 70 pounds per cubic foot.

-2.6 The aggregate shall be of such nature that when once thoroughly coated withe the bituminous material proposed for the work the coating will not slough off upon contact with water.

-2.7 Bituminous Materials. The bituminous material shall be cut-back asphalt, 95/e liquid asphalt, OH-1 liquid asphalt, tar or emulsified asphalt, whichever is called for in the Bid Schedule and the Award. Liquid asphalts shall be homogeneous and free from water. Refined tars shall be homogeneous. The emulsified asphalt shall be homogeneous and shall meet the requirements hereinafter prescribed using A.A.S.H.O. Method T-59. It shall show no separation of asphalt at the time of use, provided that separation has not been caused by freezing after delivery, and provided further that this requirement shall not apply if the material is held more than 30 days. If a liquid asphalt or tar is to be used, the particular grade shall be selected by the engineer from the tables given hereinbelow and shall meet the respective requirements set out in the table for that grade.

Cut-back Asphalts

| Designation | A.A.S.H.O. | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point, °F. | T-48 | 80 | | 80 | | 80 | |
| Viscosity, Furol | T-72 | | | | | | |
| at 122°F., sec. | | 200 | 400 | | | | |
| 140°F., sec. | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78 | | | | | | |
| (% by vol.) | | | | | | | |
| to 437°F. | | 10 | | 3 | | 0.5 | |
| 600°F. | | 20 | | 14 | | 7 | |
| 680°F. | | | 35 | | 30 | | 25 |
| Pene. Residue | T-49 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. Residue | T-51 | 60 | | 60 | | 60 | |
| Sol. Residue ($CS_2$) | T-44 | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 125 | 155 | 145 | 175 | 170 | 200 |

95% Liquid Asphalt

| Designation | A.A.S.H.O. | Min. | Max. |
|---|---|---|---|
| Water | T-55 | | 0.5% |
| Sediment | T-55 | | 1% |
| Flash Point °F. | T-48 | 400 | |
| Float Test 122°F., sec. | T-50 | 250 | |
| Residue of 80 Pene. | T-56 | 95% | |
| Percent of Residue | | | |
| Sol. in $CS_2$ | T-44 | 99.5% | |
| Pene. of Residue after | | | |
| loss on heating 325°F. | | | |
| 5 hr. | T-49 | 125 | |
| Temp. of Application °F. | | 325 | 375 |

OH-1 Liquid Asphalt

| Designation | A.A.S.H.O. | Min. | Max. |
|---|---|---|---|
| Specific Gravity | T-43 | 0.970 | |
| Flash Point | T-48 | 176°F. | |
| Specific Viscosity 212°F. | T-54 | | 60 |
| Float Test 89.6°F., sec. | T-50 | 60 | |
| Bitumen (Sol. $CS_2$) | T-44 | 99.5% | |
| Percent Bitumen | T-46 | 6% | |
| insol. 86° Be. naphtha | | | |
| Loss at 325°F. | T-47 | | 10% |
| (a) Float Test on Residue: | | | |
| 122°F., sec. | T-50 | 60 | |
| Temp. of Application °F. | | 225 | 300 |

Refined Tars

| Designation | A.A.S.H.O. | TC-3 | | TC-4 | | R-T-131t | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Specific Gravity | T-43t | 1.100 | | 1.100 | 1.180 | 1.140 | |
| Specific Viscosity 104°F. | T-54t | 18 | 25 | 25 | 35 | | |
| Float Test 89.6°F., sec. | T-50t | | | | | 60 | 150 |
| Bitumen (Sol. $CS_2$) | T-44t | 90% | | 90% | | 85% | |
| Water | T-55t | | 2% | | 2% | | 0 |
| Total Distillate by weight | T-52t | | | | | | |
| to 338°F. | | | 5% | | 3% | | 1% |
| 518°F. | | | 30% | | 30% | | 15% |
| 572°F. | | | 40% | | 40% | | 25% |
| Soft. pt. Residue °F. | T-53t | | 140 | | 140 | | 149 |
| Temp. of Application °F. | | 80 | 150 | 80 | 150 | 170 | 225 |

Emulsified Asphalt

| | Minimum | Maximum |
|---|---|---|
| Viscosity, Furol at 77°F | 20 | 100 |
| Settlement, 5-day | | 3% |
| Demulsibility, using 35 ml. 0.02 N. $CaCl_2$ solution | 50% | 100% |
| Sieve test | | 0t20% |
| Residue by Distillation | 55% | 60% |
| Pene. of Residue | 100 | 200 |
| Soluble Residue ($CS_2$)t | 95% | |
| Ash | | 2% |
| Ductility of Residue | 40 | |
| Specific Gravity at 77°F. | 1.00 | |
| Temp. of Application °F. | 60 | 120 |

-2.8 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed. Sampling, testing shipment, reports and inspection at delivery shall be as required for "Heavy Armor Coat."

-3.1 Construction Methods. The methods employed in performing the work and all equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of suitable units, including long base blader, long base maintainer, broom dragging equipment, distributor, powered roller weighing not less than 5 tons and aggregate spreading equipment with positive control, adjustable to spread accurately the given amount per square yard of road surface. The contractor shall also provide a power revolving broom or a power blower. The broom dragging equipment, consisting essentially of non-revolving brooms, may be either an independent unit or an accessory attachment on the roller or other equipment. The spreading equipment shall preferably be a power spreader, but the contractor may use trucks equipped to distribute the aggregate in a thin uniform sheet over a one-lane strip.

Distributors shall be equipped with pneumatic tires of sufficient width and design so that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire.

Distributors shall be equipped with suitable manifold and appliances so designed as to distribute evenly heated material at the temperature at all times including thermometers reading temperature of tank contents. The distributor shall be so designed as to maintain a constant and uniform pressure upon the bituminous material as it passes through the nozzles. Sufficient and proper screens shall be installed between the tank and the nozzles and the same shall be cleaned frequently to prevent clogging of the nozzles.

Distributors shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface under the operating conditions, and with tachometers reading speeds in feet per minute. The capacity of the distributor shall be .05 to 2.0 gallons per square yard, 25 to 75 pounds pressure, and variable width up to 15 feet.

-3.2 Application of Bituminous Material. After the prime coat, or tack coat, has been completed and is in proper condition in the judgment of the engineer, an application of the bituminous binder called for shall be made on the prepared surface in the amount determined by the engineer as indicated in Article -1.2 herein. The particular grade of liquid asphalt or tar to be used shall be designated by the engineer for the application. The temperature of the material at application shall be as indicated by the specification for the particular grade. The material shall be applied only when the prepared surface is firm and intact and free from moisture.

Where the Bid Schedule calls for emulsified asphalt, the application directly on the prepared surface as prescribed above with liquid asphalts or tar shall be omitted.

-3.3 First Spreading of Aggregate. After the applicationeof the bituminouse material, or in the case of emulsified asphalt, when the surface to be treated has been prepared, coarse aggregate in the amount determined by the engineer as indicated in Article -1.2 shall be spread uniformly with the spreading equipment hereinbefore indicated. Dumping en masse on the road shall not be permitted. If the rock segregates into sizes in handling, it shall be mixed until it presents a uniform appearance prior to being spread.

After the coarse aggregate has been spread, it shall be brought to a smooth and even surface by means of the long base blader, maintainer, or drag, and the entire surface shall then be rolled as directed. In the case where emulsion is used it shall be rolled once over only.

-3.4 Application of Bituminous Material. After the rolling, liquid asphalt, tare or emulsified asphalt, as the case may be, shall be applied in the amount set by the engineer for the application as indicated in Article -1.2

-3.5 Spreading of Chips. Immediately following the above application thee bituminous material shall be covered with chips in the amount set by the engineer as indicated in Article -1.2. The surface shall then be rolled and broom-dragged. While this operation is in progress additional chips, if necessary to prevent picking up by the roller, shall be added as directed. The operation shall be continued until the aggregate is thoroughly set in the bituminous binder.

-3.6 Application of Bituminous Material and Spreading of Fine Chips. In thee case of emulsified asphalt after the above operation is complete, another application of emulsified asphalt shall be made in the amount determined by the engineer as indicated in Article -1.2, followed by a spreading of "Chips," similarly as indicated in Article -1.2, and the operation of broom dragging and rolling repeated until the surfacing is fully compacted and bonded to the full width.

-3.7 Supplemental Aggregate. Chips meeting the requirements as prescribed ine Tables IIIor IV as the case may be shall be furnished and stockpiled in the average total amount of 30 tons per mile at such places and in piles of such forms and quantities as the engineer may direct in writing. Prior to stockpiling the material, the sites selected shall be cleared and leveled as directed by the engineer and at the expense of the contractor.

-3.8 If during any application any spots are missed, bituminous material shall bee applied to those spots by some means which will insure that the spot will be bituminized at the required rate.

During the application, the surface of all structures, guard rails and trees shall be protected in a satisfactory manner so as to prevent their being spattered or marred. Discharging the bituminous material into borrow pits or gutters will not be permitted.

In order to secure uniform distribution at the junction of two applications, the distribution shall be stopped promptly when the uniform flow decreases, indicating the tank is about empty. The distributor shall be equipped with a trough under the sprays, properly arranged to be swung out of the way after the sprayers are operating in a uniform manner at the desired pressure, or building paper shall be spread over the treated surface for a sufficient length back so that the sprayers are operating properly when the uncovered surface is reached. The building paper shall then be removed and burned. The contractor shall furnish, and keep on the work at all times, an accurate thermometer suitable for measuring the temperature of the material being applied.

All bituminous material shall be applied under 25 to 75 pounds pressure. Bituminous materials shall be applied only when the atmospheric temperature is 50°F. or above, only between April 1st and November 1st and only when the degree of dryness of the base and aggregates meet approval of the engineer. The temperature and seasonal requirements given above may be waived but only when so directed by the engineer. The application temperatures shall conform to the requirements given in the specifications of bituminous materials.

Where detours are not available, bituminous surface treatment shall be applied to but one-half the width of the roadbed at a time, confining traffic under one-way control to the other half of the roadway. The contractor shall provide flagmen and a light car and driver to conduct public traffic through portions of the roadway under one-way traffic control.

-4.1 Method of Measurement. The tonnage of aggregate to be paid for shall be the number of tons of aggregate actually used in the accepted work and shall include the tonnage placed in stockpiles as ordered in writing. The aggregate shall be weighed on scales furnished by and at the expense of the contractor. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous materials to be paid for shall be the number of gallons, measured at 60°F., or converted to this temperature in accordance with A.S.T.M. D-208-34, actually used as ordered in the accepted work. When so called for in the Bid Schedule the unit for measuring bituminous material shall be the ton of 2,000 pounds.

Any aggregate or bituminous material used for repairing damage due to contractor's operations shall not be included in the pay measurement, but all such expense shall be borne by the contractor.

-5.1 Basis of Payment. The tonnage of aggregate and gallonage of bituminous material (or tonnage when so called for in the Bid Schedule), determined as provided above, shall be paid for at the respective contract unit prices per ton and per gallon bid for "Class A Seal Aggregate-Grading A," or "Class A Seal Aggregate-Grading B," and for "Cutback Asphalt for Class A Seal," "95/ Liquid Asphalt for Class A Seal," "OH-1 Liquid Asphalt for Class A Seal," "Tar for Class A Seal," or "Emulsified Asphalt for Class A Seal," as the cases may be, which prices and payments shall be full compensation for furnishing, preparing, handling, delivery and placing or application of all materials, for all conditioning of the roadway shoulders and ditches not covered under "Bituminous Prime Coat" or "Bituminous Tack Coat," for all blading, brooming and compacting, including rolling, for the construction or repairing of roads to make the source of materials available, for clearing and stripping of the quarry and for pit cleanup, for the handling and disposal of unsuitable material encountered in quarry or pit operations, for clearing and leveling stockpile sites, for furnishing and sealing scales, including the weigh house, for traffic control, and for all labor, equipment, tools and incidentals necessary to complete the item.

Class A Bituminous Pavements

## 114 DOUBLE BITUMINOUS TREATMENT AND SEAL

114-1.1 Description. This item shall consist of a wearing surface composed of twoe applications of selected bituminous material, interspersed and covered with appropriate spreadings of mineral aggregate totaling 75 pounds per square yard of surface and rolled as ordered. It shall be constructed either in accordance with these specifications on a road surface which complies with the profile and cross section crown shown on the plans and has been prepared for bituminizing under the item "Reconditioning of Used Roadbed" or on an approved newly constructed base or surfacing and which in any case immediately prior to placing this proposed treatment has been treated as prescribed under the item "Bituminous Prime Coat" or under the item "Bituminous Tack Coat."

-1.2 The sequence of operations and the approximate amounts of material per square yard of road surface treated shall be in accordance with the following table.

| | Bituminous materials (Gal.) | Coarse Aggregate | Chips |
|---|---|---|---|
| On Treated Surface (Prime or Tack) | | | |
| Application | .35 | | |
| Spreading | | 55 lb. | |
| Application | .30 | | |
| Spreading | | | 20 lb. |
| Totals | .65 | | 75 lb. |

The amounts given in the table are approximate. After the particular job materials have been tested and approved for use, the engineer will set the exact amounts to be used in each "Application" and "Spreading." He may vary the amount of bituminous material per square yard from that called for in the table to better suit the conditions, but the 75 pound total for aggregate shall not be changed save that the engineer may order, in writing, some of the apportionment for stockpiling used on the road at once if deemed advantageous. The actual rate of distribution of bituminous material on each square yard of surface shall not vary from the rate ordered by the engineer by more than 5 percent.

-2.1 Materials. Aggregate shall be crushed gravel, stone or slag, furnished in twoe sizes to be designated by size as "Coarse Aggregate" and "Chips." The grading of these aggregates shall conform to the following requirements using with A.A.S.H.O. Method T-27.

Stone, Slag or Gravel

| | Coarse Aggregate | Chips |
|---|---|---|
| Square Openings-Percent Passing | | |
| 1 inch | 100 | |
| 3/4 inch | 90-100e | |
| 1/2 inch | | 100 |
| 3/8 inch | 20- 55e | 90-100e |
| No. 4 | 0- 10e | 0- 25e |
| No. 8 | | 0- 5e |

Loss by elutriation shall not exceed 2 percent.

-2.2 Crushed gravel shall consist of clean, hard, tough, sound and durable stonee fragments and shall be the product obtained by scalping the quarry material on a screen which will remove and waste sufficient of the fine fractions so that the material scalped, when tested by laboratory methods, shall be retained on a 1½ inch sieve with square openings. The portion thus retained on the scalping screen shall then be crushed to provide the mineral aggregate. The finer fractions passing the scalping screen shall be discarded and not used in this item.

-2.3 Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter.

-2.4 Crushed slag shall be air-cooled blast furnace slag and shall consist of angular fragments reasonably uniform in density and quality, and reasonably free from thin, elongated, or glassy pieces, dirt, or other objectionable matter.

-2.5 Crushed stone shall show a percent of wear of not more than 7, slag ao percent of wear of not more than 15 and gravel a percent of wear of not more than 15 for uncrushed and not more than 25 for crushed pieces using A.A.S.H.O. Method T-3 or T-4. Slag shall have a weight of not less than 70 pounds per cubic foot.o

-2.6 The aggregate shall be of such nature that when once thoroughly coated witho the bituminous material proposed for the work the coating will not slough off upon contact with water.

-2.7 Bituminous Materials. The bituminous material shall be cut-back asphalt, 95/ liquid asphalt, OH-1 liquid asphalt, or tar, whichever is called for in the Bid Schedule and the Award. Liquid asphalts shall be homogeneous and free from water. Refined tars shall be homogeneous. The particular grade shall be selected by the engineer from the tables given hereinbelow and shall meet the respective requirements set out in the table for that grade.

Cut-back Asphalts

| Designation | A.A.S.H.O. | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point °F. | T-48 | 80 | | 80 | | 80 | |
| Viscosity, Furol | T-72 | | | | | | |
| at 122°F., sec. | | 200 | 400 | | | | |
| 140°F., sec. | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78o | | | | | | |
| (% vol.) | | | | | | | |
| to 437oF. | | 10 | | 3 | | 0.5 | |
| 600oF. | | 20 | | 14 | | 7 | |
| 680°F. | | | 35 | | 30 | | 25 |
| Pene. Residue | T-49 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. Residue | T-51o | 60 | | 60 | | 60 | |
| Sol. Residue ($CS_2$)o | T-44 | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 125 | 155 | 145 | 175 | 170 | 200 |

95/ Liquid Asphalt

| Designation | A.A.S.H.O. | Min. | Max. |
|---|---|---|---|
| Water | T-55o | | 0.5% |
| Sediment | T-55o | | 1% |
| Flash Point °F. | T-48o | 400 | |
| Float Test 122°F., sec. | T-50o | 250 | |
| Residue of 80 Pene. | T-56o | 95% | |
| Percent of Residue | | | |
| Sol. in $CS_2$ | T-44 | 99.5% | |
| Pene. of Residue after | | | |
| loss on heating 325°F. | | | |
| 5 hr. | T-49o | 125 | |
| Temp. of Application °F. | | 325 | 375 |

OH-1 Liquid Asphalt

| Designation | A.A.S.H.O. | Min. | Max. |
|---|---|---|---|
| Specific Gravity | T-43e | 0.970 | |
| Flash Point | T-48e | 176°F. | |
| Specific Viscosity 212°F. | T-54e | | 60 |
| Float Test 89.6°F., sec. | T-50 | 60e | |
| Bitumen (Sol. $CS_2$) | T-44 | 99.5% | |
| Percent Bitumen | T-46e | 6% | |
| Insol. 86° Be. naphtha | | | |
| Loss at 325°F. | T-47e | | 10% |
| (a)e Float Test on Residuee: | | | |
| 122°F., sec.e | T-50e | 60 | |
| Temp. of Application °F. | | 225 | 300 |

Refined Tars

| Designation | A.A.S.H.O. | TC-3 Min. | TC-3 Max. | TC-4 Min. | TC-4 Max. | R-T-12 Min. | R-T-12 Max. |
|---|---|---|---|---|---|---|---|
| Specific Gravity | T-43e | 1.100 | | 1.10 | 1.18 | 1.140 | |
| Specific Viscosity 104°F. | T-54e | 18 | 25 | 25 | 35 | | |
| Float Test 89.6°F., sec. | T-50e | | | | | 60e | 150 |
| Bitumen (Sol. $CS_2$)e | T-44 | 90% | | 90% | | 85% | |
| Water | T-55e | | 2% | | 2% | | 0 |
| Total Distillate by weight | T-52e | | | | | | |
| to 338°F. | | | 5% | | 3% | | 1% |
| 518°F. | | | 30% | | 40% | | 15% |
| 572°F. | | | 40% | | 40% | | 25% |
| Soft. pt. Residue °F. | T-53 | | 140 | | 140 | | 149 |
| Temp. of Application °F. | | 80 | 150 | 80 | 150 | 170 | 225 |

-2.8 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed. Sampling, testing, shipment, reports and inspection at delivery shall be as required for "Heavy Armor Coat."

-3.1 Construction Methods. The methods employed in performing the work and alle equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of suitable units, including long base blader, long base maintainer, broom dragging equipment, distributor, powered roller weighing not less than 5 tons and aggregate spreading equipment with positive control, adjustable to spread accurately the given amount per square yard of road surface. The contractor shall also provide a power revolving broom or a power blower. The broom dragging equipment, consisting essentially of nonrevolving brooms, may be either an independent unit or an accessory attachment on the roller or other equipment. The spreading equipment shall preferably be a power spreader, but the contractor may use trucks equipped to distribute the aggregate in a thin uniform sheet over a one-lane strip.

Distributors shall be equipped with pneumatic tires of sufficient width and design so that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire.

Distributors shall be equipped with suitable manifold and appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heat and temperature at all times, including thermometers reading temperature of tank contents. The distributor shall be so designed as to maintain a constant and uniform pressure upon the bituminous material as it passes through the nozzles. Sufficient and proper screens shall be installed between the tank and the nozzles and the same shall be cleaned frequently to prevent clogging of the nozzles.

Distributors shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface under the operating conditions, and with tachometers reading speeds in feet per minute. The capacity of the distributor shall be .05 to 2.0 gallons per square yard, 25 to 75 pounds pressure, and variable width up to 15 feet.

-3.2 Application of Bituminous Material. After the prime coat or tack coat hase been completed and in proper condition in the judgment of the engineer, an application of the bituminous binder called for shall be made on the prepared surface in the amount determined by the engineer, as indicated in Article -1.2 herein. The particular grade of liquid asphalt or tar to be used shall be designated by the engineer for the application. The temperature of the material at application shall be as indicated by the specification for the particular grade. The material shall be applied only when the prepared surface is firm and intact and free from moisture.

-3.3 First Spreading of Aggregate. After the first application of tar or liquid asphalt, coarse aggregate in the amount determined by the engineer as indicated in Article -1.2 shall be spread uniformly with the spreading equipment hereinbefore indicated. Dumping en masse on the road shall not be permitted. If the rock segregates into sizes in handling, it shall be mixed until it presents a uniform appearance prior to being spread.

After the coarse aggregate has been spread, it shall be brought to a smooth and even surface by means of the long base blader, maintainer, or drag, and the entire surface shall then be rolled as directed.

-3.4 Application of Bituminous Material. After the rolling, tar or liquid asphalt, as the case may be, shall be applied in the amount set by the engineer for the application as indicated in Article -1.2.

-3.5 Second Spreading of Aggregate. Immediately following the above seconde application the bituminous material shall be covered with chips in the amount set by the engineer as indicated in Article -1.2 The surface shall then be rolled and broom-dragged. While this operation is in progress additional aggregate, if necessary to prevent picking up by the roller, shall be added as directed. The operation shall be continued until the aggregate is thoroughly set in the bituminous binder.

-3.6 Supplemental Aggregate. Chips shall be furnished and stockpiled in thee average total amount of 40 tons per mile at such places and in piles of such forms and quantities as the engineer may direct in writing. Prior to stockpiling the material, the sites selected shall be cleared and leveled as directed by the engineer and at the expense of the contractor.

-3.7 If during any application any spots are missed, bituminous material shalle be applied to those spots by some means which will insure that the spot will be bituminized at the required rate.

During the application, the surface of all structures, guard rails and trees shall be protected in a satisfactory manner so as to prevent their being spattered or marred. Discharging the bituminous material into borrow pits or gutters will not be permitted.

In order to secure uniform distribution at the junction of two applications, the distribution shall be stopped promptly when the uniform flow decreases, indicating the tank is about empty. The distributor shall be equipped with a trough under the sprays, properly arranged to be swung out of the way after the sprayers are operating in a uniform manner at the desired pressure, or building paper shall be spread over the treated surface for a sufficient length back so that the sprayers are operating properly when the uncovered surface is reached. The building paper shall then be removed and burned. The contractor shall furnish, and keep on the work at all times, an accurate thermometer suitable for measuring the temperature of the material being applied.

All bituminous material shall be applied under 25 to 75 pounds pressure. Bituminous materials shall be applied only when the atmospheric temperature is 50°F., or above, only between April 1st and November 1st and only when the degree of dryness of the base and aggregates meet the approval of the engineer. The temperature and seasonal requirements given above may be waived but only when so directed by the engineer. The application temperatures shall conform to the requirements given in the specifications of bituminous materials.

Where detours are not available, bituminous surface treatments shall be applied eto but one-half the width of the roadbed at a time, confining traffic under one-way control to the other half of the roadway. The contractor shall provide flagmen and ae

light car and driver to conduct public traffic through portions of the roadway under one-way traffic control.

-4.1 Method of Measurement. The tonnage of aggregate to be paid for shall be the number of tons of aggregate actually used in the accepted work, and shall include the tonnage placed in stockpiles as ordered in writing. The aggregate shall be weighed on scales furnished by and at the expense of the contractor. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous materials to be paid for shall be the number of gallons, measured at 60°F., or converted to this temperature in accordance with A.S.T.M. D-208-34, actually used as ordered in the accepted work. When so called for in the Bid Schedule the unit for measuring bituminous material shall be the ton of 2,000 pounds.

Any aggregate or bituminous material used for repairing damage due to contractor's operations shall not be included in the pay measurement, but all such expense shall be borne by the contractor.

-5.1 Basis of Payment. The tonnage of aggregate and gallonage of bituminous material (or tonnage when so called for in the Bid Schedule), determined as provided above, shall be paid for at the respective contract unit prices per ton and per gallon bid for "Aggregate for Class A Pavement" and for "Cut-back Asphalt for Class A Pavement," "95% Liquid Asphalt for Class A Pavement," "OH-1 Liquid Asphalt for Class A Pavement" or "Tar for Class A Pavement" as the case may be, which prices and payments shall be full compensation for furnishing, preparation, handling, delivery and placing or application of all materials, for all conditioning of the roadway shoulders and ditches not covered under "Bituminous Prime Coat" or "Bituminous Tack Coat," for all blading, brooming and compacting, including rolling, for the construction or repairing of roads to make the source of materials available, for clearing and stripping of the quarry and pit clean-up, for the handling of and disposal of unsuitable material encountered in quarry or pit operations, for clearing and leveling stockpile sites, for furnishing and sealing scales, including the weigh house, for traffic control and for all labor, equipment, tools and incidentals necessary to complete the item.

Class A Bituminous Pavements

115 LIGHT ARMOR COAT

115-1.1 Description. This item shall consist of a wearing surface composed of 2 or 3 applications of selected bituminous material, interspersed and covered with appropriate spreadings of mineral aggregate totaling 60 pounds per square yard of surface, inclusive of the final "Seal Coat," and rolled as ordered. It shall be constructed either on a road surface which complies with the profile and cross section crown shown on the plans and has been prepared for bituminizing under the item "Reconditioning of Used Roadbed," or on an approved newly constructed base or surfacing, and which, in any case, immediately prior to placing this proposed treatment, has been treated as prescribed under the item "Bituminous Prime Coat" or under the item "Bituminous Tack Coat."

-1.2 The sequence of operations and the approximate amount of material per square yard of road surface treated shall be in accordance with the following tables, Table I giving amounts per square yard of surface when liquid asphalt is used and Table II when emulsified asphalt is used.

Table I

| | Liquid Asphalt (Inc. 95% Liquid and Cut-back Asphalt) (Gal.) | Coarse Aggregate | Key Rock | Fine Chips |
|---|---|---|---|---|
| | On Treated Surface (Prime or Tack) | | | |
| Application: Spreading | 0.15 | 40 lb. | | |
| Application: Spreading | 0.30 | | 12 lb. | |
| Application: Spreading | 0.15 | | | 8 lb. |
| Totals | 0.60 | | | 60 lb. |

Table II

| | Emulsified Asphalt (Gal.) | Coarse Aggregate | Key Rock | Fine Chips |
|---|---|---|---|---|
| | On Treated Surface (Prime or Tack) | | | |
| Spreading | | 36 lb. | | |
| Application: Spreading | 0.45 | | 16 lb. | |
| Application: Spreading | 0.25 | | | 8 lb. |
| Totals | 0.70 | | | 60 lb. |

The amounts given in Tables I and II are approximate. After the particular job materials have been tested and approved for use, the engineer will set the exact amounts to be used in each "Application" and "Spreading" or "Spreadings." He may vary the amount of bituminous material per square yard from that called for in the table to better suit the conditions, but the 60-pound total for aggregate shall not be changed save that the engineer may order, in writing, some of the apportionment for stockpiling used on the road at once if deemed advantageous. The actual rate of distribution of bituminous material on each square yard of surface shall not vary from the rate ordered by the engineer by more than 5 percent.

-2.1 Materials. The aggregate shall be crushed gravel, stone or slag furnished in 3 sizes, to be known and graded as provided in Table III when liquid asphalt is used as binder, and as provided in Table IV when emulsified asphalt is used as binder, using A.A.S.H.O. Method T-27.

Table III

| | Liquid Asphalt | | |
|---|---|---|---|
| | Coarse Aggregate | Key Rock | Fine Chips |
| | Square Openings - Percent Passing | | |
| 1" | 100 | | |
| 3/4" | 95-100e | | |
| 1/2" | 0-10e | 100 | 100 |
| 3/8" | | | 95-100e |
| No. 4 | | 0-10e | |
| No. 10 | | | 0-10e |

Table IV

| | Emulsified Asphalt | | |
|---|---|---|---|
| | Coarse Aggregate | Key Rock | Fine Chips |
| | Square Openings - Percent Passing | | |
| 1" | 100 | | |
| 3/4" | 95-100e | | |
| 1/2" | 0-10e | 100 | |
| 3/8" | | 95-100e | 100 |
| No. 4 | | | 90-100e |
| No. 10 | | 0-10e | 0-10e |

-2.2 Crushed gravel shall consist of clean, hard, tough, sound and durable stonee fragments and shall be the product obtained by scalping the quarry material on a screen which will remove and waste sufficient of the fine fractions so that the material scalped, when tested by laboratory methods, shall be retained on a 1½-inch sieve with square openings. The portion thus retained on the scalping screen shall then be crushed to provide the mineral aggregate. The finer fractions passing the scalping screen shall be discarded and not used in this item except that, if so desired, the fraction meeting the requirements for "Fine Chips," may be used therefor.

-2.3 Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter.

-2.4 Crushed slag shall be air-cooled blast furnace slag and shall consist ofe angular fragments reasonably uniform in density and quality and reasonably free from thin elongated, or glassy pieces, dirt or other objectionable matter.

-2.5 Crushed stone shall show a percent of wear of not more than 7, slag a percent of wear of not more than 15 and gravel a percent of wear of not more than 15 for uncrushed and not more than 25 for crushed pieces using A.A.S.H.O. Method T-3 or T-4. Slag shall have a weight of not less than 70 pounds per cubic foot.

-2.6 The aggregate shall be of such nature that when once thoroughly coated withe the bituminous material proposed for the work the coating will not slough off upon contact with water.

-2.7 Bituminous Materials. The bituminous material shall be cut-back asphalt, 95/ liquid asphalt, or emulsified asphalt, whichever is called for in the Bid Schedule and the Award. Liquid asphalts shall be homogeneous and free from water. The emulsified asphalt shall be homogeneous and shall meet the requirements herein prescribed using A.A.S.H.O. Method T-59. It shall show no separation of asphalt at the time of use, provided that separation has not been caused by freezing after delivery, and provided further that this requirement shall not apply if the material is held more than 30 days. If a liquid asphalt is to be used, the particular grade shall be selected by the engineer, unless a particular grade is stipulated by the Bid Schedule, from the tables given hereinbelow and shall meet the respective requirements set out in the table for that grade.

Cut-back Asphalts

| Designation | A.A.S.H.O. | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point °F. | T-48 | 80 | | 80 | | 80 | |
| Viscosity, Furol | T-72 | | | | | | |
| at 122°F., sec. | | 200 | 400 | | | | |
| 140°F., sec. | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78 | | | | | | |
| (% by vol.) | | | | | | | |
| to 437°F. | | 10 | | 3 | | 0.5 | |
| 600°F. | | 20 | | 14 | | 7 | |
| 680°F. | | | 35 | | 30 | | 25 |
| Pene. Residue | T-49 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. Residue | T-51 | 60 | | 60 | | 60 | |
| Sol. Residue ($CS_2$) | T-44 | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 125 | 155 | 145 | 175 | 170 | 200 |

95% Liquid Asphalt

| Designation | A.A.S.H.O. | Min. | Max. |
|---|---|---|---|
| Water | T-55 | | 0.5% |
| Sediment | T-55 | | 1% |
| Flash Point °F. | T-48 | 400 | |
| Float Test 122°F., sec. | T-50 | 250 | |
| Residue of 80 Pene. | T-56 | 95% | |
| Percent of Residue | | | |
| Sol. in $CS_2$ | T-44 | 99.5% | |
| Pene. of Residue after | | | |
| loss on heating 325°F. | | | |
| 5 hr. | T-49 | 125 | |
| Temp. of Application °F. | | 325 | 375 |

Emulsified Asphalt

| | Minimum | Maximum |
|---|---|---|
| Viscosity, Furol 77°F. | 20 | 100 |
| Settlement, 5-day | | 3% |
| Demulsibility, using 35 ml. | | |
| 0.02 N. $CaCl_2$ solution | 50% | 100% |
| Sieve Test | | 0.20% |
| Residue by Distillation | 55% | 60% |
| Pene. of Residue | 100 | 200 |
| Soluble Residue ($CS_2$) | 95% | |
| Ash | | 2% |
| Ductility of Residue | 40 | |
| Specific Gravity at 77°F. | 1.00 | |
| Temp. at Application °F. | 60 | 120 |

-2.8 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed. Sampling, testing, shipment, reports and inspection at delivery shall be as required for "Heavy Armor Coat."

-3.1 Construction Methods. The methods employed in performing the work and alle equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

The equipment used by the contractor shall be made up of suitable units, including long base blader, long base maintainer, broom-dragging equipment, distributor, powered roller weighing not less than 5 tons and aggregate spreading equipment with positive control, adjustable to spread accurately the given amount per square yard of road surface. The contractor shall also provide a power revolving broom or a power blower. The broom-dragging equipment, consisting essentially of non-revolving brooms, may be either an independent unit or an accessory attachment on the roller or other equipment. The spreading equipment shall preferably be a power spreader, but the contractor may use trucks equipped to distribute the aggregate in a thin uniform sheet over a one lane strip.

Distributors shall be equipped with pneumatic tires of sufficient width and design so that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire.

Distributors shall be equipped with suitable manifold and appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heat and temperature at all times including thermometers reading temperature of tank contents. The distributor shall be so designed as to maintain a constant and uniform pressure upon the bituminous material as it passes through the nozzles. Sufficient and proper screens shall be installed between the tank and the nozzles and the same shall be cleaned frequently to prevent clogging of the nozzles.

Distributors shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface under the operating conditions, and with tachometers reading speeds in feet per minute. The capacity of the distributor shall be .05 to 2.0 gallons per square yard, 25 to 75 pounds pressure, and variable width up to 15 feet.

-3.2 Application of Bituminous Material. After the prime coat or tack has beene completed and is in proper condition in the judgment of the engineer, an application of the bituminous binder called for shall be made on the prepared surface in the amount determined by the engineer as indicated in Article -1.2 herein. The particular grade of liquid asphalt to be used shall be designated by the engineer for the application. The material shall be applied only when the prepared surface is firm and intact and free from moisture.

Where the Bid Schedule calls for emulsified asphalt, the application directly on the prepared surface as prescribed above with liquid asphalts shall be omitted.

-3.3 First Spreading of Aggregate. After the application of liquid asphalt one the prepared surface, or in the case of emulsified asphalt, when the surface to be treated has been prepared, coarse aggregate in the amount determined by the engineer as indicated in Article -1.2 shall be spread uniformly with the spreading equipment hereinbefore indicated. Dumping en masse on the road shall not be permitted. If the rock segregates into sizes in handling, it shall be mixed until it presents a uniform appearance prior to being spread.

After the coarse aggregate has been spread, it shall be brought to a smooth and even surface by means of the long base blader, maintainer, or drag, and the entire surface shall then be rolled as directed. In the case where emulsion is used it shall be rolled once over only.

-3.4 Application of Bituminous Material. After the rolling, liquid asphalt or emulsified asphalt, as the case may be, shall be applied in the amount set by the engineer for the application as indicated in Article -1.2

-3.5 Spreading of Key Rock. Immediately following the above application the bituminous material shall be covered with key rock in the amount set by the engineer as indicated in Article -1.2. The surface shall then be rolled and broom-dragged.

While this operation is in progress additional key rock, if necessary to prevent picking up by the roller, shall be added as directed. The operation shall be continued until the aggregate is thoroughly set in the bituminous binder.

-3.6 Application of Bituminous Material and Spreading of Fine Chips. After thee above operation is complete, another application of liquid asphalt or emulsified asphalt, as the case may be, shall be made in the amount determined by the engineer as indicated in Article -1.2, followed by a spreading of fine chips, similarly as indicated in Article -1.2, and the operation of broom dragging and rolling repeated until the surfacing is fully compacted and bonded to the full width.

-3.7 Supplemental Aggregate. Key rock and fine chips in equal amounts, but kept segregated, shall be stockpiled in the average total amount of 40 tons per mile at such places and in piles of such forms and quantities as the engineer may direct. Prior to stockpiling the material, the sites selected shall be cleared and leveled as directed by the engineer and at the expense of the contractor.

-3.8 If during any application any spots are missed, bituminous material shalle be applied to those spots by some means which will insure that the spot will be bituminized at the required rate.

During the application, the surface of all structures, guard rails and trees shall be protected in a satisfactory manner so as to prevent their being spattered or marred. Discharging the bituminous material into borrow pits or gutters will not be permitted.

In order to secure uniform distribution at the junction of two applications, the distribution shall be promptly stopped when the uniform flow decreases, indicating the tank is about empty. The distributor shall be equipped with a trough under the sprays, properly arranged to be swung out of the way after the sprayers are operating in a uniform manner at the desired pressure, or building paper shall be spread over the treated surface for a sufficient length back so that the sprayers are operating properly when the uncovered surface is reached. The building paper shall then be removed and burned. The contractor shall furnish, and keep on the work at all times, an accurate thermometer suitable for measuring the temperature of the material being applied.

All bituminous material shall be applied under 25 to 75 pounds pressure. Bituminous materials shall be applied only when the atmospheric temperature is 50°F. or above, only between April 1st and November 1st and only when the degree of dryness of the base and aggregates meet the approval of the engineer. The temperature and seasonal requirements given above may be waived but only when so directed by the engineer. The application temperatures shall conform to the requirements given in the specifications of bituminous materials.

Where detours are not available, bituminous surface treatment shall be applied to but one-half the width of the roadbed at a time, confining traffic under one-way control to the other half of the road-way. The contractor shall provide flagmen and a light car and driver to conduct public traffic through portions of the roadway under one-way traffic control.

-4.1 Method of Measurement. The tonnage of aggregate to be paid for shall bee the number of tons of aggregate actually used in the accepted work and shall include the tonnage placed in stockpiles as ordered in writing. The aggregate shall be weighed on scales furnished by and at the expense of the contractor. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous materials to be paid for shall be the number of gallons, measured at 60°F., or converted to this temperature in accordance with A.S.T.M. D-208 actually used as ordered in the accepted work. When so called for in the Bide Schedule the unit for measuring bituminous material shall be the ton of 2,000 pounds.e

Any aggregate or bituminous material used for repairing damage due to contractor's operations shall not be included in the pay measurement, but all such expense shall be borne by the contractor.

-5.1 Basis of Payment. The respective tonnages of aggregate and gallons of bituminous material (or tonnage when so called for in the Bid Schedule), determined as provided above, shall be paid for at the respective contract unit prices per ton or

per gallon bid for "Aggregate for Light Armor Coat," and for "Cut-back Asphalt for Class A pavement," "95/ Liquid Asphalt for Class A pavement" or "Emulsified Asphalt for Class A pavement," as the case may be, which prices and payments shall be full compensation for furnishing, preparing, handling, delivery and placing or application of all materials, for all conditioning of the roadway shoulders and ditches not covered under "Bituminous Prime Coat" or "Bituminous Tack Coat," for all blading, brooming and compacting including rolling, for the construction or repairing of roads to make the source of materials available, for clearing and stripping of the quarry and for pit cleanup, for the handling and disposal of unsuitable material encountered in quarry or pit operations, for clearing and leveling stockpile sites, for furnishing and sealing scales, including the weigh house, for traffic control, and for all labor, equipment, tools and incidentals necessary to complete the item.

Class A Bituminous Pavements

116 HEAVY ARMOR COAT

116-1.1 Description. This item shall consist of a wearing surface composed of 3 or 4 applications of selected bituminous material, interspersed and covered with appropriate spreadings of mineral aggregate totaling 110 pounds per square yard of surface, inclusive of the final "Seal Coat," and rolled as ordered. It shall be constructed on a road surface which complies with the profile and cross section crown shown on the plans and has been prepared for bituminizing under the item "Reconditioning of Used Roadbed," or on an approved newly constructed base or surfacing and which, in any case, immediately prior to placing this proposed treatment, has been treated as prescribed under the item "Bituminous Prime Coat" or under the item "Bituminous Tack Coat."

-1.2 The sequence of operations and the approximate amounts of material per square yard of road surface treated shall be in accordance with the following tables, Table I giving amounts per square yard of surface when liquid asphalt is used and Table II when emulsified asphalt is used.

Table I

| | Liquid Asphalt (Incl. Cut-back and 95% Liquid Asphalt) (Gal.) | Coarse Aggregate | Key Rock | Fine Chips | Screenings or Sand |
|---|---|---|---|---|---|
| On Treated Surface (Prime or Tack) | | | | | |
| Application Spreading | 0.20 | 70 lb. | | | |
| Application Spreading | 0.40 | | 20 lb. | | |
| Application Spreading | 0.20 | | | 12 lb. | |
| Seal Application Spreading | 0.20 | | | | 8 lb. |
| Totals | 1.00 | | | | 110 lb. |

Table II

| | Emulsified Asphalt (Gal.) | Coarse Aggregate | Key Rock | Fine Chips | Screenings or Sand |
|---|---|---|---|---|---|
| On Treated Surface (Prime or Tack) | | | | | |
| Spreading | | 70 lb. | | | |
| Application Spreading | 0.40 | | 20 lb. | | |
| Application Spreading | 0.45 | | | 12 lb. | |
| Seal Application Spreading | 0.25 | | | | 8 lb. |
| Totals | 1.10 | | | | 110 lb. |

The amounts given in Tables I and II are approximate. After the particular job materials have been tested and approved for use, the engineer will set the exact amounts to be used in each "Application" and "Spreading." He may vary the amount of bituminous material per square yard in any or all spreadings from that called for in the table to better suit the conditions, but the 110 pound total for aggregate shall not be changed save that the engineer may order, in writing, some of the 110 pound total apportioned to the stockpiles as an additional reserve or he may similarly order some of the apportionment for stockpiling used on the road at once if deemed advantageous. The actual rate of distribution of bituminous material on each square yard of surface shall not vary from the rate ordered by more than 5 percent.

-2.1 Materials. The aggregate shall be crushed gravel, stone or slag furnished in 4 sizes, to be known and graded as provided in Table III when cut-back asphalt is used as binder, and as provided in Table IV when emulsified asphalt is used as binder, using A.A.S.H.O. Method T-27.

Table III

| | Liquid Asphalt | | | |
|---|---|---|---|---|
| | Coarse Aggregate | Key Rock | Fine Chips | Screenings or Sand |
| | Square Openings - Percent Passing | | | |
| 1½" | 100 | | | |
| 1" | 95-100 | | | |
| 3/4" | | 100 | | |
| 1/2" | 0-10 | | 100 | |
| 3/8" | | 0-10 | 95-100 | 100 |
| No. 4 | | | | 95-100 |
| No. 10 | | | 0-10 | 50-100 |
| No. 200 | | | | 0-10 |

Table IV

| | Emulsified Asphalt | | | |
|---|---|---|---|---|
| | Coarse Aggregate | Key Rock | Fine Chips | Screenings or Sand |
| | Square Openings - Percent Passing | | | |
| 1½" | 100 | | | |
| 1" | 95-100 | | | |
| 3/4" | | | | |
| 1/2" | 0-10 | 100 | | |
| 3/8" | | 95-100 | 100 | 100 |
| No. 4 | | | 95-100 | 95-100 |
| No. 10 | | 0-10 | 0-10 | 50-100 |
| No. 200 | | | | 0-10 |

-2.2 Crushed gravel shall consist of clean, hard, tough, sound and durable stone fragments and shall be the product obtained by scalping the quarry material on a screen which will remove and waste sufficient of the fine fractions so that the material scalped, when tested by laboratory methods, shall be retained on a 1½-inch sieve with square openings. The portion thus retained on the scalping screen shall then be crushed to provide the mineral aggregate. The finer fractions passing the scalping screen shall be discarded and not used in this item except that, if so desired, the fraction meeting the requirements for "Screenings or Sand," may be used therefor.

-2.3 Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft or disintegrated pieces, dirt, or other objectionable matter.

-2.4 Crushed slag shall be air-cooled blast furnace slag and shall consist of angular fragments reasonably uniform in density and quality and reasonably free from thin elongated, or glassy pieces, dirt, or other objectionable matter.

-2.5 Crushed stone shall show a percent of wear of not more than 7, slag a percent of wear of not more than 15 and gravel a percent of wear of not more than 15 for uncrushed and not more than 25 for crushed pieces using A.A.S.H.O. Method T-3 or T-4. Slag shall have a weight of not less than 70 pounds per cubic foot.

-2.6 The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

-2.7 Bituminous Materials. The bituminous material shall be cut-back asphalt, 95/ liquid asphalt, or emulsified asphalt, whichever is called for in the Bid Schedule and the Award. Liquid asphalts shall be homogeneous and free from water. The emulsified asphalt shall be homogeneous and shall meet the requirements herein prescribed using

A.A.S.H.O. Method T-59. It shall show no separation of asphalt at the time of use, provided that separation has not been caused by freezing after delivery, and provided further that this requirement shall not apply if the material is held more than 30 days. If a liquid asphalt is to be used, the particular grade shall be selected by the engineer from the tables given hereinbelow and shall meet the respective requirements set out in the table for that grade.

Cut-back Asphalts

| Designation | A.A.S.H.O. | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash point °F | T-48 | 80 | | 80 | | 80 | |
| Viscosity, Furol | T-72 | | | | | | |
| at 122°F., sec. | | 200 | 400 | | | | |
| 140°F., sec. | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78 | | | | | | |
| (% by vol.) | | | | | | | |
| to 374°F. | | | | | | | |
| 437°F. | | 10 | | 3 | | 0.5 | |
| 600°F. | | 20 | | 14 | | 7 | |
| 680°F. | | | 35 | | 30 | | 25 |
| Pene. Residue | T-49 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. Residue 77°F. | T-51 | 60 | | 60 | | 60 | |
| Sol. Residue ($CS_2$) | T-44 | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 125 | 155 | 145 | 175 | 170 | 200 |

95% Liquid Asphalt

| Designation | A.A.S.H.O. | Minimum | Maximum |
|---|---|---|---|
| Water | T-55 | | 0.5% |
| Sediment | T-55 | | 1% |
| Flash Point °F. | T-48 | 400 | |
| Float Test 122°F., sec. | T-50 | 250 | |
| Residue of 80 Pene. | T-56 | 95% | |
| Percent of Residue | | | |
| Sol. in $CS_2$ | T-44 | 99.5% | |
| Pene. of Residue after | | | |
| loss on heating 325°F | | | |
| 5 hr. | T-49 | 125 | |
| Temp. of Application °F | | 325 | 375 |

Emulsified Asphalt

| | Minimum | Maximum |
|---|---|---|
| Viscosity, Furol 77°F. | 20 | 100 |
| Settlement, 5-day | | 3% |
| Demulsibility, using 35 ml. | | |
| 0.02 N. $CaCl_2$ solution | 50% | 100% |
| Sieve Test | | 0.20% |
| Residue by Distillation | 55% | 60% |
| Pene. of Residue | 100 | 200 |
| Soluble Residue ($CS_2$) | 95% | |
| Ash | | 2% |
| Ductility of Residue | 40 | |
| Specific Gravity at 77°F. | 1.00 | |
| Temp. of Application °F. | 60 | 120 |

-2.8 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed.

A sample of the bituminous material that the contractor proposes to use in his work, together with a statement as to its source and character must be submitted and approved before construction begins.

A sample of the emulsified asphalt that the contractor proposes to use in his work, taken from not less than a 20,000 gallon lot of emulsion, together with a statement as to the source and character of the crude petroleum from which manufactured must be submitted and approved before construction begins. No emulsified asphalt other than that represented by the sample submitted and approved shall be used.

-2.10 Shipment Reports and Inspection at Delivery. A test report shall be furnishede in duplicate by the vendor at the time of shipment to each car, showing the results of the above described tests on this shipment together with the date of shipment, car initial and number, destination and project number for which shipped, type and grade of material, gravity of the material both specific and A.P.I., the loading temperature with the number of gallons loaded at that temperature and the number of gallons reduced to 60°F.

One copy of this report shall be mailed to the District Engineer of the U.S. Bureau of Public Roads in whose district the work is located and the other copy shall be mailed to the Resident Engineer in charge of the project to which the shipment is made.

When requested by the engineer the vendor shall furnish and ship a one-quart sample from each car furnished to such point or destination as may be required. The engineer reserves the right in case of question as to the quality of the bituminous material to sample and test it at the point of delivery at the project. No bituminous material shall be applied until approved by the engineer and if separation of the material in the car at the time of proposed use is found to have occurred, the material shall be rejected. The contractor shall not be allowed any compensation for any delays or damages sustained pending the completion of testing and approval.

-2.11 Weigh House. A weigh house shall be furnished by the contractor to protect the weighing device of the scales and to provide storage space for the testing equipment. The weigh house shall be not less than 10' x 12' in size, weather proof and shall have one door, one sliding window facing the scale platform, one end window, and a shelf desk at least 24 inches wide. The scales and weigh houses shall remain the property of the contractor upon completion of the contract.

-3.1 Construction Methods. The methods employed in performing the work and alle equipment, tools and machinery used for handling and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of suitable units, including long base blader, long base maintainer, broom dragging equipment, distributor, powered roller weighing not less than 5 tons and aggregate spreading equipment with positive control, adjustable to spread accurately the given amount per square yard of road surface. The contractor shall also provide a power revolving broom or a power blower. The broom dragging equipment, consisting essentially of non-revolving brooms, may be either an independent unit or an accessory attachment on the roller or other equipment. The spreading equipment shall preferably be a power spreader, but the contractor may use trucks equipped to distribute the aggregate in a thin uniform sheet over a one lane strip.

Distributors shall be equipped with pneumatic tires of sufficient width and design so that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire.

Distributors shall be equipped with suitable manifold and appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heat and temperature at all times including thermometers reading temperature of tank contents. The distributor shall be so designed as to maintain a constant and uniform pressure upon the bituminous material as it passes through the nozzles. Sufficient and proper screens shall be installed between the tank and the nozzles and the same shall be cleaned frequently to prevent clogging of the nozzles.

Distributors shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous material being applied

per square yard of surface under the operating conditions, and with tachometers reading speeds in feet per minute. The capacity of the distributor shall be .05 to 2.0 gallons per square yard, 25 to 75 pounds pressure, and variable width up to 15 feet.

-3.2 Application of Bituminous Material. After the prime coat or tack coat has been completed and is in proper condition in the judgment of the engineer, an application of the bituminous binder called for shall be made on the prepared surface in the amount determined by the engineer as indicated in Article -1.2 herein. The particular grade of liquid asphalt to be used shall be designated by the engineer for the application. The material shall be applied only when the prepared surface is firm and intact and free from moisture.

Where the Bid Schedule calls for emulsified asphalt, the application directly on the prepared surface as prescribed above with liquid asphalts shall be omitted.

-3.3 First Spreading of Aggregate. After the application of liquid asphalt on the prepared surface, or in the case of emulsified asphalt, when the surface to be treated has been prepared, coarse aggregate in the amount determined by the engineer as indicated in Article -1.2 shall be spread uniformly with the spreading equipment hereinbefore indicated. Dumping en masse on the road shall not be permitted. If the rock segregates into sizes in handling, it shall be mixed until it presents a uniform appearance prior to being spread.

After the coarse aggregate has been spread, it shall be brought to a smooth and even surface by means of the long base blader, maintainer, or drag, and the entire surface shall then be rolled as directed. In the case where emulsion is used it should be rolled once over only.

-3.4 Application of Bituminous Material. After the rolling, liquid asphalt or emulsified asphalt, as the case may be, shall be applied in the amount set by the engineer for the application as indicated in Article -1.2.

-3.5 Spreading of Key Rock. Immediately following the above application the bituminous material shall be covered with key rock in the amount set by the engineer as indicated in Article -1.2. The surface shall then be rolled and broom-dragged. While this operation is in progress additional key rock, if necessary to prevent picking up by the roller, shall be added as directed. The operation shall be continued until the aggregate is thoroughly set in the bituminous binder.

-3.6 Application of Bituminous Material and Spreading of Fine Chips. After the above operation is complete, another application of liquid asphalt or emulsified asphalt, as the case may be, shall be made in the amount determined by the engineer as indicated in Article -1.2, followed by a spreading of fine chips, similarly as indicated in Article -1.2, and the operation of broom dragging and rolling repeated until the surfacing is fully compacted and bonded to the full width.

The work shall be maintained under traffic, as ordered, until the placing of the seal coat.

-3.7 Seal Coat. Not less than 24 hours after completion of the work previously described the sealing application of the bituminous material, liquid asphalt, or emulsified asphalt, as the case may be, shall be made, and screenings or sand spread in the amounts determined by the engineer as indicated in Article -1.2 and the whole work rolled, broom dragged and finished.

-3.8 Supplemental Aggregate. Key rock and fine chips in equal amounts, but kept segregated, shall be stockpiled in the average total amount of 40 tons per mile at such places and in piles of such forms and quantities as the engineer may direct. Prior to stockpiling the material, the sites selected shall be cleared and leveled as directed by the engineer and at the expense of the contractor.

-3.9 If during any application any spots are missed, bituminous material shall be applied to those spots by some means which will insure that the spot will be bituminized at the required rate.

During the application, the surface of all structures, guard rails and trees shall be protected in a satisfactory manner so as to prevent their being spattered or marred. Discharging the bituminous material into borrow pits or gutters will not be permitted.

In order to secure uniform distribution at the junction of two applications, the distribution shall be promptly stopped when the uniform flow decreases, indicating the tank is about empty. The distributor shall be equipped with a trough under the sprays,

properly arranged to be swung out of the way after the sprayers are operating in a uniform manner at the desired pressure, or building paper shall be spread over the treated surface for a sufficient length back so that the sprayers are operating properly when the uncovered surface is reached. The building paper shall then be removed and burned. The contractor shall furnish, and keep on the work at all times, an accurate thermometer suitable for measuring the temperature of the material being applied.

All bituminous material shall be applied under 25 to 75 pounds pressure. Bituminous materials shall be applied only when the atmospheric temperature is 50°F. or above, only between April 1st and November 1st and only when the degree of dryness of the base and aggregates meet the approval of the engineer. The temperature and seasonal requirements given above may be waived but only when so directed by the engineer. The application temperatures shall conform to the requirements given in the specifications of bituminous materials.

Where detours are not available, bituminous surface treatment shall be applied to but one-half the width of the roadbed at a time, confining traffic under one-way control to the other half of the roadway. The contractor shall provide flagmen and a light car and driver to conduct public traffic through portions of the roadway under one-way traffic control.

-4.1 Method of Measurement. The tonnage of aggregate to be paid for shall be the number of tons of aggregate of the separate gradings actually used in the accepted work and shall include the tonnage placed in stockpiles as ordered in writing. The aggregate shall be weighed on scales furnished by and at the expense of the contractor. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous materials to be paid for shall be the number of gallons, measured at 60°F., or converted to this temperature in accordance with A.S.T.M. D-208, actually used as ordered in the accepted work. When so called for in the Bid Schedule the unit for measuring bituminous material shall be the ton of 2,000 pounds.

Any aggregate or bituminous material used for repairing damage due to contractor's operations shall not be included in the pay measurement, but all such expense shall be borne by the contractor.

-5.1 Basis of Payment. The tonnage of aggregate and gallonage of bituminous material (or tonnage when so called for in the Bid Schedule, determined as provided above, shall be paid for at the respective contract unit prices per ton and per gallon bid for "Aggregate for Heavy Armor Coat," and for "Cut-back Asphalt for Class A pavement," "95% Liquid Asphalt for Class A pavement," or "Emulsified Asphalt for Class A pavement," as the case may be, which prices and payments shall be full compensation for furnishing, preparing, handling, delivery and placing or application of all materials, for all conditioning of the roadway shoulders and ditches not covered under "Bituminous Prime Coat," or "Bituminous Tack Coat," for all blading, brooming and compacting including rolling, for the construction or repairing of roads to make the source of materials available, for clearing and stripping of the quarry and for pit cleanup, for the handling and disposal of unsuitable material encountered in quarry or pit operations, for clearing and leveling stockpile sites, for furnishing and sealing scales, including the weigh house, for traffic control, and for all labor, equipment, tools and incidentals necessary to complete the item.

Class B Bituminous Pavements

## 120 TYPE B-1 DENSE GRADED ROAD MIX SURFACE COURSE

120-1.1 Description. This item shall consist of a wearing course, composed of "Aggregate" and "Bituminous Material" mixed in place on the road, constructed in accordance with these specifications and finished in conformity with the lines, grades and typical cross section shown on the plans, with or without a seal coat as called for by the Bid Schedule and including required widening on curves. Suitable aggregate present in the existing road, salvaged and if necessary to meet the grading requirements blended with appropriate "New Aggregate," shall be used as the "Aggregate" to the extent directed by the engineer.

-1.2 Master Grading. The blend of salvaged and new aggregate, or the new aggregate where no salvaging is involved, shall meet the grading requirements for Grading A or Grading B as called for by the Bid Schedule, each as respectively tabulated below, by weight, except that aggregate for seal coat shall meet the grading limits for cover aggregate as tabulated below.

| | Grading A | Grading B | Cover Aggregate |
|---|---|---|---|
| Square Openings - Percent Passing | | | |
| 1 inch | 100 | 100 | |
| 3/4 inch | 75-100 | 95-100 | |
| 1/2 inch | | | 100 |
| 3/8 inch | | | 90-100 |
| No. 4 | 40-65 | 55-85 | 0-25 |
| No. 10 | 30-55 | 45-70 | 0-10 |
| No. 40 | 15-35 | 15-45 | |
| No. 200 | 4-10 | 5-15 | 0-2 |

-1.3 Job Grading. Within the above master requirements the grading of the job materials furnished shall be held to a uniformity such that the fractions of aggregate passing the Numbers 4, 10 and 200 sieves will remain constant throughout any one "run" within the following respective tolerances of variation from the average percent of the "run."

Material passing No. 4 sieve ±5
Material passing No. 10 sieve ±5
Material passing No. 200 sieve ±2

Samples from the prepared aggregate as windrowed after blending shall be tested for conformity with these requirements.

Each "run" shall be staked or otherwise adequately identified by the engineer or inspector. A "run" shall be construed as that length of aggregate windrowed along the road fixed upon by the engineer as a convenient unit and shall be such as to involve an amount of aggregate not less than the daily capacity of the mixing outfit. The length of the "runs" in any project may be varied and adjusted to fit the changes of pit when a pit is exhausted and for similar reasons but the length of run in any case shall not be less than above indicated. Sufficient samples shall be taken from the windrowed aggregate so that each shall represent not more than 1,000 square yards of finished surface course and in no case shall less than 5 samples be analyzed from each "run." Each sample shall represent an equal amount of material. No bituminous material shall be applied on any "run" until sieve analyses of the samples have been made and the "run" approved as within the job grading tolerance.

-1.4 Determining Total Amount of Bituminous Material. The amount of bituminous material used in each "run" shall be as designated by the engineer for each "run." It will involve the determination of the total combined volume of aggregate as windrowed in each "run" including both salvaged aggregate and new aggregate. The total volume will therefore be determined by measurement of the windrow of graded, blended aggregate. The proportion of bituminous material will be based primarily on the surface area of the aggregate as indicated by the grading.

In arriving at the total amount of bitumen for any given "run" the engineer will determine from the grading analyses, the average content for the "run" of the fractions retained on the No. 10, passing the No. 10 and retained on the No. 200 and passing the No. 200 respectively. Applying these averages, he will then make use of the following

formula with, however, such adjustment for surface characteristics, absorption and other special properties of the aggregate, as in his judgment the job materials and special project conditions make necessary. The formula gives the proportions by weight, which figure must be converted to gallons per volume of aggregate, and applied against the measured volume of the windrow in the "run."

$$P = .02a + .045b + \begin{cases} 0.15c \text{ for } 15\% \text{ passing No. } 200 \\ 0.18c \text{ for } 10\% \text{ passing No. } 200 \\ 0.20c \text{ for } 5\% \text{ or less passing No. } 200 \end{cases}$$

Wherein P = Percent of bituminous material by weight
a = Percent of aggregate retained on No. 10 sieve
b = Percent of aggregate passing No. 10 sieve and retained on the No. 200 sieve
c = Percent of aggregate passing No. 200 sieve

In order that the volumetric measurement may be conveniently and accurately performed the combined salvaged and new aggregate shall be formed or moved into convenient windrow or windrows of uniform size and sampled and measured in the windrow. In order to secure satisfactory uniformity of windrow cross section a windrow shaper or some equivalent equipment shall be provided and used by the contractor, or the same essential purpose accomplished by an approved construction operation sufficiently accurate for the purpose and satisfactory to the engineer. The windrow, after shaping, shall be left undisturbed until duly measured and sampled.

-2.1 Materials. Aggregates shall consist of screened gravel, crushed to sizee as necessary, or crushed stone, in either case composed of sound, tough, durable pebbles or fragments of rock and shall contain or have incorporated in it sand, stone dust or other inert finely divided mineral material, the whole meeting the grading requirements hereinbefore prescribed. Gravel shall have a percent of wear of not more than 20 percent for uncrushed pieces and not more than 30 percent for crushed pieces using A.A.S.H.O. Method T-4, and stone present shall have a percent of wear of not more than 8 using A.A.S.H.O. Method T-3, and all material shall be free from clay balls and adherent films of clay or other matter that will prevent a thorough coating of the particles with a tenacious film of the bituminous material. Oversized gravel shall not be wasted but shall be crushed until graded to size. The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

Added mineral filler shall be material passing the 200 mesh sieve, found suitable by the engineer to be used to supplement the fines in the aggregate so as to meet the grading and other requirements hereinbefore specified.

That portion of the total aggregate passing the No. 40 sieve shall have a "Plasticity Index" of not more than 8 when determined by the physical tests as described in Public Roads, Vol. 12, No. 8, issue of October, 1931.

Conformity of all aggregate to the grading requirements hereinbefore prescribed shall be determined by the "Washed Mechanical Analysis" performed in the following manner.

A representative test sample of the aggregate shall be secured by quartering or by use of a sampler. After drying the sample shall weigh not less than 3,000 grams. The sample shall be dried to constant weight at a temperature not exceeding 230°F. and weighed. The sample shall then be placed in a pan 12 inches in diameter by not less than 4 inches deep (as nearly as may be obtained), after which sufficient water shall be poured into the pan to cover the sample. The material shall be agitated vigorously for 15 seconds with a trowel or stirring rod. After it has settled for 15 seconds the water shall be poured off, care being taken not to pour off any particles which have settled. This procedure shall be repeated until the wash water is clear. The wash water shall be poured through a No. 200 sieve and any material retained thereon shall be returned to the washed sample.

The washed material shall be dried to constant weight at a temperature not exceeding 230°F. and weighed. The washed sample shall be passed through each of the standard sieves specified. The sieving on each sieve shall be continued until less than one percent of the weight retained on each sieve shall pass through the sieve during the last minute of sieving. The percentage by weight retained on each sieve shall be determined.

The percentages in the washed mechanical analysis shall be reported as the percent passing each sieve specified beginning with the largest size and ending with the loss by elutriation. The percent reported as passing the No. 200 sieve shall be the percent

determined by the mechanical analysis on the washed sample plus the percent lost by elutriation.

The bituminized aggregate shall have a swell of not more than 1.5 percent when subjected to the following test. A sample of the total aggregate as prepared for use shall be combined with the type and quantity of bituminous material proposed for the work. After mixing it shall be compacted by tamping in a metal cylinder 4 inches in diameter and at least 5 inches high. Sufficient mixture shall be used to form a compacted briquette, and then covered with water to a depth of 2-1/2 inches and any resulting swell measured after 24 hours. The vertical expansion or swell is to be measured accurately to the nearest 1/1000 of an inch.

-2.2 Bituminous Material. The bituminous material to be used shall be one ore more of the following described "Slow Curing Asphalts" for the road mixed course and one of the following described "Cut-back Asphalts" for the seal coat. Slow curing asphalt shall be homogeneous. Cut-back asphalt shall be homogeneous and free from water. The particular grade to be used shall be selected by the engineer from the table given below and shall meet the respective requirements set out in the table for that grade.

Slow Curing Asphalts

| Designation | A.A.S.H.O. | SC-2 | | SC-3 | |
|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. |
| Water and Sediment | T-55e | | 2% | | 2% |
| Flash Point °F. | T-48e | 200 | | 200 | |
| Viscosity, Furol | T-72e | | | | |
| at 122°F., sec. | | 200 | 320 | | |
| 140°F., sec. | | | | 150 | 300 |
| Total Distillate | T-78e | | | | |
| (% by vol.) | | | | | |
| to 437°F. | | | 2e | | 2 |
| 600°F. | | | 15 | | 10 |
| 680°F. | | | 25 | | 20 |
| Float Test on Residue | T-50e | | | | |
| at 122°F., sec. | | 25 | | 25 | |
| Sol. of Residue $CS_2$ | T-44e | 99 | | 99 | |
| Temp. of Application °F. | | 125 | 155 | 135 | 165 |

Cut-back Asphalts for Seal

| Designation | A.A.S.H.O. | RC-1 | | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Min.e | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point °F. | T-48e | 80 | | 80 | | 80 | | 80 | |
| Viscosity, Furol | T-72e | | | | | | | | |
| at 122°F., sec. | | 80 | 160 | 200 | 400 | | | | |
| 140°F., sec. | | | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78e | | | | | | | | |
| (% by vol.) | | | | | | | | | |
| to 374°F. | | 5 | | | | | | | |
| 437°F. | | 12 | | 10 | | 3 | | 0.5 | |
| 600°F. | | 25 | | 20 | | 14 | | 7 | |
| 680°F. | | | 40 | | 35 | | 30 | | 25 |
| Pene. of Residue | T-49e | 60 | 120 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. of Residue 77°F. | T-51e | 60 | | 60 | | 60 | | 60 | |
| Sol. of Residue $CS_2$ | T-44e | 99.5% | | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 105 | 135 | 125 | 155 | 145 | 175 | 170 | 200 |

-2.3 Sources of Supply. Approval of sources of supply of the mineral aggregate shalle be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed.

A sample of each bituminous material that the contractor proposes to use in his work, together with a statement as to its source and character must be submitted and approved before use of the material begins.

A test report shall be furnished in duplicate by the vendor at the time of shipment of each car, showing the results of all the above described tests on this shipment together with the date of shipment, car initial and number, destination, project number for which shipped, type and grade of material, gravity of the material both specific and A.P.I., the loading temperature with the number of gallons loaded at that temperature and the number of gallons converted to 60°F.

One copy of this report shall be mailed to the District Engineer of the U.r S. Bureau of Public Roads in whose district the work is located and the other copy shall be mailed to the Resident Engineer in charge of the project to which the shipment is made.

When requested by the engineer the vendor shall furnish and ship a one-quart sample from each car furnished to such point or destination as may be required. The engineer reserves the right in case of question as to the quality of the bituminous material to sample and test it at the point of delivery at the project. No bituminous material shall be applied until approved by the engineer and if separation of the material in the car at the time of proposed use is found to have occurred the material shall be rejected. The contractor shall not be allowed any compensation for any delays or damages sustained pending the completion of testing and approval.

-3.1 Construction Methods. The methods employed in performing the work and allr equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of suitable units including tractor-drawn or motor bladers or "blader mixers," approved distributors and rollers supplemented by spreading and smoothing apparatus, or his equipment outfit may be of the traveling plant type including adequate units of equipment for spreading, compacting and smoothing including power rollers. In any case the contractor shall supply long base maintainers, steel brush or broom drag, and other necessary finishing equipment designed and operated to avoid causing as well as to remedy corrugations and irregularities and to produce a true riding surface of uniform texture.

Scarifiers shall be of the 4-wheel type and have a wheel-base of not less than 15 and preferably 16 feet. Disc harrows used shall be so designed as to prevent unintentional cutting into the subgrade during operation. Other harrows shall be either of the spring or spike tooth type and designed for positive control and mounted, preferably on wheels. For road mixing, power-drawn bladers shall have a wheel-base of not less than 15 and preferably 16 feet, shall be in good order and tightly articulated; moldboards on all mixing machines shall have a radius of curvature of not more than 15 inches. All machines used in mixing, laying down and finishing shall be rubber tired, preferably pneumatic, except crawler type tractors and except units for which wide tired steel wheels or street plates are specifically permitted by the engineer. Rollers for compacting the wearing surface shall be self-propelled road rollers weighing from 8 to 10 tons unless otherwise permitted by the engineer in writing.

The heating equipment supplied shall be of adequate capacity to heat the bituminous material properly. Heating of cars, tanks and distributors shall be accomplished without introducing steam or moisture into the bituminous material. The use of any agitating accessory to aid in the heating will be prohibited, if, in the opinion of the engineer, it injures or in any way changes the characteristics of the bituminous material. Any heating system or accessory which results in coking or burning of the material shall be cause for disapproval of the equipment. Approved thermometers shall be supplied by the contractor.

Tank wagons and trucks used for the transportation or application of asphalt shall have either a steam or air-kerosene, or equivalent, system for the clearing of lines and pumps. Evidence of fluxing with kerosene or emulsification by steam shall be sufficient cause for rejection of the delivery. Distributors shall have tires of sufficient width that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire. Pneumatic dual tires are required except that for a reasonable cause the engineer by written order may waive this particular requirement.

Distributors shall be equipped with suitable manifold and other appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heating and temperature at all times, including approved thermometers reading temperature of tank contents. The distributor shall be so designed as to keep a constant and uniform pressure upon the bituminous material as it passes through the nozzles. Sufficient and proper screens shall be installed between the tank and the nozzles and the same shall be cleaned frequently to prevent clogging of the nozzles.

Distributors shall be equipped with devices and charts to provide for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface, and with tachometers reading speeds in feet per minute. The equipment shall be so designed and articulated in controlled amount that uniform application of bituminous material may be made, ranging from 0.05 to 2.0 gallons per square yard of surface and to a width of at least 15 feet and with a range of pressure from 25 to 75 pounds per square inch.

All self-powered distributors or trucks or other hauling units shall have sufficient power to maintain a constant and uniform speed over the aggregate.

For broadcasting the cover aggregate a spreader shall be provided unless waived by the engineer. It shall be so designed, with a positive control, that the required poundage per square yard or per running foot shall be deposited in a thin uniform sheet. Preferably, it shall be a hopper type spreader with a large drum in the bottom of the hopper, so arranged and driven by the supporting wheels that the speed of operation will not affect the regularity of the spread. The control gates shall be so arranged that the operator cannot vary the desired amount accidentally. A windrow shaper as specified in Article -1.4 shall be provided or a windrow gage meeting the approval of the engineer.

When traveling mixing plants or similar equipment are used, the requirements in these specifications concerning temperatures at the time of application, uniformity and thoroughness of mixing, spreading and compacting of the mixed surfacing, corrections of mixture and removal therefrom of excess moisture shall be complied with and this form of equipment shall be supplemented by ordinary blader mixing equipment to complete any undermixed or otherwise unsatisfactory work, and by roller or rollers.

-3.2 Preparation of Base. The existing roadbed shall first be scarified, if ande as directed, to a depth just sufficient to eliminate irregularities of the surface and to permit reshaping, and the entire roadbed for the full width shall be bladed to the shape of cross section shown on the plans, and to a smooth riding profile. Ditches shall be trimmed and cleaned of all slides, stones or other debris.

Case 1. Where material in the existing roadbed surface is to be salvaged and used for the aggregate, either wholly or in part, the bladed surface shall be scarified again as ordered, to such depth and in such manner as to leave a foundation stratum of undisturbed material parallel to the proposed finished surface of the improvement both in cross section and profile. The gradation of the loosened material will be determined. To the material thus loosened new aggregate, selected for the purpose, shall be added where necessary to fill depressions and to strengthen weak places in the base, and new aggregate, so graded and in such amount as to supplement the grading of the loosened, salvaged material, shall then be added to produce from the combination a blended aggregate of the contemplated composite job grading hereinbefore prescribed and in the amount necessary, in the judgment of the engineer, to provide the thickness of metalling shown on the plans. The added material shall be thoroughly mixed with the loosened, salvaged material by suitable harrowing and/or turning with a blade or other equipment. The entire composite or blended aggregate shall then be bladed aside. The undisturbed stratum thus exposed shall then be rolled, or wetted and rolled, as ordered. The composite material bladed aside shall be formed into a windrow at the side of the roadbed trimmed with the shaper or with a windrow gauge as hereinbefore stipulated, and left until sampled and tested for amount and grading, for which at least one day shall be allowed.

If called for in the Bid Schedule, and as directed by the engineer, the undisturbed stratum shall be primed as specified under the item "Bituminous Prime Coat" provided, however, that the width of road covered shall be as regulated by the engineer and the requirement of the 48 hour curing period may be waived at the discretion of the engineer.

If the results of the sampling and testing show that additional material is necessary to produce the required depth of surfacing, it shall be obtained under direction of the engineer by further scarifying of the existing roadbed (previous to priming) or by adding new material, or new fractions of material, suitably graded. If the tests show additional material is necessary to secure the required grading, tested and approved material suitable for the purpose shall be added. The materials in the windrow thus affected shall be remixed until of satisfactory uniformity and retested for conformity to all specification requirements, if considered necessary.

Case 2. Where none of the material in the existing roadway is to be salvaged and utilized as aggregate, the base after shaping and smoothing as hereinbefore stipulated, shall be rolled, or wetted and rolled, until compacted. If ordered by the engineer, depressions shall first be filled and weak places in the subgrade or base strengthened by patching with aggregate.

If called for in the Bid Schedule, and as directed by the engineer, the road shall then be primed as specified under the item "Bituminous Prime Coat," and as prescribed in Case 1.

New aggregate of correct gradation shall be deposited in a windrow along one side of the roadbed by means of vehicles equipped or supplemented with suitable spreading devices. The aggregate shall be so deposited that the windrow will be uniform in size and in grading, and will contain the correct quantity of aggregate to provide surfacing of the required width and thickness. The windrow shall be shaped and trimmed with a shaper or with a windrow gage. As a special means of assuring uniformity, the engineer may require the contractor to accomplish the depositing of the aggregate for the windrow in the following manner. One third of the total quantity required shall be spread over the entire length of the "run." This shall be followed by the placing of the second third over the entire length of the "run." and then the remaining third shall be deposited, each third being placed continuously over the entire length of the "run." The aggregate shall then be bladed into the one windrow and trimmed as required hereinbefore.

Care shall be exercised to prevent the aggregate from becoming mixed with earth or shoulder material.

-3.3 Drying the Aggregate on the Road. When a "run" of prepared aggregate is ready for bituminizing and immediately prior to bituminizing, the aggregate to be treated shall be tested for moisture. In the event it contains more than one percent of water by weight of dried material it shall be turned by blades or disc harrows, or otherwise aerated, until the moisture content is reduced to one percent. The prepared aggregate shall then be spread smoothly and uniformly over half the road or other convenient width ready for the application of the bituminous material.

-3.4 Application and Partial Mixing. The bituminous material shall be distributed in three applications for the run each of approximately one-third of the total required amount per square yard, as determined by the engineer. It shall be applied uniformly at a temperature within the range shown in the specifications for the particular material. The rate of each application shall not vary from the rate designated by the engineer by more than 5 percent. Immediately behind the distributor shall follow an assemblage of double disc or other harrows or equivalent equipment, to partially mix the aggregate and bituminous material and to leave as little free bituminous material as possible. The interval between applications shall be as regulated by the engineer.

If any spots are missed, bituminous material shall be applied to those spots by some means which will insure the spot will be bituminized at the required rate.

During the application, the surfaces of all structures, guard rails and trees shall be protected in a satisfactory manner so as to prevent their being spattered or marred. Discharging the bituminous material into borrow pits or gutters will not be permitted.

In order to assure a uniform distribution at the junction of two distributor loads, distribution shall be stopped promptly when the uniform flow starts to decrease, indicating that the tank is nearly empty.

-3.5 Mixing. After the last application and "partial mixing," the entire mass of bituminized aggregate shall be moved by a heavy blader into a windrow near the center of the road, and then mixed by the assemblage of mixing units provided, by blading the treated material from side to side of the road or by manipulations producing equivalent results until all particles are coated with the bituminous material and the whole mass has a uniform color. During the mixing care shall be taken to avoid cutting into the underlying base. Care shall also be taken that none of the mixture is spread on earth shoulders or on any unprepared areas where it may become contaminated with earth and extraneous matter.

In lieu of mixing the materials as above specified, other equipment and methods, such as rotary mixers and traveling plants, may be employed provided that there is produced a mixture satisfactory to the engineer and at least equal to that which can be produced by the means above specified. The engineer shall have the right to order discontinuance of the use of any equipment or method which, in his opinion, fails to produce a satisfactory mixture.

When so directed the mixing process shall be confined to part of the width or area of the road so as to allow traffic to pass conveniently and undisturbed.

Before the mixture is spread, the windrowed mixture will be examined by the engineer, who shall determine whether the mixing is complete, the bituminous content correct and the moisture removal satisfactory. Should the mixture show an excess, deficiency or uneven distribution of bituminous material, the unsatisfactory condition shall be corrected by the appropriate addition of aggregate or bituminous material as required and remixing. If the moisture content exceeds one and one-half percent the contractor shall blade and reblade the material and allow it to dry out. If necessary the material shall be harrowed or disced and all compressed masses of material broken up. No spreading shall be done until authorized by the engineer, or when the base to be covered is wet.

At the end of each day's work, or when work is interrupted by weather conditions all loose material shall be bladed to a windrow whether the mixing is complete or not, and not allowed to remain spread on the roadway over night or until work is resumed.

-3.6 Procedure with Thickened Edge. If required by the approved typical section, provisions shall be made for a thickened edge of the surfacing. A triangular cut shall be made with a blade grader at each edge of the roadbed. In making the cut, the excavated material shall be thrown to the shoulder in a small windrow against which the bituminized mixture shall be spread.

-3.7 Laying Down and Compacting the Mixture. After the mixing has been completed the mixed material shall be spread from the windrow to the width required by a blade grader or equivalent equipment in successive uniform layers, approximately one inch thick, until the required total amount per square yard is obtained. Ordinarily, unless prevented by job conditions each layer should be opened to traffic and partial compaction obtained thereby. During compaction the surface shall be dragged or bladed as necessary to fill any ruts and to remove incipient corrugations, waves or other irregularities. The interval between laying down successive layers shall be as directed by the engineer.

In spreading from the windrow care shall be taken to prevent cutting into the underlying base. In order to prevent such cutting a layer of the mixture approximately one-half inch thick may be ordered left on the bottom of the windrow.

After the surface has set up sufficiently the edges of the mat shall be trimmed neatly and the surfacing rolled as directed.

Rolling shall be longitudinal and shall commence at the outer edges of the road overlapping the shoulders, and progress toward the center. Blading shall continue during the rolling. The combined operation shall continue until the surfacing has a uniform texture and compaction and is true to grade and cross section. Under no circumstances shall the center of the surface course be rolled first.

While the surface is being compacted and finished, the contractor shall shape and finish the entire roadway. The gutters shall be cleaned and all excess material, loose stones and rock fragments that may be dragged to the surface or loosened shall be removed and disposed of as directed by the engineer.

-3.8 Improving Unsatisfactory Areas. If prior to acceptance fat spots develop under traffic such areas shall be scarified and sufficient uncoated graded aggregate incorporated to produce a satisfactory mixture. If lean spots develop additional bituminous material shall be applied and such spots remixed to the full depth until all particles in the mixture are coated uniformly and properly. Should any portion of the surface of a mat become rough or uneven, and it is found impossible to remedy the condition by dragging or blading, such areas shall be scarified, remixed and relaid as the engineer may direct.

-3.9 Operating Under Unfavorable Weather Conditions. No bituminous material shall be applied nor shall road mixing proceed when the aggregate contains more than one percent of moisture by weight, nor when the air temperature is less than 40°F. nor during excessively damp, rainy weather, nor during the night between sunset and sunrise, nor at any time when, in the judgment of the engineer, the weather conditions are such that satisfactory results cannot be obtained. No bituminous material shall be applied to frozen or excessively cold aggregate.

If rain commences to fall during the bituminous treating of mixing operations the uncompleted mixture shall be windrowed promptly. The treated material and mixture and the base shall then be allowed to dry out before the resumption of any work, except such turning as will facilitate evaporation. The engineer shall be the sole judge as to when the road and mixture have dried sufficiently to allow the work to be resumed.

-3.10 Testing Road-Mixed Surface. The complete road-mixed surface shall be compacted thoroughly, be smooth and even, true to grade and cross section, and free from

ruts, bumps, depressions, or irregularities. When a straight edge ten feet long is laid on the finished surface and parallel with the center line of the road, the surface shall vary in no place more than one-quarter inch from the lower edge of the straight edge. It shall be maintained in that condition by the contractor until accepted for traffic, or until the completion of the contract.

-3.11 Seal Coat. When the Bid Schedule contains items for seal coat the road surface shall be open to traffic for at least two weeks and shall then be swept clean. Bituminous material for seal coat shall be applied only when the roadway is dry and the atmospheric temperature 50°F. or higher. Application shall be in the amount of one-sixth to one-fourth gallon per square yard. When the desired stage of tackiness is attained cover aggregate shall be spread in the amount of 10 to 20 pounds per square yard. The aggregate shall contain not more than 3 percent of moisture. The exact amount of bituminous material and cover aggregate shall be determined by the engineer. Immediately after spreading the cover aggregate the surface shall be rolled with a self-propelled roller weighing from 5 to 10 tons. This shall be followed by alternate brooming with a broom drag and rolling until the cover material is embedded and the surface is thoroughly compacted and uniform in texture.

-3.12 Accommodating Public Traffic. The work shall be maintained continuously in serviceable condition proper for accommodation of public traffic except that in areas where the condition of the work is unavoidably such that vehicles will be subject to inconvenience and damage due to spattering with oil or bituminized aggregate the contractor at his own expense, shall arrange convenient detours. While the seal coat is being applied traffic shall be routed over detours or the seal coat shall be placed one-half width at a time and the other half shall be kept clear and open to traffic.

Suitable warning signs, illuminated at night by lanterns or flares shall be provided to mark the places where the surfacing ends or is not compacted and at other places deemed necessary by the engineer. The contractor shall also provide flagmen and a light car and driver to conduct public traffic through portions of the road under one-way traffic control.

-3.13 Supplemental Material. When directed by the engineer, road mixed aggregate, taken from the completely mixed windrow just prior to its being laid down and by taking one shovelful from the windrow at such intervals as will produce the desired quantity, shall be placed in stockpiles, at locations selected by the engineer at the rate of 50 tons of road mixed aggregate per mile of road. Cover aggregate, when directed by the engineer shall be stockpiled at the points directed by the engineer and at the rate of 20 tons per mile of road.

-4.1 Method of Measurement. The mileage of surfacing laid, to be paid for, shall be the length, expressed in miles, of surfacing completed to the width shown on the plans including any widening ordered at curves and at intersections and finished with seal coat as called for in the Bid Schedule, and accepted, measured complete in place. The length will be measured horizontally along the center line of the improved road.

The tonnage of new aggregate to be paid for shall be the number of tons of new aggregate actually used in the mixed surfacing, together with that placed in stockpiles, but excluding aggregate originally present on the road, weighed on scales furnished by and at the expense of the contractor. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds.

The tonnage of cover aggregate to be paid for shall be the number of tons of cover aggregate actually used in the seal coat, together with that placed in stockpiles.

The yardage of added mineral filler to be paid for shall be the number of cubic yards, measured in the vehicle at point of delivery and of mineral filler added under written order and not included in the material weighed and paid for as new aggregate.

The gallonages of bituminous material to be paid for shall be the number of gallons each of slow curing asphalt and of cut-back asphalt, measured at 60°F. or converted to this temperature in accordance with A.S.T.M. specification D 206-34, actually used as ordered in the accepted work. When so called for in the Bid Schedule the unit for measuring bituminous material shall be the ton of 2,000 pounds.

The amount of watering to be paid for shall be the number of thousand gallon units of water, measured in the vehicle at the point of delivery on the road and used as ordered.

-5.1 Basis of Payment. The mileage of surfacing, determined as provided above shall be paid for at the contract unit price per mile bid for "B-1 Road Mix Surfacing Laid," which price and payment shall constitute full compensation for the scarifying and preparation of the existing road and of the subgrade including any extra sanding or other protection of the prime, for handling, grading, blending, placing and mixing all materials, including the heating and application of all bituminous materials involved, rolling, finishing and completion of the work, the trimming and shaping of shoulders and ditches, and the placing and completion of the seal coat as called for in the Bid Schedule, and all labor, equipment, tools and incidentals necessary to complete the item, except the furnishing of the new aggregate, cover aggregate, mineral filler, bituminous materials and the watering.

The tonnages, determined as provided above, shall each be paid for at the respective contract unit pricesper ton bid for "Class B New Aggregate," Grading A or Grading B as the case may be, and for "Class B Cover Aggregate" which prices and payments shall be full compensation for furnishing these materials and hauling and delivering on the road at the job.

The yardage of added mineral filler, determined as provided above, shall be paid for at the contract unit price per cubic yard bid for "Mineral Filler for Class B," which price and payment shall be full compensation for furnishing, hauling and delivering this material.

The gallonage or tonnage of bituminous material, determined as provided above shall be paid for at the respective contract unit prices per gallon or per ton bid for "Slow Curing Asphalt for Class B Road Mix" and "Cut-back Asphalt for Class B Seal," as the case may be, which prices and payments shall constitute full compensation for furnishing the bituminous material delivered at the job.

The number of thousand gallon units of watering, determined as provided above, shall be paid for at the contract unit price per unit bid for "Watering," which price and payment shall constitute full compensation for all labor, operators, equipment, gas, oil, repairs and supplies necessary for furnishing, hauling and applying the water.

Priming, if called for in the Bid Schedule, shall be paid for under and in accordance with the terms of the item "Bituminous Prime Coat."

Where the trimming of shoulders and ditches and the removal of slide material taken together in any hundred foot station amounts to more than 5 cubic yards, the excess yardage over 5 yards shall be paid for as "Unclassified Excavation."

Class B Bituminous Pavements

## 121 TYPE B-2 DENSE GRADED PLANT MIX SURFACE COURSE

121-1.1 Description. This item shall consist of a wearing course, composed ofa mineral aggregate mixed in a central plant with a slow curing bituminous material, constructed in accordance with these specifications and finished in conformity with the lines, grades and typical cross section shown on the plans, with a seal coat if so called for by the Bid Schedule. It shall be placed on a subgrade (or base) conditioned in accordance with the specifications for "Reconditioning of Used Roadbed" and "Bituminous Prime Coat."

-1.2 Master Grading. The mineral aggregate for the wearing course shall bea graded to meet the following primary course composition limits by weight, Grading A or Grading B, whichever is called for by the Bid Schedule. The seal coat aggregate shall meet the grading limits for cover aggregate as tabulated below.

| | Primary Course Grading A | Primary Course Grading B | Cover Aggregate |
|---|---|---|---|
| Square Openings - Percent Passing | | | |
| 1 inch | 100 | 100 | |
| 3/4 inch | 75-100a | 75-100a | |
| 1/2 inch | | | 100 |
| 3/8 inch | | | 90-100a |
| No. 4 | 35- 65a | 50- 75a | 0- 25a |
| No. 10 | 25- 55a | 30- 60a | 0- 5a |
| No. 40 | 15- 35a | 15- 45a | |
| No. 200 | 4- 15a | 5- 15a | 0- 2a |

-1.3 Job Grading. Within the above master grading requirements for "Primary Course" the grading of the job materials furnished shall be held to a uniformity such that the fractions of aggregate passing the Numbers 4, 10 and 200 sieves will remain constant throughout any one 8-hour "run" within the following respective tolerances of variation from the average percent of the "run."

Material passing No. 4 sieve ±5
Material passing No. 10 sieve ±5
Material passing No. 200 sieve ±2

Samples taken from the plant during operation, each representing not more than 100 tons of mixture, or such lesser amount that the determinations shall be made on not less than 5 samples for each 8-hour run, shall be tested for conformity with these requirements. When the aggregate prepared in any "run" is found not to meet these requirements with respect to one or more fractions the contractor, at his expense, shall immediately change the material furnished or make such other adjustments as will result in production of mixture within the above tolerances.

-1.4 Determination of Proportion of Bituminous Material. The amount ofa bituminous material used shall be as designated by the engineer. In arriving at the percent or proportion of the bituminous material he will make use of the following formula with, however, such adjustments for surface characteristics, absorption and other special properties of the aggregate, as in his judgment the job materials and special project conditions make necessary:

$$P = .02a + 0.45b + \begin{cases} 0.15c \text{ for } 15\% \text{ passing No. } 200 \\ 0.18c \text{ for } 10\% \text{ passing No. } 200 \\ 0.20c \text{ for } 5\% \text{ or less passing No. } 200 \end{cases}$$

Wherein P = Percent of bituminous material by weight
a = Percent of aggregate retained on No. 10 sieve
b = Percent of aggregate passing No. 10 sieve and retained on the No. 200 sieve
c = Percent of aggregate passing No. 200 sieve

-2.1 Materials. Aggregates shall consist of screened gravel, crushed to size as necessary, or crushed stone, in either case composed of sound, tough, durable pebbles or fragments of rock and shall contain or have incorporated in it sand, stone dust or other inert finely divided mineral material, the whole meeting the grading requirements as set out in Article -1.2 and -1.3. If gravel is used not less than 50 percent of the material retained on the Number 4 sieve, as indicated by samples tested, shall have at least one fractured face.

Gravel shall have a percent of wear of not more than 20 for uncrushed pieces and not more than 30 for crushed pieces, using A.A.S.H.O. Method T-4, and stone present shall have a percent of wear of not more than 8, using A.A.S.H.O. Method T-3, and all material shall be free from clay balls and adherent films of clay or other matter that will prevent a thorough coating of the particles with a tenacious film of the bituminous material. Oversized gravel shall not be wasted but shall be crushed until graded to size. The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

The bituminized aggregate shall have a swell of not more than 1.5 percent when subjected to the "Swell" test.

That portion of the total aggregate passing the No. 40 sieve shall have a Plasticity Index of not more than 8.

Conformity of all aggregate to the grading requirements hereinabove prescribed shall be determined by the "Washed Mechanical Analysis." The "Swell Test" and the "Washed Mechanical Analysis" shall each be made and the "Plasticity Index" shall be determined as prescribed for "Type B-1, Dense Graded Road Mix Surface Course."

-2.2 Bituminous Materials. The bituminous materials to be used shall be one or more of the following described "Slow Curing Asphalts" for the plant mix and one of the following described "Cut-back Asphalts" for the seal coat. Slow curing asphalts shall be homogeneous. Cut-back asphalts shall be homogeneous and free from water. The particular grades to be used shall be selected by the engineer from the table given below and each shall meet the respective requirements set out in the table for that grade.

Liquid and Cut-back Asphalts

| Designation | A.A.S.H.O. | SC-3 | | SC-4 | |
|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. |
| Water and Sediment | T-55 | | 2% | | 2% |
| Flash Point °F. | T-48 | 200 | | 250 | |
| Viscosity, Furol | T-72 | | | | |
| at 122°F., sec. | | | | | |
| 140°F., sec. | | 150 | 300 | 350 | 550 |
| Total Distillate | T-78 | | | | |
| (% by vol.) | | | | | |
| to 437°F. | | | 2 | | 2 |
| 600°F. | | | 10 | | 8 |
| 680°F. | | | 20 | | 18 |
| Float Test on Residue | T-50 | | | | |
| at 122°F., sec. | | 25 | | 25 | |
| Sol. of Residue $CS_2$ | T-44 | 99% | | 99% | |
| Temp. of Application °F. | | 135 | 165 | 165 | 195 |

Cut-back Asphalts for Seal

| Designation | A.A.S.H.O. | RC-1 | | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point °F. | T-48e | 80 | | 80 | | 80 | | 80 | |
| Viscosity, Furole | T-72e | | | | | | | | |
| at 122°F., sec. | | 80 | 160 | 200 | 400 | | | | |
| 140°F., sec. | | | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78e | | | | | | | | |
| (% by vol.) | | | | | | | | | |
| to 374°F. | | 5 | | | | | | | |
| 437°F. | | 12 | | 10 | | 3 | | 0.5 | |
| 600°F. | | 25 | | 20 | | 14 | | 7 | |
| 680°F. | | | 40 | | 35 | | 30 | | 25 |
| Pene. of Residue | T-49e | 60 | 120 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. of Residue 77°F. | T-51e | 60 | | 60 | | 60 | | 60 | |
| Sol. of Residue $CS_2$ | T-44e | 99.5% | | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 105 | 135 | 125 | 155 | 145 | 175 | 170 | 200 |

-2.3 Sources of Supply. Approval of sources of the mineral aggregate shall bee obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed. Sampling, testing, shipment, reports and inspection at delivery shall be as required for "Type B-1 Dense Graded Road Mix Surface Course."

-3.1 Construction Methods. The methods employed in performing the work and alle equipment, tools and machinery and other plant used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools, machinery and plant used must be maintained in a satisfactory working condition.

-3.2 Plant and Machinery. The mixing plant used by the contractor in the preparation of the bituminous mixture shall comply with the following requirements:

All plant screens shall be designed, constructed and operated so as to screen all aggregates to their specified sizes and proportions and shall have a capacity, when operated at normal speed, slightly in excess of the maximum capacity of the mixer.

The plant shall have a storage bin, protected from the weather, of sufficient capacity to furnish the necessary amount of all aggregates up to the maximum rated capacity of the plant with no undue periods of waiting for material.

The bin shall be divided into at least two compartments so proportioned as to insure adequate storage of appropriate fractions of the aggregate. To insure this provision, compartment spaces should be adjustable within reasonable limits. Each compartment shall be provided with an overflow pipe which shall be of such size and at such location as to prevent all backing up of material into other compartments.

The plant shall contain a drier suitably designed to heat and dry the aggregate to specification requirements and to agitate it continuously during heating. The drier shall be capable of preparing aggregates to the full rated capacity of the plant. The mixer shall be of adequate capacity, preferably a pug mill type. Accurate thermometers shall be furnished, suitable for determining the temperature of the mix.

The plant shall be provided with weighing equipment of sufficient and satisfactory capacity. The weighing equipment shall be constructed with the necessary devices that will permit any working part thereof that gets out of adjustment to be readjusted easily so that the equipment will function properly and accurately. All weighing equipment shall be sealed at the expense of the contractor as often as the engineer may deem necessary to assure accuracy. The bituminous materials shall be heated, preferably by steam coils, and in any case the equipment shall be of such design that steam will not be introduced directly into the bituminous material.

-3.3 Distributors used for applying the seal coat shall comply with all thee requirements for distributors prescribed under Article -3.1 of the specification for "Type B-1 Dense Graded Road Mix Surface Course." Equipment for applying the cover aggregate shall also be as prescribed for that item.

-3.4 Preparation of Mineral Aggregate. It is important that the aggregate be in a uniform and dry condition at the time of mixing and if the moisture content is more than one percent the aggregate shall be dried before being conveyed to the plant bins for batching. The aggregate shall be screened into two or more fractions and conveyed into separate compartments, ready for batching and mixing.

-3.5 Preparation of Bituminous Mixture. Before being delivered to the road thee mineral aggregate shall be mixed with the bituminous material at a central mixing plant.

The mineral aggregate, prepared as above prescribed, shall be combined in uniform batches by weighing and conveying into the mixer the proportionate amounts of each fraction of aggregate required to meet the specified grading. The required quantity of bituminous material for each batch shall be measured by weight using scales attached to the asphalt bucket and introduced into the mixer at a temperature suitable for efficient mixing. Mineral aggregate shall also be heated if found necessary to secure complete coating of all particles. The mixing shall continue for at least 30 seconds, and for such longer period as will serve to coat all the particles completely.

Additional fines and/or filler, if required to meet the grading requirements as set up under Article -1.2 and -1.3, shall be proportioned and blended with the mineral aggregate before screening into the separate compartments. Filler may be added to the aggregate at the mixing plant by premixing it thoroughly with the other fine aggregate or by feeding it into either the hot or cold elevator. Spreading filler over the top of the aggregate pits or dumping it into the hopper at crushing plants will not be permitted.

-3.6 Transportation and Delivery of Mixture. The mixture shall be transported from the paving plant to the work in tight pneumatic tired vehicles previously cleaned of all foreign materials and when directed by the engineer each load shall be covered with canvas or other suitable material of sufficient size and thickness to protect it from bad weather conditions. Hauling shall be distributed over the entire width of the subgrade.

-3.7 Preparation of Existing Surface. The existing roadbed shall be prepared as specified under the item "Reconditioning of Used Roadbed." Ditches shall be trimmed and cleaned of all slides, stones and other debris. All ruts and irregularities shall be eliminated, and a smooth, compacted surface shall be maintained up to the time of placing the bituminous plant mixed surface course.

Separate payment will not be made for preparation of existing surface except that where the Bid Schedule calls for a bid on "Reconditioning of Used Roadbed," such work will be paid for under that item.

-3.8 Prime Coat. In advance of laying down the surfacing mixture, the subgrade shall be primed as specified under the item "Bituminous Prime Coat." After the priming material has penetrated the surface, and not less than four hours after application, the treated area shall be covered where ordered by the engineer with windrowed surfacing material reserved from the original surface or sand or other approved material in sufficient quantity to absorb any excess liquid asphalt and prevent picking up by passing vehicles. If the typical section for the bituminous plant mixed surface course requires a thickened edge, the trench for the thickened edge shall, if ordered by the engineer, be cut and compacted before the prime coat is applied.

-3.9 Procedure with Thickened Edge. If required by the typical section, provision shall be made for a thickened edge of the surfacing. A triangular cut shall be made with a blade grader at each edge of the subgrade. In making the cut the excavated material shall be thrown to the shoulder in a small windrow against which the bituminous mixture shall be spread.

-3.10 Placing Bituminous Mixture, Laying Down and Compacting. The bituminous mixture shall be laid only upon an approved underlying course, which is, in the opinion of the engineer, sufficiently dry and only when weather conditions are suitable. Immediately in advance of the placing of the mixture the roadway shall be cleaned of all loose or deleterious material. If required by the engineer, the surface shall be swept. If the typical section requires a thickened edge, the trench shall be cleaned of all loose material and debris.

The depositing, laying down and compacting of the bituminous mixture shall progress in sections not more than one mile in length. Depositing, spreading and compacting shall commence at the point or points farthest from the mixing plant, and progress continuously toward the plant, unless otherwise ordered by the engineer. Hauling over material already deposited and spread will not be allowed until the material has been compacted thoroughly in the manner hereinafter specified.

Following the depositing, the mixture shall be dried, if necessary, by windrowing it back and forth across the road, until the moisture content does not exceed 1½ percent. At the end of each day's work, or when work is interrupted by weather conditions, all mixture not completely spread shall be bladed to a windrow and not allowed to remain in a partially spread condition on the roadway over night or until work is resumed.

When the mixture is in proper condition it shall be spread to the full width of the course in the following manner. Approximately one-half of the mixed material shall be bladed out for the full width in a uniform layer, the remaining mixture being left in windrows of approximately equal amounts near the edges of the bituminous course. The area between the windrows shall then be rolled without overlap. Following this rolling the remaining mixture shall be bladed out similarly and rolled to the full width of pavement and finished to the true grade and cross section required. The interval between laying down the successive layers shall be as directed by the engineer. Special attention shall be given to the compaction of the outer quarters of the pavement, during the process of laying, to provide for equal compaction on these and the center quarters of the road. During the compaction process the surface shall be dragged or planed with the long base drag or similar equipment, and smoothed as needed to fill ruts, remove irregularities and produce a true riding surface. Any high, low or porous spots that may have developed in the pavement shall be corrected as necessary by remixing with the blader or by the removal or addition of bituminous mixture. The surface shall then be thoroughly rolled until hard and compact, with an 8 to 10 ton roller.

Rolling shall be longitudinal and shall commence at the outer edge of the road overlapping the shoulders and progress toward the center of the road, overlapping each succeeding passage an amount not less than one-third the width of the roller. Under no circumstances shall the center of the road be rolled first.

After the surface has set up sufficiently the edges of the mat shall be trimmed neatly to line. The shoulders shall be completed and shaped as called for, and properly rolled. The gutters shall be cleaned and shaped in conformity with the typical cross section.

-3.11 Operating Under Unfavorable Weather Conditions. Placing of bituminous mixture shall not be done when the atmospheric temperature is below 50°F. nor when the base is wet, nor during rainy or foggy weather, provided, however, that if the mixture has been warmed and has a temperature of not less than 150°F. nor more than 225°F. it may be laid at atmospheric temperatures of 30°F. or higher. The contractor shall furnish, and keep on the work at all times one or more accurate thermometers suitable for determining the temperature of the bituminous mixture. If the moisture content of the mixture, after it has been spread on the road but before final rolling, exceeds 1½ percent, the mixture shall be bladed and rebladed and allowed to dry out before it is finally spread. If blading and reblading of the mixture fails to reduce the moisture content below that above specified, the mixture shall be scarified, turned and respread until the moisture content does not exceed 1½ percent by weight of dry aggregate.

-3.12 Testing Plant Mixed Surface. The complete plant mixed surface shall be thoroughly compacted, smooth and even, true to grade and cross section, and free from ruts, bumps, depressions or irregularities. When a straightedge ten feet long is laid on the finished surface and parallel with the center line of the road, the surface shall vary in no place more than 1/4-inch from the lower edge of the straightedge. It shall be maintained in that condition until accepted for traffic, or until completion of contract.

-3.13 Seal Coat. When the Bid Schedule contains items for seal coat the road surface shall be opened to traffic for at least two weeks and shall then be swept clean. Bituminous material for seal coat shall be applied only when the roadway is dry and the atmospheric temperature 50°F. or higher. Application shall be in the amount of one-sixth to one-fourth gallon per square yard. When the desired stage of tackiness is attained cover aggregate shall then be spread in the amount of 10 to 20 pounds per square yard. The aggregate shall contain not more than 3 percent of moisture. The exact amount of bituminous material and cover aggregate shall be determined by the engineer. Immediately after spreading the cover aggregate the surface shall be rolled. This shall be followed by alternate brooming with a broom drag and rolling until the cover material is embedded and the surface is thoroughly compacted and uniform in texture.

-3.14 Accommodating Public Traffic. Up to the time of delivering the surfacing mixture on the subgrade the road shall be maintained continuously in serviceable condition proper for accommodation of traffic and shall be kept open at all times. During the depositing, laying down and compacting of the surfacing the work shall be conducted in such a way that traffic can proceed along the work at low speed at all times. Suitable warning signs, illuminated at night by lanterns or flares shall be provided to mark the places where the surfacing ends and the places where surfacing is not thoroughly compacted. The contractor shall provide flagmen and a light car and driver to conduct public traffic through portions of the roadway where one way traffic control is directed by the engineer.

The contractor in his operations shall keep the road free from obstructions of any nature and shall not allow traffic to be blocked by material dumped in piles, or otherwise, nor by equipment in operation, except that he may, at his own expense, arrange temporary detours to take traffic around the immediate area where placing is actually in progress. Such detours shall return the traffic conveniently to the sections where placing is not in progress.

In areas where the condition of the work is unavoidably such that vehicles will be subject to inconvenience and to damage due to spattering with oil or bituminized aggregate and similar causes, the contractor, at his own expense, shall arrange convenient detours. These detours shall be limited to brief intervals and short distances as directed by the engineer.

During the application of any required seal coat, traffic shall be routed either over the one-half width not being treated or other convenient detours at the expense of the contractor and as directed by the engineer. Where one-half width operations are in progress the other half of the road shall be kept clear and open for controlled traffic and shall be handled as described under "Traffic Control" in the specifications for "Bituminous Prime Coat."

-3.15 Supplemental Material. When directed by the engineer, plant mixed material shall be placed in stockpiles, at locations selected by the engineer, at the rate of 40 tons per mile of road. Cover aggregate, when directed by the engineer, shall be placed in stockpiles at the points directed by the engineer and at the rate of 20 tons per mile of road.

-4.1 Method of Measurement. The tonnage of bituminous mixture to be paid for shall be the number of tons actually used in the accepted work, together with that placed in stockpiles, and shall be determined by weighing on scales furnished by and at the expense of the contractor. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds. The bituminous treated material shall be weighed after mixing and no deduction will be made for the weight of the bituminous material in the mixture.

The tonnage of cover aggregate to be paid for shall be the number of tons of cover aggregate actually used in the seal, together with the untreated aggregate placed in stockpiles, and shall be weighed separately from the bituminous mixture.

The gallonages of bituminous material to be paid for shall be the number of gallons each of slow curing asphalt and of cut-back asphalt measured at 60°F., or converted to this temperature, in accordance with A.S.T.M. Specification D 206-34 actually used as ordered in the accepted work. When so called for in the Bid Schedule the unit for measuring bituminous materials shall be the ton of 2,000 pounds. In these cases the pay weight of the bituminous material shall be determined before its introduction into the mixer.

-5.1 Basis of Payment. The quantities, determined as provided above, shall be paid for at the respective contract unit prices per ton bid for "Class B Dense Plant Mixture" and "Class B Cover Aggregate" and per gallon or per ton bid for "Bituminous Material for Class B Plant Mix" or "Cut-back Asphalt for Class B Seal" as the cases may be, which prices and payment shall be full compensation for the furnishing and preparation of all material for laying down, rolling and finishing the course to profile grade and cross section, including all labor, equipment, tools and incidentals necessary to complete the item, including all work, all rollers and material furnished for patching and conditioning subgrade or base, except where the Bid Schedule calls for "Reconditioning of Used Roadbed."

Where the Bid Schedule calls for "Reconditioning of Used Roadbed" and/or "Bituminous Prime Coat," all work done and equipment and materials furnished under these items shall be paid for as provided in the respective items named, otherwise all such work done on the subgrade or existing road, together with rollers and other equipment, shall not be paid for directly but shall be considered as subsidiary to and included under the several pay items named in the paragraph above.

Class C Bituminous Pavements

## 122 TYPE C-1 DENSE GRADED ROAD MIX SURFACE COURSE

122-1.1 Description. This item shall consist of a wearing course, composed of Aggregate and Bituminous Material mixed in place on the road, constructed in accordance with these specifications and finished in conformity with the lines, grades and typical cross section shown on the plans, with or without a seal coat as called for by the Bid Schedule, and including required widening on curves. Suitable aggregate present in the existing road, salvaged and, if necessary to meet the grading requirements, blended with appropriate new material, shall be used as the "New Aggregate" to the extent directed by the engineer.

-1.2 Master Grading. The blend of salvaged and new aggregate, or the new aggregate where no salvaging is involved, shall meet the grading requirements for Grading A or Grading B as called for by the Bid Schedule, each as respectively tabulated below, by weight, except that aggregate for seal coat shall meet the grading limits for cover aggregate as tabulated below.

| | Grading A | Grading B | Cover Aggregate |
|---|---|---|---|
| | Square Openings - Percent Passing | | |
| 1 inch | 100 | 100 | |
| 3/4 inch | 75-100 | 75-100 | |
| 1/2 inch | | | 100 |
| 3/8 inch | | | 90-100 |
| No. 4 | 35- 65 | 40- 75 | 0- 25 |
| No. 10 | 25- 50 | 30- 65 | 0- 10 |
| No. 40 | 15- 35 | 15- 45 | |
| No. 200 | 2- 10 | 5- 11 | 0- 2 |

-1.3 Job Grading. Within the above master requirements the grading of the job materials furnished shall be held to a uniformity such that the fractions of aggregate passing the Nos. 4, 10 and 200 sieves will remain constant throughout any one 8-hour "run" within the following respective tolerances of variation from the average percent of the "run."

Material passing No. 4 sieve ±5
Material passing No. 10 sieve ±5
Material passing No. 200 sieve ±2

Samples from the prepared aggregate after blending shall be tested for conformity with these requirements.

Each "run" shall be staked or otherwise adequately identified by the engineer or inspector. A "run" shall be construed as that length of aggregate windrowed along the road fixed upon by the engineer as a convenient unit and shall be such as to involve an amount of aggregate not less than the daily capacity of the mixing outfit to handle. The length of the "runs" in any project may be varied and adjusted to fit the changes of pit when a pit is exhausted and for similar reasons but the length of run in any case shall not be less than above indicated. Sufficient samples shall be taken from the windrowed aggregate so that each shall represent not more than 1000 square yards of finished surface course and in no case shall less than 5 samples be analyzed from each "run." Each sample shall represent an equal amount of material. No bituminous material shall be applied on any "run" until sieve analyses of the samples have been made and the "run" approved as within the job grading tolerance.

-1.4 Determining Total Amount of Bituminous Material. The amount of bituminous material used in each "run" shall be as designated by the engineer for each "run." It will involve the determination of the total combined volume of aggregate as windrowed in each "run" including both salvaged aggregate and new aggregate. The total volume will therefore be determined by measurement of the windrow of graded, blended aggregate. The proportion of bituminous material will be based primarily on the surface area of the aggregate as indicated by the grading.

In arriving at the total amount of bitumen for any given "run" the engineer will determine from the grading analyses the average content for the "run" of the fractions retained on the Number 10, passing the Number 10 and retained on the Number 200 and passing the Number 200 respectively. Applying these averages, he will then make use of the following formula with, however, such adjustment for surface characteristics, absorption and other special properties of the aggregate, as in his judgment the job materials and special project conditions make necessary. The formula gives the proportions by weight, which figure must be converted to gallons per volume of aggregate, and applied against the measured volume of the windrow in the "run."

$$\frac{5P}{6} = .02a + .045b + \begin{cases} 0.18c \text{ for } 11\% \text{ passing No. } 200 \\ 0.20c \text{ for } 5\% \text{ or less passing No. } 200 \end{cases}$$

Wherein P = Percent of bituminous material by weight
a = Percent of aggregate retained on No. 10 sieve
b = Percent of aggregate passing No. 10 sieve and retained on the No. 200 sieve
c = Percent of aggregate passing No. 200 sieve

In order that the volumetric measurement may be conveniently and accurately performed the combined salvaged and new aggregate shall be formed or moved into convenient windrow or windrows of uniform size and sampled and measured in the windrow. In order to secure satisfactory uniformity of windrow cross section a windrow shaper or box or some equivalent equipment shall be provided and used by the contractor, or the same essential purpose accomplished by an approved construction operation sufficiently accurate for the purpose and satisfactory to the engineer. The windrow, after shaping, shall be left undisturbed until duly measured and sampled.

-2.1 Materials. Aggregates shall consist of screened gravel, crushed to size as necessary, or crushed stone, in either case composed of sound, tough, durable pebbles or fragments of rock and shall contain or have incorporated in it sand, stone dust or other inert finely divided mineral material, the whole meeting the grading requirements as set out in Articles -1.2 and -1.3. Gravel shall have a percent of wear of not more than 20 for uncrushed pieces and not more than 30 for crushed pieces, using A.A.S.H.O. Method T-4, and stone present shall have a percent of wear of not more than 8, using A.A.S.H.O. Method T-3, and all material shall be free from clay balls and adherent films of clay or other matter that will prevent a thorough coating of the particles with a tenacious film of the bituminous material. Oversized gravel shall not be wasted but shall be crushed until graded to size. The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

Added mineral filler material shall be material, passing the 200 mesh sieve, found suitable by the engineer to be used to supplement the fines in the aggregate so as to meet the grading and other requirements hereinbefore specified.

The bituminized aggregate shall have a swell of not more than 1.5 percent when subjected to the "Swell" test.

That portion of the total aggregate passing the Number 40 sieve shall have a "Plasticity Index" of not more than 8.

Conformity of all aggregate to the grading requirements hereinbefore prescribed shall be determined by the "Washed Mechanical Analysis."

The "Swell" test and the "Washed Mechanical Analysis" shall be made, and the "Plasticity Index" shall be determined as prescribed for "Type B-1 Dense Graded Road Mix Surface Course."

-2.2 Bituminous Material. The bituminous material to be used shall be one or more of the following described "Medium Curing Cutback Asphalts" for the road mixed course and one of the following described "Rapid Curing Cut-back Asphalts" for the seal coat. Cut-back asphalt shall be composed of a suitable petroleum distillate and asphalt base. It shall be free from water, and show no separation on standing. The particular grade to be used shall be selected by the engineer from the table given below and each shall meet the respective requirements set out in the table for that grade.

Medium Curing Cut-back Asphalts

| Designation | A.A.S.H.O. | MC-2 | | MC-3 | | MC-4 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point, °F. | T-48 | 150 | | 150 | | 150 | |
| Viscosity, Furol | T-72 | | | | | | |
| at 140°F., sec. | | 150 | 250 | 300 | 500 | 500 | 800 |
| Total Distillate | T-78 | | | | | | |
| (% by vol.) | | | | | | | |
| to 437°F. | | | 2 | | 2 | | 1 |
| 600°F. | | 10 | 20 | 8 | 20 | 7 | 16 |
| 680°F. | | | 27 | | 25 | | 25 |
| Pene. Residue | T-49 | 100 | 300 | 100 | 300 | 100 | 300 |
| Duct. Residue, 77°F. | T-51 | 60 | | 60 | | 60 | |
| Sol. Residue $SC_2$ | T-44 | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 65 | 95 | 155 | 185 | 165 | 195 |

Rapid Curing Cut-back Asphalts for Seal

| Designation | A.A.S.H.O. | RC-1 | | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point, °F. | T-48 | 80 | | 80 | | 80 | | 80 | |
| Viscosity, Furol | T-72 | | | | | | | | |
| at 122°F., sec. | | 80 | 160 | 200 | 400 | | | | |
| 140°F., sec. | | | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78 | | | | | | | | |
| (% by vol.) | | | | | | | | | |
| to 374°F. | | 5 | | | | | | | |
| 437°F. | | 12 | | 10 | | 3 | | 0.5 | |
| 600°F. | | 25 | | 20 | | 14 | | 7 | |
| 680°F. | | | 40 | | 35 | | 30 | | 25 |
| Pene. of Residue | T-49 | 60 | 120 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. of Residue, 77°F. | T-51 | 60 | | 60 | | 60 | | 60 | |
| Sol. of Residue $CS_2$ | T-44 | 99.5% | | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 105 | 135 | 125 | 155 | 145 | 175 | 170 | 200 |

-2.3 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed. Sampling, testing, shipment, reports and inspection at delivery shall be as required for "Type B-1 Dense Graded Road Mix Surface Course."

-3.1 Construction Methods. The methods employed in performing the work and all equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of suitable units, including tractor-drawn or motor bladers or blader mixers, approved distributors and rollers supplemented by spreading and smoothing apparatus, or his equipment outfit may be of the traveling plant type including adequate units of equipment for spreading, compacting and smoothing, including power rollers. In any case the contractor shall supply long base maintainers, steel brush or broom drag, and other necessary finishing equipment designed and operated to avoid causing, as well as to remedy, corrugations and irregularities and to produce a true riding surface of uniform texture.

The equipment outfit furnished and used by the contractor shall contain the individual units all as indicated in the specification for "Type B-1 Dense Graded Road Mix Surface Course" and meeting all the requirements therein set out.

-3.2 Preparation of Base. The existing roadbed shall first be scarified, if and as directed, to a depth just sufficient to eliminate irregularities of the surface and to permit reshaping, and the entire roadbed for the full width shall be bladed to the shape of cross section shown on the plans, and to a smooth riding profile. Ditches shall be trimmed and cleaned of all slides, stones or other debris.

Case 1. Where material in the existing roadbed surface is to be salvaged and used for the aggregate, either wholly or in part, the bladed surface shall be scarified again as ordered, to such depth and in such manner as to leave a foundation stratum of undisturbed material parallel to the proposed finished surface of the improvement both in cross section and profile. The gradation of the loosened material will be determined. To the material thus loosened new aggregate, selected for the purpose, shall be added where necessary to fill depressions and to strengthen weak places in the base, and new aggregate, so graded and in such amount as to supplement the grading of the loosened, salvaged material, shall then be added to produce from the combination a blended aggregate of the contemplated composite job grading hereinbefore prescribed and in the amount necessary, in the judgment of the engineer, to provide the thickness of metalling shown on the plans. The added material shall be mixed thoroughly with the loosened, salvaged material by suitable harrowing and/or turning with a blade or other equipment. The entire composite or blended aggregate shall then be bladed aside. The undisturbed stratum thus exposed shall then be rolled, or wetted and rolled, as ordered. The composite material bladed aside shall be formed into a windrow at the side of the roadbed trimmed with the shaper or with a windrow gage as hereinbefore stipulated of an accuracy in shape as hereinbefore stipulated, and left until sampled and tested for amount and grading, for which at least one day shall be allowed.

If called for in the Bid Schedule, and as directed by the engineer, the undisturbed stratum shall be primed as specified under the item "Bituminous Prime Coat" provided, however, that the width of road covered shall be as regulated by the engineer and the requirement of the 48 hour curing period may be waived at the discretion of the engineer.

If the results of the sampling and testing show that additional material is necessary to produce the required depth of surfacing, it shall be obtained under direction of the engineer by further scarifying of the existing roadbed (previous to priming) or by adding new material, or new fractions of material, suitably graded. If the tests show additional material is necessary to secure the required grading, tested and approved material suitable for the purpose shall be added. The materials in the windrow thus affected shall be remixed until of satisfactory uniformity and retested for conformity to all specification requirements if considered necessary.

Case 2. Where none of the material in the existing roadway is to be salvaged and utilized as aggregate, the base after shaping and smoothing as hereinbefore stipulated, shall be rolled, or wetted and rolled, until compacted. If ordered by the engineer depressions shall first be filled and weak places in the subgrade or base strengthened by patching with aggregate.

If called for in the Bid Schedule, and as directed by the engineer, the road shall then be primed as specified under the item "Bituminous Prime Coat," and as prescribed for case 1.

New aggregate of correct gradation shall be deposited in a windrow along one side of the roadbed by means of vehicles equipped or supplemented with suitable spreading devices. The aggregate shall be so deposited that the windrow will be uniform in size and in grading, and will contain the correct quantity of aggregate to provide surfacing of the required width and thickness. The windrow shall be shaped and checked with a shaper or windrow gage. As a special means of assuring uniformity, the engineer may require the contractor to accomplish the depositing of the aggregate for the windrow in the following manner. One-third of the total quantity required shall be spread over the entire length of the run. This shall be followed by the placing of the second third over the entire length of the run, and then the remaining third shall be deposited, each third being placed continuously over the entire length of the run. The aggregate shall then be bladed into the one windrow and trimmed as required hereinbefore.

Care shall be exercised to prevent the aggregate from becoming mixed with earth or shoulder material.

-3.3 Drying the Aggregate on the Road. When a run of prepared aggregate is ready for bituminizing and immediately prior to bituminizing, the aggregate to be treated shall be tested for moisture. In the event it contains more than one percent of water by weight of dried material it shall be turned by blades or disc harrows, or otherwise aerated, until the moisture content is reduced to one percent. The prepared aggregate shall then be spread smoothly and uniformly over one-half the road or other convenient width ready for the application of the bituminous material.

-3.4 Application and Partial Mixing. The bituminous material shall be distributed in three applications for the run each of approximately one-third of the total required amount per square yard, as determined by the engineer, for the run. It shall be applied uniformly at a temperature within the range shown in the specifications for the particular material. The rate of each application shall not vary from the rate designated by the engineer by more than 5 percent. Immediately behind the distributor shall follow an assemblage of double disc or other harrows or equivalent equipment, to mix partially the aggregate and bituminous material and leave as little free bituminous material as possible. The interval between applications shall be as regulated by the engineer.

If any spots are missed, bituminous material shall be applied to those spots by some means which will insure the spot will be bituminized at the required rate.

During the application, the surfaces of all structures, guard rails and trees shall be protected in a satisfactory manner so as to prevent their being spattered or marred. Discharging the bituminous material into borrow pits or gutters will not be permitted.

In order to assure a uniform distribution at the junction of two distributor loads, distribution shall be stopped promptly when the uniform flow starts to decrease, indicating that the tank is nearly empty.

-3.5 Mixing. After the last application and the "partial mixing," the entire mass of bituminized aggregate shall be moved by a heavy blader into a windrow near the center of the road, and then mixed by the assemblage of mixing units provided by blading the treated material from side to side of the road or by manipulations producing equivalent results until all particles are coated with the bituminous material and the whole mass has a uniform color. During the mixing, care shall also be taken that none of the mixture is spread on earth shoulders or on any unprepared areas where it may become contaminated with earth and extraneous matter.

In lieu of mixing the materials as above specified, other equipment and methods, such as rotary mixers and traveling plants, may be employed provided that there is produced a mixture satisfactory to the engineer and at least equal to that which can be produced by the means above specified. The engineer shall have the right to order discontinuance of the use of any equipment or method which, in his opinion, fails to produce a satisfactory mixture.

When so directed the mixing process shall be confined to part of the width or area of the road so as to allow traffic to pass conveniently and undisturbed.

Before the mixture is spread, the windrowed mixture will be examined by the engineer, who shall determine whether the mixing is complete, the bituminous content correct and the moisture removal satisfactory. Should the mixture show an excess, deficiency or uneven distribution of bituminous material, the unsatisfactory condition shall be corrected by the appropriate addition of aggregate or bituminous material as required, and remixing. If the moisture content exceeds one and one-half percent the contractor shall blade and reblade the material and allow it to dry out. If necessary, the material shall be harrowed or disced and all compressed masses of material broken up. No spreading shall be done until authorized by the engineer, or when the base to be covered is wet.

At the end of each day's work, or when work is interrupted by weather conditions all loose material shall be bladed to a windrow whether the mixing is complete or not, and not allowed to remain spread on the roadway over night or until work is resumed.

-3.6 Procedure with Thickened Edge. If required by the approved typical section, provision shall be made for a thickened edge of the surfacing. A triangular cut shall be made with a blade grader at each edge of the roadbed. In making the cut, the excavated material shall be thrown to the shoulder in a small windrow against which the bituminized mixture shall be spread.

-3.7 Laying Down and Compacting the Mixture. After the mixing has been completed the mixed material shall be left in the windrow for a period of two days or longer if the engineer so directs. During this period the windrow shall be passed across the roadway at least twice each day to aerate the solvent in the medium curing cut-back.

When the mixed material is cured satisfactorily and is in proper condition, it shall be spread from the windrow to the width required by a blade grader or equivalent equipment in successive uniform layers, approximately one inch thick, until the required total amount per square yard is obtained. Ordinarily, unless prevented by job conditions each layer should be opened to traffic and partial compaction obtained thereby. During compaction the surface shall be dragged or bladed as necessary to fill any ruts and to remove incipient corrugations, waves or other irregularities. The interval between laying down successive layers shall be as directed by the engineer.

In spreading from the windrow care shall be taken to prevent cutting into the underlying base. In order to prevent such cutting a layer of the mixture approximately one-half inch thick may be ordered left on the bottom of the windrow.

After the surface has set up sufficiently, the edges of the mat shall be trimmed neatly and the surfacing rolled as directed.

Rolling shall be longitudinal, shall commence at the outer edges of the road overlapping the shoulders, and progress toward the center. Blading shall continue during the rolling. The combined operation shall continue until the surfacing has a uniform texture and compaction and is true to grade and cross section. Under no circumstances shall the center of the surface course be rolled first.

While the surface is being compacted and finished, the contractor shall shape and finish the entire roadway. The gutters shall be cleaned and all excess material, loose stones and rock fragments that may be dragged to the surface or loosened shall be removed and disposed of as directed by the engineer.

-3.8 Improving Unsatisfactory Areas. If prior to acceptance fat spots develop under traffic such areas shall be scarified and sufficient uncoated graded aggregate incorporated to produce a satisfactory mixture. If lean spots develop additional bituminous material shall be applied and such spots remixed to the full depth until all particles in the mixture are coated uniformly and properly. Should any portion of the surface of a mat become rough or uneven, and if found impossible to remedy the condition by dragging or blading, such areas shall be scarified, remixed and relaid as the engineer may direct.

-3.9 Operating Under Unfavorable Weather Conditions. No bituminous material shall be applied nor shall road mixing proceed when the aggregate contains more than one percent of moisture, by weight, nor when the air temperature is less than 40°F., nor during excessively damp, rainy weather, nor during the night between sunset and sunrise, nor at any time when, in the judgment of the engineer, the weather conditions are such that satisfactory results cannot be obtained. No bituminous material shall be applied to frozen or excessively cold aggregate.

If rain commences to fall during the bituminous treating or mixing operations the uncompleted mixture shall be windrowed promptly. The treated material and mixture and the base shall then be allowed to dry out before the resumption of any work, except such turning as will facilitate evaporation. The engineer shall be the sole judge as to when the road and mixture have dried sufficiently to allow the work to be resumed.

-3.10 Testing Road-Mixed Surface. The complete road-mixed surface shall be compacted thoroughly, be smooth and even, true to grade and cross section, and free from ruts, bumps, depressions, or irregularities. When a straight edge ten feet long is laid on the finished surface and parallel with the center line of the road, the surface shall vary in no place more than one-quarter inch from the lower edge of the straight edge. It shall be maintained in that condition by the contractor until accepted for traffic, or until the completion of the contract.

-3.11 Seal Coat. When the Bid Schedule contains items for seal coat the road surface shall be open to traffic for at least two weeks and shall then be swept clean. Bituminous material for seal coat shall be applied only when the roadway is dry and the atmospheric temperature 50°F. or higher. Application shall be in the amount of one-sixth to one-fourth gallons per square yard. When the desired stage of tackiness is attained, cover aggregate shall then be spread in the amount of 10 to 20 pounds per square yard. The aggregate shall contain not more than 3 percent of moisture. The exact amount of bituminous material and cover aggregate shall be determined by the engineer. Immediately after spreading the cover aggregate the surface shall be rolled. This shall be followed by alternate brooming with a broom drag and rolling until the cover material is embedded and the surface is thoroughly compacted and uniform in texture.

-3.12 Accommodating Public Traffic. The work shall be maintained continuously in serviceable condition proper for the accommodation of public traffic except that, in areas where the condition of the work is unavoidably such that vehicles will be subject to inconvenience or damage due to spattering with oil or bituminized aggregate, the contractor at his own expense shall arrange convenient detours. While the seal coat is being applied traffic shall be routed over detours or the seal coat shall be placed one-half width at a time, and the other half shall be kept clear and open to traffic.

Suitable warning signs, illuminated at night by lanterns or flares shall be provided to mark the places where the surfacing ends or is not compacted and at other places deemed necessary by the engineer. The contractor shall also provide flagmen and a light car and driver to conduct public traffic through portions of the road under one-way traffic control.

-3.13 Supplemental Material. When directed by the engineer, road mixed aggregate, taken from the completely mixed windrow just prior to its being laid down and by taking one shovelful from the windrow at such intervals as will produce the desired quantity, shall be placed in stockpiles, at locations selected by the engineer at the rate of 50 tons of road mixed aggregate per mile of road. Cover aggregate, when directed by the engineer shall be placed in stockpiles at the locations selected by the engineer and at the rate of 20 tons per mile of road.

-4.1 Method of Measurement. The mileage of surfacing laid, to be paid for, shall be the length, expressed in miles, of surfacing completed to the width shown on the plans including any widening ordered at curves and at intersections, finished with seal coat as called for in the Bid Schedule, and accepted, measured complete in place. The length will be measured horizontally along the center line of the improved road.

The tonnage of new aggregate to be paid for shall be the number of tons of new aggregate actually used in the mixed surfacing, together with that placed in stockpiles but excluding aggregate originally present on the road, weighed on scales furnished by and at the expense of the contractor. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds.

The tonnage of cover aggregate to be paid for shall be the number of tons of cover aggregate actually used in the seal coat, together with that placed in stockpiles.

The yardage of added filler to be paid for shall be the number of cubic yards, measured in the vehicle at point of delivery and of mineral filler added under written order and not included in the material weighed and paid for as new aggregate.

The gallonages of bituminous material to be paid for shall be the number of gallons each of cut-back asphalt for road mix and seal measured at 60°F. or converted to this temperature, in accordance with A.S.T.M. specification D 206-34, actually used as ordered in the accepted work. When so called for in the Bid Schedule the unit for measuring bituminous material shall be the ton of 2,000 pounds.

The amount of watering to be paid for shall be the number of thousand gallon units of water, measured in the vehicle at the point of delivery on the road and used as ordered.

-5.1 Basis of Payment. The mileage of surfacing, determined as provided above shall be paid for at the contract unit price per mile bid for "C-1 Road Mix Surfacing Laid" which price and payment shall constitute full compensation for the scarifying and preparation of the existing road and of the subgrade including any extra sanding or other protection of the prime except priming, for handling, grading, blending, placing and mixing all materials, including the heating and application of all bituminous material involved, rolling, finishing and completion of the work, the trimming and shaping of shoulders and ditches, and the placing and completion of the seal coat as called for in the Bid Schedule, and all labor, equipment, tools and incidentals necessary to complete the item, except the furnishing of the new aggregate, cover aggregate, mineral filler, bituminous material and the watering.

The tonnages, determined as provided above, shall each be paid for at the respective contract unit prices per ton bid for "Class C New Aggregate" Grading A or Grading B as the case may be and for "Class C Cover Aggregate," which prices and payment shall be full compensation for furnishing these materials and hauling and delivery on the road at the job.

The yardage of added mineral filler, determined as provided above, shall be paid for at the contract unit price per cubic yard bid for "Mineral Filler for Class C," which price and payment shall be full compensation for furnishing, hauling and delivering this material.

The gallonages or tonnages of bituminous material, determined as provided above, shall be paid for at the contract unit prices per gallon or per ton bid for "Cut-back Asphalt for Class C Road Mix" and "Cut-back Asphalt for Class C Seal," as the case may be, which prices and payment shall constitute full compensation for furnishing the bituminous material delivered at the job.

The number of thousand gallon units of watering, determined as provided above shall be paid for at the contract unit price per unit bid for "Watering," which price and payment shall constitute full compensation for all labor, operators, equipment, gas, oil, repairs and supplies necessary and for furnishing, hauling and applying the water.

Priming if called for in the Bid Schedule shall be paid for under and in accordance with the terms of the item "Bituminous Prime Coat."

Where the trimming of shoulders and ditches and the removal of slide material taken together in any hundred foot station amounts to more than 5 cubic yards, the excess yardage over 5 yards shall be paid for as "Unclassified Excavation."

Class C Bituminous Pavements

## 123 Type C-2 BITUMINOUS RETREAD
## (RC Cutback, Emulsified Asphalt or Tar)

123-1.1 Description. This item shall consist of a wearing course composed of "Aggregate" in the total amount, exclusive of Seal Coat, of 120, 160 or 200 pounds per square yard whichever is called for in the Bid Schedule, mixed in place on the road with the selected Bituminous Material called for in the Bid Schedule, and with or without a seal coat as called for in the Bid Schedule, all in accordance with these specifications and in conformity with the lines, grades and typical cross section shown on the plans, and including required widening on curves. It shall be constructed on a road surface which has been prepared under the item "Reconditioning of Used Roadbed" or on an approved newly constructed base or surface. If called for in the Bid Schedule or directed by the engineer the road surface shall be treated under the item "Bituminous Prime Coat" or under the item "Bituminous Tack Coat."

-1.2 The sequence of operations and the approximate amounts of material per square yard of road surface paved shall be in accordance with the following tables for Light Retread, Medium Retread or Heavy Retread as the case may be, Part A to be used in each case where liquid asphalt or tar is called for in the Bid Schedule, and Part B to be used where emulsified asphalt is called for in the Bid Schedule. The contractor shall furnish coarse aggregate and key rock in the particular grading (A, B, C or D) called for in the Bid Schedule and shall furnish the bituminous material of the grade ordered by the engineer. The contractor shall furnish and construct the particular seal called for in the Bid Schedule (Retread Seal or Choked Seal) and use bituminous material of the grade ordered by the engineer for this purpose. Part A of Table II shall be used when liquid asphalts or tars are called for in the Bid Schedule and Part B of Table II shall be used when emulsified asphalts are called for in the Bid Schedule. Any seal coat set out in Table II shall be omitted when not called for in the Bid Schedule.

Table I

LIGHT RETREAD
(120 Pounds Per Square Yard)
Plus Seal

| Sequence of Operations | Part A Liquid Asphalt or Tar Grading B, C or D | | | Part B Emulsified Asphalt Grading B, C or D | | |
|---|---|---|---|---|---|---|
| | Gal. Bit. | Coarse Aggregate | Key Rock | Gal. Bit. | Coarse Aggregate | Key Rock |
| | On Treated Surface (Prime or Tack) | | | | | |
| Spreading | | 105 lb. | | | 105 lb. | |
| Application | 0.30 | | | 0.30 | | |
| Road Mix | | | | | | |
| Application | 0.25 | | | 0.30 | | |
| Road Mix | | | | | | |
| Initial Rolling | | | | | | |
| Planing | | | | | | |
| Curing | | | | | | |
| Spreading Key Rock | | | 15 lb. | | | 15 lb. |
| Application | 0.25 | | | 0.35 | | |
| Rolling | | | | | | |
| Seal | See Table II | | | | | |
| Totals (except seal) | 0.80 | | 120 lb. | 0.95 | | 120 lb. |

Table I

MEDIUM RETREAD
(160 Pounds Per Square Yard)
Plus Seal

| Sequence of Operations | Part A Liquid Asphalt or Tar Grading A, B, C or D | | | Part B Emulsified Asphalt Grading A, B, C or D | | |
|---|---|---|---|---|---|---|
| | Gal. Bit. | Coarse Aggregate | Key Rock | Gal. Bit. | Coarse Aggregate | Key Rock |
| | On Treated Surface (Prime or Tack) | | | | | |
| Spreading | | 135 lb. | | | 135 lb. | |
| Application | 0.35 | | | 0.35 | | |
| Road Mix | | | | | | |
| Application | 0.30 | | | 0.40 | | |
| Road Mix | | | | | | |
| Initial Rolling | | | | | | |
| Planing | | | | | | |
| Curing | | | | | | |
| Spreading Key Rock | | | 25 lb. | | | 25 lb. |
| Application | 0.25 | | | 0.40 | | |
| Rolling | | | | | | |
| Seal | See Table II | | | | | |
| Totals (except seal) | 0.90 | | 160 lb. | 1.15 | | 160 lb. |

Table I

HEAVY RETREAD
(200 Pounds Per Square Yard)
Plus Seal

| Sequence of Operations | Part A Liquid Asphalt or Tar Grading A, B, C or D | | | Part B Emulsified Asphalt Grading A, B, C or D | | |
|---|---|---|---|---|---|---|
| | Gal. Bit. | Coarse Aggregate | Key Rock | Gal. Bit. | Coarse Aggregate | Key Rock |
| | On Treated Surface (Prime or Tack) | | | | | |
| Spreading | | 175 lb. | | | 175 lb. | |
| Application | 0.40 | | | 0.40 | | |
| Road Mix | | | | | | |
| Application | 0.40 | | | 0.50 | | |
| Road Mix | | | | | | |
| Initial Rolling | | | | | | |
| Planing | | | | | | |
| Curing | | | | | | |
| Spreading Key Rock | | | 25 lb. | | | 25 lb. |
| Application | .3 | | | 0.45 | | |
| Rolling | | | | | | |
| Seal | See Table II | | | | | |
| Totals (except seal) | 1.1 | | 200 lb. | 1.35 | | 200 lb. |

Table II

SEALS

| Sequence of Operations | Part A Liquid Asphalt or Tar | | | | | Part B Emulsified Asphalt | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Retread Seal | | Choked Seal | | | Retread Seal | | Choked Seal | | |
| | Gal. Bit. | Cover | Gal. Bit. | Choker Screenings | Cover | Gal. Bit. | Cover | Gal. Bit. | Choker Screenings | Cover |
| Spreading | | 15 lb. | | 12 lb. | | | 15 lb. | | 12 lb. | |
| Application | 0.15 | | 0.30 | | | 0.15 | | 0.30 | | |
| Steel or Broom Dragging | | | | | | | | | | |
| Application | 0.15 | | | | | 0.15 | | | | |
| Spreading | | 12 lb. | | | 15 lb. | | 12 lb. | | | 15 lb. |
| Broom Dragging | | | | | | | | | | |
| Final Rolling | | | | | | | | | | |
| Totals (for seals) | 0.30 | 27 lb. | 0.30 | 12 lb. | 15 lb. | 0.30 | 27 lb. | 0.30 | 12 lb. | 15 lb. |

The amounts given in the tables are approximate. After the particular job materials have been tested and approved for use the engineer will set the exact amounts to be used in each application and spreading. He may vary the amount of aggregate per square yard in any or all spreadings from that called for in the table to suit the conditions better, but the particular total per square yard given in the table and called for in the Bid Schedule shall not be changed save that the engineer may order, in writing, some of the poundage apportioned to the stockpiles as an additional reserve, or he may similarly order some of the apportionment for stockpiling used on the road at once if deemed advantageous. The actual rate of distribution of bituminous material on each square yard of surface shall not vary from the rate ordered by more than 5 percent.

In no case shall the bituminous material be applied at such a rate as will cause it to flow off the road surface, even though it becomes necessary to subdivide any prescribed application into two applications. In any such case no additional compensation shall accrue to the contractor.

-2.1 Materials. Aggregate shall consist of crushed gravel, stone or slag graded as provided in Table III, using A.A.S.H.O. Method T-27.

TABLE III

| Sieve | Grading A | | Grading B | | Grading C | | Grading D | |
|---|---|---|---|---|---|---|---|---|
| | Coarse | Key | Coarse | Key | Coarse | Key | Coarse | Key |
| | Percent passing square openings | | | | | | | |
| 2½-inch | 100 | | | | | | | |
| 2 " | 95-100 | | | | | | | |
| 1½ " | | | 100 | | | | 100 | |
| 1 " | 0- 20 | | 90-100 | | 100 | | 90-100 | |
| 3/4 " | 0- 5 | 100 | | | 90-100 | | | |
| 1/2 " | 0- 2 | 90-100 | 0- 15 | 90-100 | | 100 | 25- 60 | 100 |
| 3/8 " | | | | | 20- 55 | 90-100 | | 90-100 |
| No. 4 | | 0- 15 | 0- 5 | 0- 15 | 0- 10 | 0- 25 | 0- 10 | 20- 40 |
| No. 8 | | 0- 5 | | 0- 5 | | | | 0- 10 |

SEALS

| Sieve | Retread Seal Cover | Choked Seal Cover | |
|---|---|---|---|
| | | Choker Screenings | Cover |
| | Percent passing square openings | | |
| 1/2-inch | 100 | | 100 |
| 3/8 " | 90-100 | | 90-100 |
| No. 4 | 20- 40 | 100 | 20- 40 |
| No. 8 | 0- 10 | | 0- 10 |
| No. 10 | | 0- 10 | |

-2.2 Gravel shall consist of clean, hard, tough and durable stone fragments and shall be screened and crushed to size as necessary to meet the grading requirements. Not less than 50 percent of the material retained on the No. 4 sieve, as indicated by samples tested, shall have at least one fractured face.

-2.3 Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft, or disintegrated pieces, dirt or other objectionable matter.

-2.4 Crushed slag shall be air-cooled blast furnace slag and shall consist of angular fragments reasonably uniform in density and quality and reasonably free from thin elongated or glassy pieces, dirt or other objectionable matter.

-2.5 Crushed stone shall show a percent of wear of not more than 7, slag a percent of wear of not more than 15 and gravel a percent of wear of not more than 15 for uncrushed and not more than 25 for crushed pieces using A.A.S.H.O. Method T-3 or T-4. Slag shall have a weight of not less than 70 pounds per cubic foot.

-2.6 The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

-2.7 Bituminous Materials. The bituminous material shall be cut-back asphalt, emulsified asphalt, or tar, whichever is called for in the Bid Schedule and the award. Liquid asphalts shall be homogeneous and free from water. The emulsified asphalt shall be homogeneous and shall meet the requirements herein prescribed using A.A.S.H.O. Method T-59. It shall show no separation of asphalt at the time of use, provided that separation has not been caused by freezing after delivery, and provided further that this requirement shall not apply if the material is held more than 30 days. Refined tars shall be homogeneous. If a cut-back asphalt or tar is to be used, the particular grade shall be selected by the engineer from the tables given hereinbelow and each shall meet the respective requirements set out in the table for that grade.

Rapid Curing Cut-back Asphalts

| Designation | A.A.S.H.O. | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point, °F. | T-48 | 80 | | 80 | | 80 | |
| Viscosity, Furol | T-72 | | | | | | |
| at 122°F., sec. | | 200 | 400 | | | | |
| 140°F., sec. | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78 | | | | | | |
| (% by vol.) | | | | | | | |
| to 437°F. | | 10 | | 3 | | 0.5 | |
| 600°F. | | 20 | | 14 | | 7 | |
| 680°F. | | | 35 | | 30 | | 25 |
| Pene. of Residue | T-49 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. of Residue, 77°F. | T-51 | 60 | | 60 | | 60 | |
| Sol. Residue ($CS_2$) | T-44 | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application °F. | | 125 | 155 | 145 | 175 | 170 | 200 |

Emulsified Asphalt

| | Minimum | Maximum |
|---|---|---|
| Viscosity, Furol at 77°F. | 20 | 100 |
| Settlement, 5 day | | 5% |
| Demulsibility, using 50 ml. | | |
| 0.10 N. $NaCl_2$ solution | 0 | 30% |
| Sieve Test | | 0.20% |
| Residue by Distillation | 55% | 60% |
| Pene. of Residue | 100 | 200 |
| Soluble Residue ($CS_2$) | 95% | |
| Ash | | 2% |
| Ductility of Residue | 40 | |
| Specific Gravity | 1.00 | |
| Temp. of Application °F. | 60 | 120 |

The sample shall be taken from factory storage containing not less than 20,000 gallons of the emulsified asphalt.

Refined Tars

| Designation | A.A.S.H.O. | R-T-136 TM-1 Min. | R-T-136 TM-1 Max. | R-T-136 TM-2 Min. | R-T-136 TM-2 Max. | R-T-131 Min. | R-T-131 Max. |
|---|---|---|---|---|---|---|---|
| Specific Gravity | T-43e | 1.10 | 1.22 | 1.10 | 1.22 | 1.14 | |
| Specific Viscosity 122°F. | T-54e | 16 | 26 | 26 | 36 | | |
| Float Test 89.6°F., sec. | T-50 | | | | | 60 | 150 |
| Bitumen (Sol. $CS_2$) | T-44e | 87% | | 87% | | 85% | |
| Water | T-55 | | 2% | | 2% | | 0 |
| Total Distillate by wt. | T-52e | | | | | | |
| to 338°F. | | | 5% | | 5% | | 1% |
| 518°F. | | | 25% | | 25% | | 15% |
| 572°F. | | | 35% | | 35% | | 25% |
| Soft. pt. Residue °F. | T-53e | 95 | 140 | 95 | 140 | | 149 |
| Temp. of Application | | 100 | 150 | 100 | 150 | 170 | 225 |

-2.8 Sources of Supply. Approval of sources of mineral aggregate shall be obtainede from the engineer prior to delivery of material. Samples of each shall be submitted as directed. Sampling, testing, shipment reports and inspection at delivery shall be as required for "Type B-1 Dense Graded Road Mix Surface Course."

-3.1 Construction Methods. The methods employed in performing the work and alle equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

The equipment outfit used by the contractor shall be made up of suitable units, including all those specified in the item for "Type B-1 Dense Graded Road Mix Surface Course." The individual units, including the heating and transportation equipment, pressure distributor for bituminous material and spreaders and allied equipment for handling aggregate, all shall be as required, respectively, in the specification above cited.

-3.2 First Spreading of Aggregate. After the prime coat, or tack coat, has beene completed and is in proper condition in the judgment of the engineer, coarse aggregate of the particular grading called for in the Bid Schedule in the required amount per square yard as determined by the engineer, and indicated in Article -1.2 shall be spread uniformly on the prepared road with the spreading equipment hereinbefore indicated. Dumping en masse on the road will not be permitted. Before spreading the aggregate, all dust, dirt, mud or foreign material shall be removed from the area to be surfaced and care taken that such spoils material does not become mixed with the clean aggregate. The aggregate shall be spread only when the prepared surface is firm and intact and free from water. If rain falls on the loose aggregate, and the engineer so directs, it shall be windrowed and respread to facilitate drying. If directed by the engineer the operations shall be confined to one-half, or one lane, of the road, leaving the balance of the road unobstructed for public traffic.

-3.3 First Application of Bituminous Material. Upon the coarse aggregate, spread as required above, and dry, the selected bituminous material shall be applied uniformly with the prescribed pressure distributor in the required amount per square yard as determined by the engineer and indicated in Article -1.2. The particular grade to be used shall be designated by the engineer. The temperature of the material during application shall be within the range specified for the particular grade.

-3.4 Partial Road Mix. Immediately following the application the aggregate ande bituminous material shall be mixed by blading from side to side of the road or by manipulations producing equivalent results until all particles are coated with the bituminous material and the whole mass has a uniform color. During the mixing care shall be taken that none of the mixture is spread on earth shoulders or on any unprepared areas where it may become contaminated with earth and extraneous matter. Care shall also be taken not to dig into or disturb the underlying base surface.

In lieu of mixing the materials as above specified, other equipment and methods, such as rotary mixers and traveling plats, may be employed provided there is produced a mixture satisfactory to the engineer and at least equal to that which can be produced by the means above specified. The engineer shall have the right to order discontinuance of the use of any equipment or method, which, in his opinion, fails to produce a satisfactory result.

When so directed the mixing process shall be confined to part of the width or area of the road so as to allow traffic to pass conveniently and undisturbed.

After each mixing the bituminized material shall be again spread in place to receive the next increment of bituminous material.

-3.5 Second Application and Road Mixing. Immediately after the first mixing hase been accomplished and before the bituminous material is entirely dried or set, the second application shall be made in the required amount per square yard as determined by the engineer and indicated in Article -1.2 and thoroughly road mixed as required for the first application. The mixing shall continue until all particles are coated and the mixture gets viscous and begins to set. The mixed material shall then be spread and bladed to the specified width and cross section with long base equipment until a true even surface is obtained.

-3.6 Initial Rolling. Planing. As soon as the mixture is in the proper conditione of tackiness it shall be rolled so as to cover the whole surface once, slightly overlapping each trip of the roller. The roller wheels shall be kept oiled or moistened to prevent picking up mixture. Any area that tends to ravel shall be repaired with premixed material. After rolling once any irregularities in the surface shall be corrected by planing with long base equipment. The blades shall be set to a depth just sufficient to plane the irregularities from the surface. Successive readjustment of the blades shall be made, if necessary, and the planing continued until all irregularities are removed.

-3.7 Testing Road Mixed Surface. When a straight edge ten feet long is laid on thee finished surface and parallel with the center line of the road, the surface shall vary in no place more than 3/8 of an inch from the lower edge of the straight edge. The surface shall be maintained in that condition of trueness by the contractor until accepted for traffic or until the completion of the contract.

-3.8 Spreading Key Rock. After the surface has been allowed to cure properly, key rock in the required amount per square yard as determined by the engineer and indicated in Article -1.2 shall be spread uniformly with the mechanical equipment prescribed for broadcasting cover aggregate. The key material shall be broomed, or broom dragged, into the surface voids as directed. Only the amount of material required to fill the surface voidse shall be used and the surface shall not be "blinded," but the mixture shall remain partly visible. As soon as the key rock is in place, the third application of bituminous materiale shall be made in the required amount per square yard as determined by the engineer and indicated in Article -1.2.e

-3.9 Rolling. As soon as it attains the proper condition, the work shall be rollede thoroughly until the mixture is well keyed and does not move under the roller, but shall be discontinued before the aggregate is crushed or pulverized. The rolling shall be continued at proper periods during several days.

-3.10 The work shall be maintained under traffic, as ordered, until the placing ofe the seal coat.

-3.11 Seal Coat. Not less than 24 hours after completion of the work previously described the sealing application of the bituminous material shall be made in the manner hereinbefore prescribed for previous applications, and choker screenings and/or cover aggregate spread in the required amounts per square yard as determined by the engineer and indicated in Article -1.2, and the whole work rolled, broom dragged and finished.

-3.12 Supplemental Aggregate. Key Rock and/or Cover Aggregate in equal amounts, but kept segregated, shall be placed in stockpiles in the average total amount of 60 tons per mile at such places and in piles of such forms and quantities as the engineer may direct.

-3.13 If during any application any spots are missed, bituminous material shall bee applied to those spots by some means which will insure that the spot will be bituminized at the required rate.

During the application, the surface of all structures, guard rails and trees shall be protected in a satisfactory manner so as to prevent their being spattered or marred. Discharging the bituminous material into borrow pits or gutters will not be permitted.

In order to secure uniform distribution at the junction of two applications, the distribution shall be stopped promptly when the uniform flow decreases, indicating that the tank is about empty. The distributor shall be equipped with a trough under the sprays, properly arranged to be swung out of the way after the sprayers are operating in a uniform

manner at the desired pressure, or building paper shall be spread over the treated surface for a sufficient length back so that the sprayers are operating properly when the uncovered surface is reached. The building paper shall then be removed and burned. The contractor shall furnish, and keep on the work at all times, an accurate thermometer suitable for measuring the temperature of the material being applied.

All bituminous material shall be applied under 25 to 75 pounds pressure. Bituminous materials shall be applied only when the atmospheric temperature is 50°F. or above, only between April 1 and November 1 and only when the degree of dryness of the base and aggregates meet the approval of the engineer. The temperature and seasonable requirements given above may be waived but only when so directed by the engineer.

-3.14 Where detours are not available, bituminous surfacing work shall be confined to one-half the width of the road bed at a time, confining traffic under one-way control to the other half of the roadway. The contractor shall provide flagmen and a light car and driver to conduct public traffic through portions of the roadway under one-way traffic control.

-4.1 Method of Measurement. The tonnages of aggregate to be paid for shall be the number of tons of aggregate of the separate gradings actually used in the accepted work, together with the tonnages placed in stockpiles as ordered in writing. The tonnage of "Retread," whether "Light," "Medium" or "Heavy," shall be the combined tonnage of "Coarse Aggregate" and "Key Aggregate." The aggregate shall be weighed on scales furnished by and at the expense of the contractor. Each grading of aggregate shall be weighed separately. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds.

The gallonages of bituminous material to be paid for shall be the number of gallons for road mix and seal, measured at 60°F., or converted to this temperature, in accordance with A.S.T.M. D 206-34, actually used as ordered in the accepted work. When so called for in the Bid Schedule the unit for measuring bituminous material shall be the ton of 2,000 pounds.

-5.1 Basis of Payment. The tonnages of aggregate and gallonages of bituminous material (or tonnage when so called for in the Bid Schedule), determined as provided above, shall be paid for at the respective contract unit prices per ton or per gallon bid for "Light Retread," "Medium Retread," or "Heavy Retread," each of the particular Grading, A, B, C or D selected therefor, as the case may be, for "Retread Seal Cover" or "Choked Seal Cover," and for "Cut-back Asphalt for Retread," "Tar for Retread" or "Emulsified Asphalt for Retread" also as the cases may be, which prices and payments shall be full compensation for furnishing, preparing, handling, delivery and placing or application of all materials, for all conditioning of the roadway shoulders and ditches not covered under "Bituminous Prime Coat" or "Bituminous Tack Coat," for all blading, brooming and rolling, for the construction or repairing of roads to make the source of materials available, for clearing and stripping of the quarry and for pit clean-up, for the handling and disposal of unsuitable material encountered in quarry or pit operations, for clearing and leveling stockpile sites, for furnishing and sealing scales, including the weigh house, for traffic control, and for all labor, equipment, tools and incidentals necessary to complete the item.

"Reconditioning of Used Roadbed," "Bituminous Prime Coat" or "Bituminous Tack Coat" shall be paid for in accordance with the terms prescribed in the specifications for the items mentioned. Where the trimming of shoulders and ditches and the removal of slide material taken together in any 100-foot station amounts to 5 cubic yards, the excess yardage over 5 yards shall be paid for as "Unclassified Excavation."

Class D Bituminous Pavements

## 130 TYPE D-1 MOSAIC MACADAM PAVEMENT (Asphalt or Tar, Hot Application)

130-1.1 Description. This item shall consist of a pavement composed of a total of 350 pounds of crushed stone per square yard of pavement placed in successive graduated spreads and two penetration applications of bituminous material in the amount per square yard ordered, and shall be constructed on the approved completed choked and bonded stone, or similar, base course in accordance with these specifications and in conformity with the lines, grades and typical cross section shown on the plans.

-1.2 The sequence of operations and the amount of material in each shall be in accordance with the following Table I. At the start of and during progress of the work, the weights of materials in the individual operations shall be varied and adjusted as ordered by the engineer in writing but the total weight per square yard of mineral aggregate, including supplemental stockpiles, in all cases shall be as stated above. The gallons of bituminous material in the individual operations and/or in the total pavement shall be varied and adjusted as ordered by the engineer in writing at the start of operations and during progress of the work.

TABLE I

| | Amounts per Square Yard | | | |
|---|---|---|---|---|
| | Bituminous Material Gallons | Coarse Aggregate | Key Rock | Mineral Chips |
| First Spreading | | 285 lb. | | |
| First Application | 1.85 | | | |
| Second Spreading | | | 30 lb. | |
| Second Application | 0.30 | | | |
| Third Spreading | | | | 25 lb. |
| Supplemental Stockpiles | | | | 10 lb. |
| Totals | 2.15 | | | 350 lb. |

-2.1 Materials. The aggregate shall be crushed stone. Crushed stone shall consist of clean, hard, tough, durable fragments reasonably free from flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter.

The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

The crushed stone furnished for "Coarse Aggregate," "Key Rock" or "Mineral Chips" shall all be produced from the same source and the coarse and key aggregate shall be of the "Extra Hard" variety or both shall fall in the "Hard" variety, and shall meet the respective requirements for abrasion and toughness, using A.A.S.H.O. Methods T-3 and T-5, specified in Table I, and the grading requirements, using A.A.S.H.O. Method T-27, specified in Table II.

TABLE II

| | "Extra Hard" Aggregate | | "Hard" Aggregate | | |
|---|---|---|---|---|---|
| | Coarse | Key | Coarse | Key | Mineral Chips |
| Percentage of Wear (T-3) not more than | 3 | 3 | 6 | 6 | 6 |
| Toughness (T-5) not less than | 12 | 12 | 5 | 5 | 5 |

TABLE III

| | "Extra Hard" Aggregate | | "Hard" Aggregate | | |
|---|---|---|---|---|---|
| | Coarse | Key | Coarse | Key | Mineral Chips |
| | 2½-inch | 3/4-inch | 3½-inch | 1½-inch | 3/4-inch |
| | Square Openings - Percent Passing | | | | |
| 3½ inch | | | 100 | | |
| 3 inch | | | 90-100 | | |
| 2½ inch | 100 | | | | |
| 2 inch | 90-100 | | 0- 15 | | |
| 1½ inch | 5- 25 | | | 100 | |
| 1 inch | | | | 90-100 | |
| 3/4 inch | 0- 5 | 100 | | | 100 |
| 1/2 inch | | 90-100 | | 0- 15 | 90-100 |
| No. 4 | | 0- 15 | | | 0- 15 |
| No. 8 | | 0- 5 | | | 0- 5 |

-2.2 Bituminous Material. The material supplied under this specification shall be (1) asphalts prepared by the distillation of asphaltic petroleum or by the fluxing of hard native asphalts with suitable petroleum flux, or (2) refined tar.

Those materials only which have been demonstrated by service tests as satisfactory for the intended use will be acceptable. Only one kind, type and grade of material shall be used in any one contract.

The asphalt shall be homogeneous, free from water, shall not foam when heated to 347°F. and shall meet one of the following sets of requirements:

| Designation | A.A.S.H.O. | AP-3 | | AB-2 | |
|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. |
| Specific Gravity | T-43 | 1.000 | | 1.040 | 1.060 |
| Flash Point, °F. | T-48 | 347 | | 347 | |
| Softening Point, °F. | T-53 | 104 | 140 | 104 | 122 |
| Penetration | T-49 | 85 | 100 | 100 | 120 |
| Bitumen $CS_2$ | T-44 | 99.5% | | 95% | |
| (a) Organic insols | | | 0.2% | | |
| (b) Inorganic " | | | | 1.5% | 3% |
| Loss at 325°F. | T-47 | | 1% | | 3% |
| (a) Pene. Drop | T-49 | | 40% | | 50% |

Petroleum asphalt for any one contract shall not vary more than 0.020 in specific gravity nor more than 18°F. in softening point within the test limits above specified. No mineral matter other than that naturally contained in the asphalt shall be present.

-2.3 Refined tar shall be homogeneous and free from water and shall meet the following requirements:

| Designation | A.A.S.H.O. | TP-4 | | TP-3 | |
|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. |
| Specific Gravity 77°/77°/ F. | T-43 | 1.200 | 1.260 | 1.15 | 1.20 |
| Float Test at 122°F. | T-50 | 130 | 190 | 130 | 190 |
| Bitumen $CS_2$ | T-44 | 80% | 95% | 95% | |
| Total Distillate | T-52 | | | | |
| to 338°F. | | | 1% | | 1% |
| to 518°F. | | | 10% | | 10% |
| to 572°F. | | | 20% | | 20% |
| (a) Softening Point of Residue, °F. | T-53 | | 149 | | 149 |

-2.4 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed.

A sample of the asphalt or refined tar that the contractor proposes to use in his work, together with a statement as to its source and character and, in the case of asphalt, the crude petroleum from which manufactured, must be submitted and approved before use of the material begins. If the contractor proposes to prepare the asphalt cement at the paving plant then, in lieu of the above, a sample each of flux and of refined asphalt must be submitted and approved before use of the material begins, together with a statement as to the source and character of each and the proportions in which they will be combined to produce the asphalt which he proposes to use. No asphalt cement, flux or refined asphalt, or refined tar other than that represented by the sample submitted and approved shall be used.

-2.5 Field Laboratory. The contractor shall provide a field laboratory in which to house and use the testing equipment. This laboratory is to be maintained for the exclusive use of the engineers and inspectors and shall be located in accordance with the engineer's instructions.

-3.1 Construction Methods. Performance methods employed and all equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory thereafter shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

-3.2 The equipment outfit used by the contractor shall be made up of suitable units, including tractor-drawn or motor bladers, approved distributors and rollers supplemented by spreading and smoothing apparatus, steel brush or broom drag and other necessary finishing equipment designed and operated to avoid causing, as well as to remedy, corrugations and irregularities and to produce a true riding surface of uniform texture.

-3.3 The heating equipment supplied shall be of adequate capacity to heat the bituminous material properly. Heating of cars, tanks and distributors shall be accomplished without introducing steam or moisture into the bituminous material. The use of any agitating accessory to aid in the heating will be prohibited if, in the opinion of the engineer, it injures or in any way changes the characteristics of the bituminous material. Any heating system or accessory which results in coking or burning of the material shall be cause for disapproval of the equipment. Approved thermometers shall be supplied by the contractor.

-3.4 Tank wagons and trucks used for the transportation or application of bituminous material shall have either a steam or air-kerosene, or equivalent, system for the clearing of lines and pumps. Evidence of fluxing with kerosene or emulsification by steam shall be sufficient cause for rejection of the delivery. Distributors shall have tires of sufficient width that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire. Pneumatic dual tires are required except that for reasonable cause the engineer by written order may waive this particular requirement.

-3.5 Distributors shall be equipped with suitable manifold and other appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heating and temperature at all times. Sufficient and proper screens shall be installed between the tank and the nozzles, and the same shall be cleaned frequently to prevent clogging of the nozzles.

The distributor shall be so designed as to keep a constant and uniform pressure upon the bituminous material as it passes through the nozzles, and shall be equipped with devices and charts to provide at all times for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface. Distributors shall be of an approved type equipped with thermometers reading temperature of tank contents, and tachometers reading speeds in feet per minute.

All self-powered distributors or trucks or other hauling units shall have sufficient power to maintain a constant and uniform speed over the aggregate. The equipment shall be so designed and articulated that uniform application of bituminous material may be made in controlled amount, ranging from 0.05 to 2.0 gallons per square yard of surface and at pressures of 25 to 75 pounds per square inch, and to a width of at least 15 feet.

-3.6 Rollers. All rolling required by the specification shall be done with 3 wheele power rollers weighing not less than 12 tons with a compression on the rear wheels of at least 400 pounds per linear inch of tire width. If excessive crushing of the stone is noted a 3 wheel roller weighing not less than 10 tons with a compression on the rear wheels of at least 300 pounds per linear inch of tire width may be substituted upon written permission of the engineer. A sufficient number of rollers shall be furnished on the work to provide one roller for each 200 tons of macadam laid per 8-hour day. The rear wheels shall be cylinders rolling about a common axis.

-3.7 Conditioning of Existing Base Course and Shoulders. The base course upon which this pavement is to be constructed shall be swept thoroughly clean and, in case of a waterbound base course, in such manner as to expose the embedded aggregate to a depth of not more than 1/4-inch. This sweeping shall be done within 500 feet immediately in advance of spreading.

Except where there are curbs or headers, before placing any aggregate the shoulders shall be constructed to the height of the finished pavement and of a width sufficient to carry the roller. The shoulders shall be true to alignment and grade and so constructed that the side next to the proposed edge of the pavement shall be approximately vertical.

-3.8 Spreading Coarse Aggregate. Upon this conditioned base course the coarsee aggregate shall be spread in the amount of 285 pounds per square yard. It shall be spread, from dumpboards, by means of approved stone spreaders or by other approved methods. It shall be spread to a uniform depth and in such manner that there shall be no deviation greater than 1/2-inch horizontally from the alignment and so that a true grade will be formed parallel to the profile grade shown on the plans. A testing templet cut to the crown of the finished course shall be furnished by the contractor and used to secure uniformity of crown. Power graders will not be permitted for use as spreaders.

Any thin, flat or oversized aggregate that appears on the surface at any time during the process of construction shall be removed therefrom. The coarse aggregate shall have a uniform distribution of size and all patches or areas of fine or undersized material shall be removed and replaced with suitable material before rolling. This correction shall be accomplished by hand picking wherever ordered and shall be continued after the initial rolling until the appearance and texture are uniform and all ridges are removed.

-3.9 Rolling. The coarse aggregate shall be dry rolled until the aggregate is compacted and keyed together. Rolling shall start at the side and progress toward the center parallel with the center line of the roadway, uniformly lapping each preceding track by at least one-half the width of a rear wheel and continuing until the material does not creep or wave ahead of the roller. At the edges the outside driver of the roller shall cover equal portions of the aggregate spread and the shoulder and the roller run forward and backward until the shoulder and metal are firmly bound together. The rolling shall stop before the voids are closed enough to prevent free and uniform penetration of the bituminous material; any irregularities greater than 3/8-inch when tested with a 10-foot straightedge applied parallel to the center line of the pavement shall be loosened and reshaped with the same size and kind of material as that of which this course is constructed, and again rolled as required above. Material which crushes under the roller so as to prevent the free and uniform penetration of the bituminous material shall be removed and replaced by suitable material. Any depression shall be suitably eliminated. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade and shall present a texture which will allow of uniform penetration of the bituminous material.

Along curbs, headers and other structures, and all places not accessible to the roller, the course shall be thoroughly tamped with machine or hand tampers. Hand tampers shall weigh not less than 50 pounds and shall have a face area of not more than 100 square inches.

Any aggregate in this or any subsequent spread which becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed, replaced with clean aggregate and rerolled.

After the stone has been spread and rolled and prior to applying any bituminous material, test holes shall be dug each 200 linear feet of pavement to determine the uniformity of the depth of aggregate in place, which shall be measured and recorded carefully for purposes of information. These test holes shall be dug on each 200-foot section, in two alternating series of three holes each. On the first section series No. 1 shall be dug, one test hole at the center of the pavement and one on each side approximately six inches from the edges. On the second section series No. 2 shall be dug, one test hole at the center and one on each side at the quarter points. These alternate series shall be continued throughout the length of the pavement. The Government also reserves the right to make such additional tests of the completed spread as may be deemed necessary to satisfy the engineer that the requirements as to uniformity of thickness have been fulfilled.

The test holes shall be dug and refilled by the contractor under the direct supervision of the inspector, which work shall be considered as included in the contract unit price per ton of pavement.

-3.10 First Application of Bituminous Material. Over the clean surface of thee coarse aggregate placed as required abovee an application of bituminous material heated to not less than 300°F. nor more than 350°F. for asphalt, and not less than 200°F. nore more than 275°F. for tar, shall be made in the amount of 1.85 gallons per square yard of surface unless increased by written order. No bituminous material shall be applied unless the entire depth of the stone surface course is thoroughly dry and the atmospheric temperature is at 40°F., or above, and in no case shall bituminous material be applied when conditions do not permit satisfactory penetration and adhesion.

The bituminous material shall be distributed by approved distributors operating under a pressure at the nozzles of 25 to 75 pounds per square inch as may be directed. The length of road treated before covering shall be gaged according to the labor and equipment on hand for doing the work and as regulated by the engineer.

In order to insure uniform distribution at the junction of two loads, when the last of any load starts to thin, distribution shall be shut off, and upon resuming distribution building paper shall be spread over the latter portion of the previous application and the distributor shall lap back over this paper sufficiently to start the sprayers full force when the uncovered surface is reached. This building paper shall then be removed and destroyed. If building paper is not available a trough or other equivalent accessory may be used to collect the bituminous material until the full pressure of the distributor is obtained.

-3.11 Spreading Key Rock. Immediately after the application of the bituminouse material, key rock in the amount of 30 pounds per square yard shall be spread evenly over the surface to fill the voids nearly to the surface. The key rock shall be added in small amounts as may be most effective while the rolling continues until the coarse aggregate is filled and keyed firmly. The surface shall then be rolled, care being taken that the rolling starts while the surface is still warm, until the bituminous binder is set up and the whole work is rolled to refusal and has become bonded to form a stable pavement. The time, extent and manner of rolling shall be subject to the direction of the engineer.

Continuous care shall be taken in spreading this material to insure uniformity of surface. Sweeping the surface with push brooms, or broom dragging, shall be resorted to if in the opinion of the engineer it is necessary. No key rock shall be distributed over any portion of the coarse aggregate which has not received the first application of bituminous material and in no case shall the key rock be dumped directly on either the treated or untreated coarse aggregate.

-3.12 Second Application of Bituminous Material. After the work has been rollede to refusal, the pavement shall be swept clean of all loose material and treated with a second application of bituminous material under the same conditions and in the same manner as specified above except that the application shall be in the amount of 0.30 gallon per square yard, or as directed by the engineer. The bituminous material when applied to the upper course of stone shall have a temperature of not less than 300°F. nor more than 350°F.e for asphalt, and not less than 200°F. nor more than 275°F. for tar. The contractor shall not allow the bituminous material to be overheated or burned. After second application of bituminous material, key rock or mineral chips, as ordered, shall be spread evenly in the amount of 25 pounds per square yard and rolled to refusal.

-3.13 Supplemental Stockpiles. Crushed stone for supplemental stockpiles shall bee furnished by the contractor in the amount of 10 pounds per square yard of pavement. It shall consist of mineral chips of the same quality specified for use in the pavement. It shall be neatly piled on the side of the road at such points as may be designated by the engineer.

-3.14 Testing Surface. The finished surface of the bituminous macadam pavement shall conform so nearly to that required by the plans that it will nowhere vary more than 3/8-inch when tested with a 10-foot straightedge applied to the surface parallel to the center line of the pavement or from a templet conforming to the cross section shown on the plans. In making this test the straightedge shall be advanced by increments of half its length, measurements shall be taken of the greatest space found between its lower edge and the pavement surface which at no point shall exceed 3/8-inch. The entire pavement shall be thus tested at the center line and the quarter and third points, and elsewhere as ordered. Such portions of the completed pavement as are defective in finish, compression, or composition or that do not comply in all respects with the requirements of these specifications shall be taken up, removed and replaced with suitable material properly laid in accordance with these specifications.

If at any time before the work is accepted any soft or imperfect places or spots shall develop in the surface, all such places shall be removed and replaced with new material and then rolled until compacted thoroughly and until the joints or edges at which the new work connects with the old become invisible. All such removal and replacing of unsatisfactory surfacing shall be done at the expense of the contractor.

-4.1 Method of Measurement. The tonnage to be paid for shall be the number of tons of aggregate of all gradings furnished and placed in the macadam, together with that placed in supplemental stockpiles.

If local aggregate not shipped by rail is used it shall be weighed on scales furnished by and at the expense of the contractor. Said scales shall be sealed at the expense of the contractor as often as is deemed necessary by the engineer to insure their accuracy.

If the aggregate is shipped by rail or trucks, the actual car weights or quarry weights may be accepted, but scales shall be used as above, if so directed. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous material to be paid for shall be the number of gallons, measured at 60°F. or converted to this temperature in accordance with A.S.T.M. D206-34 and actually used as ordered in the accepted work.

-5.1 Basis of Payment. The tonnage and gallonage, determined as provided above, shall be paid for at the contract unit prices per ton bid for "D-1 Mosaic Macadam Pavement" and per gallon for "D-1 Bituminous Material (asphalt)" or "D-1 Bituminous Material (tar)," as the case may be, which prices and payment shall constitute full compensation for furnishing all material, for hauling, placing, rolling, applying bituminous material and finishing and for all labor, equipment, tools and incidentals necessary to complete the item.

Class D Bituminous Pavements

## 131 TYPE D-2 THREE APPLICATION MACADAM PAVEMENT (Asphalt or Tar, Hot Application)

131-1.1 Description. This item shall consist of a pavement composed of a total of 350 pounds of crushed stone or crushed slag per square yard of pavement placed in successive graduated spreads and three penetration applications of bituminous material in the amount per square yard ordered, and shall be constructed on the approved completed choked and bonded stone, or similar, base course in accordance with these specifications and in conformity with the lines, grades and typical cross section shown on the plans.

-1.2 The sequence of operations and the amount of material in each shall be in accordance with the following Table I. At the start of and during progress of the work, the weights of materials in the individual operations shall be varied and adjusted as ordered by the engineer in writing but the total weight per square yard of mineral aggregate, including supplemental stockpiles, in all cases shall be as stated above. The gallons of bituminous material in the individual operations and/or in the total pavement shall be varied and adjusted as ordered by the engineer in writing at the start of operations and during progress of the work. When slag is used the amount of bituminous material shall be increased 10 percent unless otherwise ordered.

TABLE I

| | Amounts per Square Yard | | | |
|---|---|---|---|---|
| | Bituminous Material Gallons | Coarse Aggregate | Key Rock | Mineral Chips |
| First Spreading | | 270 lb. | | |
| First Application | 1.50 | | | |
| Second Spreading | | | 30 lb. | |
| Second Application | 0.50 | | | |
| Third Spreading | | | 25 lb. | |
| Third Application | 0.30 | | | |
| Fourth Spreading | | | | 15 lb. |
| Supplemental Stockpiles | | | | 10 lb. |
| Totals | 2.30 | | | 350 lb. |

-2.1 Materials. The aggregate shall be crushed stone or slag.

Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft, or disintegrated pieces, dirt, or other objectionable matter.

Crushed slag shall be air-cooled blast furnace slag and shall consist of angular fragments reasonably uniform in density and quality, and reasonably free from thin, elongated, or glassy pieces, dirt, or other objectionable matter.

The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

The crushed stone or crushed slag furnished respectively for "Coarse Aggregate," "Key Rock," and "Mineral Chips" shall meet the respective requirements for abrasion and toughness using A.A.S.H.O. Methods T-3, T-5 and T-19 and, for the slag, the weight per cubic foot, all as specified in Table II and the grading requirements using A.A.S.H.O. Method T-27, specified in Table III.

TABLE II

| | Stone | Slag |
|---|---|---|
| Percentage of wear (T-3), not more than | 6 | 15 |
| Toughness (T-5), not less than | 5 | |
| Weight per cubic foot (T-19), not less than | | 70 lb. |

TABLE III

| | Stone and Slag | | |
|---|---|---|---|
| | Coarse Aggregate | Key Rock | Mineral Chips |
| | 3-inch | 1-inch | 1/2-inch |
| | Percent Passing - Square Openings | | |
| 3 inch | 100 | | |
| 2 inch | 35- 70 | | |
| 1-1/2 inch | 0- 15 | | |
| 1 inch | | 100 | |
| 3/4 inch | | 90-100 | |
| 1/2 inch | | | 100 |
| 3/8 inch | | 25- 55 | 90-100 |
| No. 4 | | 0- 10 | 10- 35 |
| No. 8 | | | 0- 5 |

-2.2 Bituminous Material. The material supplied under this specification shall be (1) asphalts prepared by the distillation of asphaltic petroleum or by the fluxing of hard native asphalts with suitable petroleum flux, or (2) refined tar.

Those materials only which have been demonstrated by service tests as satisfactory for the intended use will be acceptable. Only one kind, type and grade of material shall be used in any one contract.

The asphalt shall be homogeneous, free from water, shall not foam when heated to 347°F. and shall meet one of the following sets of requirements:

| Designation | A.A.S.H.O. | AP-3 | | AB-2 | |
|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. |
| Specific Gravity | T-43 | 1.000 | | 1.040 | 1.060 |
| Flash Point, °F. | T-48 | 347 | | 347 | |
| Softening Point, °F. | T-53 | 104 | 140 | 104 | 122 |
| Penetration | T-49 | 85 | 100 | 100 | 120 |
| Bitumen $CS_2$ | T-44 | 99.5% | | 95% | |
| (a) Organic insols. | | | 0.2% | | |
| (b) Inorganic " | | | | 1.5% | 3% |
| Loss at 325°F. | T-47 | | 1% | | 3% |
| (a) Pene. Drop | T-49 | | 40% | | 50% |

Petroleum asphalt for any one contract shall not vary more than 0.020 in specific gravity nor more than 18°F. in softening point within the test limits above specified. No mineral matter other than that naturally contained in the asphalt shall be present.

-2.3 Refined tar shall be homogeneous and free from water and shall meet the following requirements.

| Designation | A.A.S.H.O. | TP-4 | | TP-3 | |
|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. |
| Specific Gravity 77°/77°F. | T-43 | 1.200 | 1.260 | 1.15 | 1.20 |
| Float Test at 122°F. | T-50 | 130 | 190 | 130 | 190 |
| Bitumen $CS_2$ | T-44 | 80% | 95% | 95% | |
| Total Distillate | T-52 | | | | |
| To 338°F. | | | 1% | | 1% |
| To 518°F. | | | 10% | | 10% |
| To 572°F. | | | 20% | | 20% |
| (a) Softening Point of Residue | T-53 | | 149°F. | | 149°F. |

-2.4 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to the delivery of material. Samples of each shall be submitted as directed.

A sample of the asphalt or refined tar that the contractor proposes to use in his work, together with a statement as to its source and character and, in the case of asphalt, the crude petroleum from which manufactured, must be submitted and approved before use of the material begins. If the contractor proposes to prepare the asphalt cement at the paving plant then, in lieu of the above, a sample each of flux and of refined asphalt must be submitted and approved before use of the material begins, together with a statement as to the source and character of each and proportions in which they will be combined to produce the asphalt which he proposes to use. No asphalt cement, flux, or refined asphalt, or refined tar other than that represented by the sample submitted and approved shall be used.

-2.5 Field Laboratory. The contractor shall provide a field laboratory in which to house and use the testing equipment. This laboratory is to be maintained for the exclusive use of the engineer and inspectors, and shall be located in accordance with the engineer's instructions.

-3.1 Construction Methods. Performance methods employed and all equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory thereafter shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

-3.2 The equipment outfit used by the contractor shall be made up of suitable units, including tractor-drawn or motor bladers, approved distributors and rollers supplemented by spreading and smoothing apparatus, steel brush or broom drag, and other necessary finishing equipment designed and operated to avoid causing, as well as to remedy, corrugations and irregularities and to produce a true riding surface of uniform texture.

-3.3 The heating equipment supplied shall be of adequate capacity to heat the bituminous material properly. Heating of cars, tanks and distributors must be accomplished without introducing steam or moisture into the bituminous material. The use of any agitating accessory to aid in the heating will be prohibited if, in the opinion of the engineer, it injures or in any way changes the characteristics of the bituminous material. Any heating system or accessory which results in coking or burning of the material shall be cause for disapproval of the equipment. Approved thermometers shall be supplied by the contractor.

-3.4 Tank wagons and trucks used for the transportation or application of bituminous material shall have either a steam or air-kerosene, or equivalent, system for the clearing of lines and pumps. Evidence of fluxing with kerosene or emulsification by steam shall be sufficient cause for rejection of the delivery. Distributors shall have tires of sufficient width that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire. Pneumatic dual tires are required except that for reasonable cause the engineer by written order may waive this particular requirement.

-3.5 Distributors shall be equipped with suitable manifold and other appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heating and temperature at all times. Sufficient and proper screens shall be installed between the tank and the nozzles, and the same shall be cleaned frequently to prevent clogging of the nozzles.

Distributors shall be so designed as to keep a constant and uniform pressure upon the bituminous material as it passes through the nozzles, and shall be equipped with devices and charts to provide at all times for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface. Distributors shall be of an approved type equipped with thermometers reading temperature of tank contents, and tachometers reading speeds in feet per minute.

All self-powered distributors or trucks or other hauling units shall have sufficient power to maintain a constant and uniform speed over the aggregate. The equipment shall be so designed and articulated that uniform application of bituminous material may be made in controlled amount, ranging from 0.05 to 2.0 gallons per square yard of surface and at pressures from 25 to 75 pounds per square inch and to a width of at least 15 feet.

-3.6 Rollers. All rolling required by this specification shall be done with 3 wheel power rollers weighing not less than 10 tons with a compression on the rear wheels of at least 300 pounds per linear inch of tire width. A sufficient number of rollers shall be furnished on the work to provide one roller for each 200 tons of pavement laid per 8-hour day. The rear wheels shall be cylinders rolling about a common axis.

-3.7 Conditioning of Existing Base Course and Shoulders. The base course upon which this pavement is to be constructed shall be swept thoroughly clean and, in case of a waterbound base course, in such manner as to expose the embedded aggregate to a depth of not more than 1/4 of an inch. This sweeping shall be done within 500 feet immediately in advance of spreading.

Except where there are curbs or headers and before placing any aggregate the shoulders shall be constructed to the height of the finished pavement and of a width sufficient to carry the roller. The shoulders shall be true to alignment and grade and so constructed that the side next to the proposed edge of the pavement shall be approximately vertical.

-3.8 Spreading Coarse Aggregate. Upon this conditioned base course the coarse aggregate shall be spread in the amount of 270 pounds per square yard. It shall be spread from dumpboards or by means of approved stone spreaders or by other approved mechanical methods. It shall be spread to a uniform depth and in such manner that there shall be no deviation greater than 1/2 inch horizontally from the alignment and so that a true grade will be formed parallel to the profile grade shown on the plans. A testing templet cut to the crown of the finished course shall be furnished by the contractor and used to secure uniformity of crown. When required by the engineer the aggregate after spreading shall be leveled with a long base drag so manipulated as to improve the uniformity and regularity of the work. Such drag shall be at least 15 feet long.

Any thin, flat or oversized aggregate that appears on the surface at any time during the process of construction shall be removed therefrom. The coarse aggregate shall have a uniform distribution of size and all patches or areas of fine or undersized material shall be removed and replaced with suitable material before rolling. This correction shall be accomplished by hand picking wherever ordered and shall be continued after the initial rolling until the appearance and texture are uniform and all ridges are removed.

-3.9 Rolling. The coarse aggregate shall be dry rolled until the aggregate is compacted and keyed together. Rolling shall start at the side and progress toward the center parallel with the center line of the roadway, uniformly lapping each preceding track by at least 1/2 of the width of a rear wheel and continuing until the material does not creep or wave ahead of the roller. At the edges the outside driver of the roller shall cover equal portions of the aggregate spread and the shoulder and the roller run forward and backward until the shoulder and metal are firmly bound together. The rolling shall stop before the voids are closed enough to prevent free and uniform penetration of the bituminous material; any irregularities greater than 3/8 inch when tested with a 10-foot straightedge applied parallel to the center line of the pavement shall be loosened and reshaped with the same size and kind of material as that of which this course is constructed, and again rolled as required above.

Material which crushes under the roller so as to prevent the free and uniform penetration of the bituminous material shall be removed and replaced by suitable material. Any depression shall be suitably eliminated. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade and shall present a texture which will allow of uniform penetration of the bituminous material.

Along curbs, headers and other structures, and all places not accessible to the roller, the course shall be thoroughly tamped with machine or hand tampers. Hand tampers shall weigh not less than 50 pounds and shall have a face area of not more than 100 square inches.

Any aggregate in this or any subsequent spread which becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed, replaced with clean aggregate and rerolled.

After the stone has been spread and rolled and prior to applying any bituminous material, test holes shall be dug each 200 linear feet of pavement to determine the uniformity of the depth of aggregate in place, which shall be measured and recorded carefully for purposes of information. These test holes shall be dug on each 200-foot section in two alternating series of three holes each. On the first section series No. 1 shall be dug, one test hole at the center of the pavement and one on each side approximately six inches from the edges. On the second section series No. 2 shall be dug, one test hole at the center and one on each side at the quarter points. These alternate series shall be continued throughout the length of the pavement. The Government also reserves the right to make such additional tests of the completed spread as may be deemed necessary to satisfy the engineer that the requirements as to uniformity of thickness have been fulfilled.

The test holes shall be dug and refilled by the contractor under the direct supervision of the inspector, which work shall be considered as included in the contract unit price per ton of pavement.

-3.10 First Application of Bituminous Material. Over the clean surface of the coarse aggregate placed as required above, an application of bituminous material heated to not less than 300°F. nor more than 350°F. for asphalt, and not less than 200°F. nor more than 275°F. for tar, shall be made in the amount of 1.5 gallons per square yard of surface unless increased by written order. No bituminous material shall be applied unless the entire depth of the course is thoroughly dry and the atmospheric temperature is at 40°F., or above, and in no case shall bituminous material be applied when conditions do not permit satisfactory penetration and adhesion.

The bituminous material shall be distributed by approved distributors operating under a pressure at the nozzles of 25 to 75 pounds per square inch as may be directed. The length of road treated before covering shall be gaged according to the labor and equipment on hand for doing the work and as regulated by the engineer.

In order to insure uniform distribution at the junction of two loads, when the last of any load starts to thin, distribution shall be shut off, and upon resuming distribution building paper shall be spread over the latter portion of the previous application and the distributor shall lap back over this paper sufficiently to start the sprayers full force when the uncovered surface is reached. This building paper shall then be removed and destroyed. If building paper is not available a trough or other equivalent accessory may be used to collect the bituminous material until the full pressure of the distributor is obtained.

-3.11 Spreading Key Rock. Immediately after the application of the bituminous material, key rock in the amount of 30 pounds per square yard shall be spread evenly over the surface. The key rock shall be added in small amounts as may be most effective while the rolling continues until the coarse aggregate is filled and keyed firmly. The surface shall then be rolled, care being taken that the rolling starts while the surface is still warm, until the bituminous binder is set up and the whole work is rolled to refusal and has become bonded to form a stable pavement. The time, extent and manner of rolling shall be subject to the direction of the engineer.

Continuous care shall be taken in spreading this material to secure uniformity of surface. Sweeping the surface with push brooms or broom dragging shall be resorted to if in the opinion of the engineer it is necessary. No key rock shall be distributed over any portion of the coarse aggregate which has not received the first application of bituminous material and in no case shall the key rock be dumped directly on either the treated or untreated coarse aggregate.

-3.12 Second Application of Bituminous Material. After the work has been rolled to refusal the pavement shall be swept clean of all loose material and treated with a second application of bituminous material under the same conditions and in the same manner as specified above except that the application shall be in the amount of 0.50 gallon per square yard, or as directed by the engineer. The bituminous material when applied to the upper course of stone shall have a temperature of not less than 300°F. nor more than 350°F. for asphalt, and not less than 200°F. nor more than 275°F. for tar. The contractor shall not allow the bituminous material to be overheated or burned.

-3.13 Key rock shall then be distributed over the surface and spread to uniform thickness by means of a broom drag or other suitable equipment in the amount of 25 pounds per square yard. The spreading of the key rock shall be followed by a thorough rolling and brooming of the course. A portion of the key rock may be reserved and then added as required while the rolling and brooming is in progress. The rolling and brooming shall be continued until the interstices in the coarse rock are filled and until the course is solidly keyed and compacted, and until the surface is of uniform texture throughout.

The key rock is to be added in only such quantities as are required to fill the interstices in the coarse aggregate and should not be added in quantities sufficient to form a mat or separate course on top of the coarse aggregate, and if so added by mistake the excess material shall be removed by blading and/or brooming.

-3.14 Third Application of Bituminous Material. The surface of the pavement shall have swept from it all loose screenings, dust, dirt and other matter. Hot bituminous material shall then be applied in the amount of 0.30 gallon per square yard, and while still hot mineral chips shall be spread upon it in the amount of 15 pounds per square yard. The surface shall then be broomed and rolled until well compacted and of uniform texture throughout.

-3.15 Supplemental Stockpiles. Crushed stone or slag for supplemental stockpiles shall be furnished by the contractor in the amount of 10 pounds per square yard of pavement. It shall consist of mineral chips and shall be of the same quality specified for use in the pavement. It shall be neatly piled on the side of the road at such points as may be designated by the engineer.

-3.16 Testing Surface. The finished surface of the bituminous macadam pavement shall conform so nearly to that required by the plans that it will nowhere vary more than 3/8 of an inch when tested with a 10-foot straightedge applied to the surface parallel to the center line of the pavement or from a templet conforming to the cross section shown on the plans. In making this test the straightedge shall be advanced by increments of half its length, measurements shall be taken of the greatest space found between its lower edge and the pavement surface which at no point shall exceed 3/8 of an inch. The entire pavement shall be thus tested, at the center line and the quarter and third points, and elsewhere as ordered. Such portions of the completed pavement as are defective in finish, compression, or composition or that do not comply in all respects with the requirements of these specifications shall be taken up, removed, and replaced with suitable material properly laid in accordance with these specifications.

If at any time before the work is accepted any soft or imperfect places or spots shall develop in the surface, all such places shall be removed and replaced with new material and then rolled until compacted thoroughly and until the joints or edges at which the new work connects with the old become invisible. All such removal and replacing of unsatisfactory surfacing shall be done at the expense of the contractor.

-4.1 Method of Measurement. The tonnage to be paid for shall be the number of tons of aggregate of all gradings furnished and placed in the macadam, together with that placed in supplemental stockpiles.

If local aggregate not shipped by rail is used it shall be weighed on scales furnished by and at the expense of the contractor. Said scales shall be sealed at the expense of the contractor as often as is deemed necessary by the engineer to insure their accuracy.

If the aggregate is shipped by rail or trucks, the actual car weights or quarry weights may be accepted, but scales shall be used as above, if so directed. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous material to be paid for shall be the number of gallons, measured at 60°F., or converted to this temperature in accordance with A.S.T.M. D206-34, actually used as ordered in the accepted work.

-5.1 Basis of Payment. The tonnage and gallonage, determined as provided above, shall be paid for at the contract unit prices per ton bid for "D-2 Three Application Macadam" and per gallon bid for "D-2 Bituminous Material (asphalt)" or "D-2 Bituminous Material (tar)" as the case may be, which prices and payments shall constitute full compensation for furnishing all material, for hauling, placing, rolling, for applying bituminous material and finishing and for all labor, equipment, tools and incidentals necessary to complete the item.

Class E-1 Bituminous Pavements

## 132 TYPE E-1 MACADAM COURSE
## (To be Topped with a Plant Mixed Seal)

132-1.1 Description. This item shall consist of a course composed of a total of 240 pounds of crushed stone or crushed slag per square yard of the course, placed in successive graduated spreads and two penetration applications of bituminous material in the amount per square yard ordered, and shall be so constructed on the approved completed choked and bonded stone, or similar, base course in accordance with these specifications, that when a specified plant seal of 35 pounds per square yard is placed thereon the finished surface of such seal course will be in conformity with the lines, grades and typical cross section shown on the plans.

This item does not include the plant mixed seal.

-1.2 The sequence of operations and the amount of material in each shall be in accordance with the following Table I. At the start of and during progress of the work, the weights of materials in the individual operations shall be varied and adjusted as ordered by the engineer in writing but the total weight per square yard of mineral aggregate, including supplemental stockpiles, in all cases shall be as stated above. The gallons of bituminous material in the individual operations and/or in the total pavement shall be varied and adjusted as ordered by the engineer in writing at the start of operations and during progress of the work. When slag is used the amount of bituminous material shall be increased 10 percent unless otherwise ordered.

TABLE I

| | Amounts per Square Yard | | | |
|---|---|---|---|---|
| | Bituminous Material Gallons | Coarse Aggregate | Key Rock | Key Rock or Mineral Chips |
| First Spreading | | 190 lb. | | |
| First Application | 1.20 | | | |
| Second Spreading | | | 25 lb. | |
| Second Application | .30 | | | |
| Third Spreading | | | 15 lb. | |
| Supplemental Stockpiles | | | | 10 lb. |
| Totals | 1.50 | | | 240 lb. |

-2.1 Materials. The aggregate shall be crushed stone or crushed slag.

Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter.

Crushed slag shall be air-cooled blast furnace slag and shall consist of angular fragments reasonably uniform in density and quality, and reasonably free from thin, elongated, or glassy pieces, dirt or other objectionable matter.

The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

The crushed stone or crushed slag, furnished respectively for "Coarse Aggregate," "Key Rock" and "Mineral Chips," shall meet the respective requirements for abrasion, toughness and weight per cubic foot, using A.A.S.H.O. Methods T-3, T-5 and T-19, all as specified in Table II, and the grading requirements using A.A.S.H.O. Method T-27 specified in Table III.

TABLE II

| | Stone | Slag |
|---|---|---|
| Percentage of wear (T-3), not more than | 6 | 15 |
| Toughness (T-5), not less than | 6 | |
| Weight per cubic foot (T-19), not less than | | 70 lb. |

TABLE III

| | Coarse Aggregate 2-inch | Key Rock 3/4-inch | Mineral Chips 3/8-inch |
|---|---|---|---|
| | Percent Passing - Square Openings | | |
| 2 inch | 100 | | |
| 1-1/2 inch | 35- 70 | | |
| 1 inch | 0- 15 | | |
| 3/4 inch | | 100 | |
| 1/2 inch | | 90-100 | |
| 3/8 inch | | | 100 |
| No. 4 | | 0- 15 | 90-100 |
| No. 8 | | 0- 5 | 0- 15 |

-2.2 Bituminous Material. The material supplied shall be (1) asphalts prepared by the distillation of asphaltic petroleum or by the fluxing of hard native asphalts with suitable petroleum flux, or (2) refined tar.

Those materials only which have been demonstrated by service tests as satisfactory for the intended use will be acceptable under this specification. Only one kind, type and grade of material shall be used in any one contract.

The asphalt shall be homogeneous, free from water, shall not foam when heated to 347°F. and shall meet one of the following sets of requirements:

| Designation | A.A.S.H.O. | AP-3 Min. | AP-3 Max. | AB-2 Min. | AB-2 Max. |
|---|---|---|---|---|---|
| Specific Gravity | T-43 | 1.000 | | 1.040 | 1.060 |
| Flash Point, °F. | T-48 | 347 | | 347 | |
| Softening Point, °F. | T-53 | 104 | 140 | 104 | 122 |
| Penetration | T-49 | 85 | 100 | 100 | 120 |
| Bitumen (Sol. $CS_2$) | T-44 | 99.5% | | 95% | |
| (a) Organic Insols | | | 0.2% | | |
| (b) Inorganic " | | | | 1.5% | 3% |
| Loss at 325°F. | T-47 | | 1% | | 3% |
| (a) Pene. Drop | T-49 | | 40% | | 50% |

Petroleum asphalt for any one contract shall not vary more than 0.020 in specific gravity nor more than 18°F. in softening point within the test limits above specified. No mineral matter other than that naturally contained in the asphalt shall be present.

-2.3 Refined tar shall be homogeneous and free from water and shall meet the following requirements:

| Designation | A.A.S.H.O. | TP-4 | | TP-3 | |
|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. |
| Specific Gravity | T-43 | 1.200 | 1.260 | 1.15 | 1.20 |
| Float Test at 122°F. | T-50 | 130 | 190 | 130 | 190 |
| Bitumen (Sol. CS2) | T-44 | 80% | 95% | 95% | |
| Total Distillate | T-52 | | | | |
| To 338°F. | | | 1% | | 1% |
| To 518°F. | | | 10% | | 10% |
| To 572°F. | | | 20% | | 20% |
| (a) Softening Point of Residue, °F. | T-53 | | 149 | | 149 |

-2.4 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed.

A sample of the asphalt or refined tar that the contractor proposes to use in his work, together with a statement as to its source and character and, in the case of asphalt, the crude petroleum from which manufactured must be submitted and approved before use of the material begins. If the contractor proposes to prepare the asphalt cement at the paving plant then a sample each of flux and of refined asphalt must be submitted and approved before use of the material begins, together with a statement as to the source and character of each and the proportions in which they will be combined to produce the asphalt which he proposes to use. No asphalt cement, flux or refined asphalt, or refined tar other than that represented by the sample submitted and approved shall be used.

-2.5 Field Laboratory. The contractor shall provide a field laboratory in which to house and use the testing equipment. This laboratory is to be maintained for the exclusive use of the engineers and inspectors and shall be located in accordance with the engineer's instructions.

-3.1 Construction Methods. Performance methods employed and all equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory thereafter shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

-3.2 The equipment outfit used by the contractor shall be made up of suitable units, including tractor-drawn or motor bladers, approved distributors and rollers supplemented by spreading and smoothing apparatus, steel brush or broom drag and other necessary finishing equipment designed and operated to avoid causing, as well as to remedy, corrugations and irregularities and to produce true riding surface of uniform texture.

-3.3 The heating equipment supplied shall be of adequate capacity to heat the bituminous material properly. Heating of cars, tanks and distributors must be accomplished without introducing steam or moisture into the bituminous material. The use of any agitating accessory to aid in the heating will be prohibited if, in the opinion of the engineer, it injures or in any way changes the characteristics of the bituminous material. Any heating system or accessory which results in coking or burning of the material shall be cause for disapproval of the equipment. Approved thermometers shall be supplied by the contractor.

-3.4 Tank wagons and trucks used for the transportation or application of bituminous material shall have either a steam or air-kerosene, or equivalent, system for the clearing of lines and pumps. Evidence of fluxing with kerosene or emulsification by steam shall be sufficient cause for rejection of the delivery. Distributors shall have tires of sufficient width that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire. Pneumatic dual tires are required except that for reasonable cause the engineer by written order may waive this particular requirement.

-3.5 Distributors shall be equipped with suitable manifold and other appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heating and temperature at all times. Sufficient and proper screens shall be installed between the tank and the nozzles, and the same shall be cleaned frequently to prevent clogging of the nozzles.

The distributor shall be so designed as to keep a constant and uniform pressure upon the bituminous material as it passes through the nozzles, and shall be equipped with devices and charts to provide at all times for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface. Distributors shall be of an approved type equipped with thermometers reading temperature of tank contents, and tachometers reading speeds in feet per minute.

All self-powered distributors or trucks or other hauling units shall have sufficient power to maintain a constant and uniform speed over the aggregate. The equipment shall be so designed and articulated that uniform application of bituminous material may be made in controlled amount, ranging from 0.05 to 2.0 gallons per square yard of surface and at pressures of 25 to 75 pounds per square inch, and to a width of at least 15 feet.

-3.6 Rollers. All rolling required by the specification shall be done with 3 wheel power rollers weighing not less than 12 tons with a compression on the rear wheels of at least 400 pounds per linear inch of tire width. If excessive crushing of the stone is noted a 3 wheel roller weighing not less than 10 tons with a compression on the rear wheels of at least 300 pounds per linear inch of tire width may be substituted upon written permission of the engineer. A sufficient number of rollers shall be furnished on the work to provide one roller for each 200 tons of macadam laid per 8-hour day. The rear wheels shall be cylinders rolling about a common axis.

-3.7 Conditioning of Existing Base Course and Shoulders. The base course upon which this pavement is to be constructed shall be swept thoroughly clean and, in case of a waterbound base course, in such manner as to expose the embedded aggregate to a depth of not more than 1/4 inch. This sweeping shall be done within 500 feet immediately in advance of spreading.

Except where there are curbs or headers, before placing any aggregate the shoulders shall be constructed to the height of the finished macadam and of a width sufficient to carry the roller. The shoulders shall be true to alignment.

-3.8 Spreading Coarse Aggregate. Upon this conditioned base course the coarse aggregate shall be spread in the amount of 190 pounds per square yard. It shall be spread by means of approved stone spreaders or by other approved mechanical methods. Where there are no suitable concrete curbs, gutters or other equivalent guides, edge liners or side forms shall be set having a base width of not less than three inches and of the height of the loose material involved for the given weight per square yard. The forms shall be securely fastened together at their ends and shall be securely staked in such manner that there shall be no deviation greater than 1/2 inch horizontally from the line and that a true grade will be formed parallel to the profile grade shown on the plans. A testing templet cut to the crown of the finished course and resting on the side forms shall be furnished by the contractor and used to assure uniformity of depth and trueness of profile and crown. The side forms shall be backed with earth or other suitable material on the berm side, to a width of not less than two feet. After the coarse aggregate has been spread and before rolling, the side forms may be removed. The channel thus created between the aggregate spread and the earth backing shall be filled with earth or other suitable material which will compact to the final height of the course. Under the direction of the engineer the spread shall be lightly dragged with a long base drag so manipulated as to improve the uniformity and regularity of the work. Such drag shall be at least 15 feet long.

Any thin, flat or oversized aggregate that appears on the surface at any time during the process of construction shall be removed therefrom. The coarse aggregate shall have a uniform distribution of size and all patches or areas of fine or undersized material shall be removed and replaced with suitable material before dragging and rolling. This correction shall be accomplished by hand picking wherever ordered and shall be continued after the initial rolling until the appearance and texture are uniform and all ridges are removed.

-3.9 Rolling. The coarse aggregate shall be dry rolled until the aggregate is compacted and keyed together. Rolling shall start at the side and progress toward the center parallel with the center line of the roadway, uniformly lapping each preceding track by at least one-half of the width of a rear wheel and continuing until the material does not creep or wave ahead of the roller. The rolling shall stop before the voids are closed enough to prevent free and uniform penetration of the bituminous material; any irregularities greater than 3/8 inch in 10 feet or greater than 1/2 inch when tested with an 18-foot straightedge applied parallel to the center line of the pavement shall be loosened and reshaped with the same size and kind of material as that of which this course is constructed, and again rolled as required above. Material which crushes under the roller so as to prevent the free and uniform penetration of the bituminous material shall be removed and replaced by suitable material. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade and shall present a texture which will allow of uniform penetration of the bituminous material.

Along curbs, headers and other structures, and all places not accessible to the roller, the course shall be thoroughly tamped with machine or hand tampers. Hand tampers shall weigh not less than 50 pounds and shall have a face area of not more than 100 square inches.

Any aggregate in this or any subsequent spread which becomes coated or mixed with dirt or clay prior to the appplication of the bituminous material shall be removed, replaced with clean aggregate of the same specification and rerolled.

After the stone has been spread and rolled and prior to applying any bituminous material, test holes shall be dug each 200 linear feet of the course to determine the uniformity of the depth of aggregate in place, which shall be measured and recorded carefully for purposes of information. These test holes shall be dug on each 200 foot section, in two alternating series of three holes each. On the first section series No. 1 shall be dug, one test hole at the center of the pavement and one on each side approximately six inches from the edges. On the second section series No. 2 shall be dug, one test hole at the center and one on each side at the quarter points. These alternate series shall be continued throughout the length of the course. The Government also reserves the right to make such additional tests of the completed surface course as may be deemed necessary to satisfy the engineer that the requirements have been fulfilled.

The test holes shall be dug and refilled by the contractor under the direct supervision of the inspector, which work shall be considered as included in the contract unit price per ton of pavement.

-3.10 First Application of Bituminous Material. Over the clean surface of the coarse aggregate placed as required above, an application of bituminous material heated to not less than 300°F. nor more than 350°F. for asphalt, and not less than 200°F. nor more than 275°F. for tar, shall be made in the amount of 1.20 gallons per square yard of surface unless increased by written order. No bituminous material shall be applied unless the entire depth of the stone surface course is thoroughly dry and the atmospheric temperature is at 40°F., or above, and in no case shall bituminous material be applied when conditions do not permit satisfactory penetration and adhesion.

The bituminous material shall be distributed by approved distributors operating under a pressure at the nozzles of 25 to 75 pounds per square inch as may be directed. The length of road treated before covering shall be gaged according to the labor and equipment on hand for doing the work and as regulated by the engineer.

In order to insure uniform distribution at the junction of two loads, when the last of any load starts to thin, distribution shall be shut off, and upon resuming distribution building paper shall be spread over the latter portion of the previous application and the distributor shall lap back over this paper sufficiently to start the sprayers full force when the uncovered surface is reached. This building paper shall then be removed and destroyed. If building paper is not available a trough or other equivalent accessory may be used to collect the bituminous material until the full pressure of the distributor is obtained.

-3.11 Spreading Key Rock. Immediately after the application of the bituminous material, key rock in the amount of 25 pounds per square yard shall be spread evenly over the surface to fill the voids nearly to the surface. The key rock shall be added in small amounts as may be most effective while the rolling continues until the coarse aggregate is filled and keyed firmly. The surface shall then be rolled, care being taken that the rolling start while the surface is still warm, until the bituminous material is set up and the whole work is rolled to refusal and has become bonded to form a stable pavement. The time, extent and manner of rolling shall be subject to the direction of the engineer.

Continuous care shall be taken in spreading this material to insure uniformity of surface. Sweeping the surface with push brooms, or broom dragging, shall be resorted to if in the opinion of the engineer it is necessary. No key rock shall be distributed over any portion of the coarse aggregate which has not received the first application of bituminous material and in no case shall the key rock be dumped directly on either the treated or untreated coarse aggregate.

-3.12 Second Application of Bituminous Material. After the work has been rolled to refusal, the pavement shall be swept clean of all loose material and treated with a second application of bituminous material under the same conditions and in the same manner as specified above except that the application shall be in the amount of 0.30 gallon per square yard, or as directed by the engineer. The bituminous material when applied to the upper course of stone shall have a temperature of not less than 300°F. nor more than 350°F. for asphalt, and not less than 200°F. nor more than 275°F. for tar. The contractor shall not allow the bituminous material to be overheated or burned. After the second application of bituminous material, key rock or mineral chips, as ordered, shall be spread evenly in the amount of 15 pounds per square yard, and rolled to refusal.

-3.13 Supplemental Stockpiles. Crushed stone for supplemental stockpiles shall be furnished by the contractor in the amount of 10 pounds per square yard of the course. It shall consist of mineral chips and shall be of the same quality specified for use in the surface course. It shall be piled neatly on the side of the road at such points as may be designated by the engineer.

-3.14 Testing Surface. The finished surface of the bituminous macadam shall conform so nearly to that required by the plans that it will nowhere vary more than 3/8-inch when tested with a 10-foot straightedge applied to the surface parallel to the center line of the pavement or from a templet conforming with the cross section shown on the plans. In making this test the straightedge shall be advanced by increments of half its length, measurements shall be taken of the greatest space found between its lower edge and the pavement surface which at no point shall exceed 3/8-inch. The entire road shall be thus tested at the center line and the quarter and third points, and elsewhere as ordered. Such portions of the completed pavement as are defective in finish, compression, or composition or that do not comply in all respects with the requirements of these specifications shall be taken up, removed and replaced with suitable material properly laid in accordance with these specifications.

If at any time before the work is accepted any soft or imperfect places or spots shall develop in the surface, all such places shall be removed and replaced with new material and then rolled until compacted thoroughly and until the joints or edges at which the new work connects with the old become invisible. All such removal and replacing of unsatisfactory surfacing shall be done at the expense of the contractor.

-4.1 Method of Measurement. The tonnage to be paid for shall be the number of tons of aggregate of all gradings furnished and placed in the macadam, together with that placed in supplemental stockpiles.

If local stone or stone not shipped by rail is used it shall be weighed on scales furnished by and at the expense of the contractor. Said scales shall be sealed at the expense of the contractor as often as is necessary to insure their accuracy.

If the stone is shipped by rail or trucks, the actual car weights or quarry weights may be accepted, but scales shall be used as above, if so directed. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous materials to be paid for shall be the number of gallons, measured at 60°F., or converted to this temperature in accordance with A.S.T.M. D206-34 and actually used as ordered in the accepted work.

-5.1 Basis of Payment. The tonnage and gallonage, determined as provided above, shall be paid for at the contract unit prices per ton bid for "E-1 Penetration Macadam" and per gallon bid for "E-1 Bituminous Material (asphalt)" or "E-1 Bituminous Material (tar)," as the case may be, which prices and payments shall constitute full compensation for furnishing all material, for hauling, placing, rolling, for applying bituminous material and finishing and for all labor, equipment, tools and incidentals necessary to complete the item.

Class E-2 Bituminous Pavements

## 133 TYPE EM FOUR APPLICATION MACADAM PAVEMENT (Emulsified Asphalt)

133-1.1 Description. This item shall consist of a pavement composed of a total of 290 pounds of crushed stone per square yard, placed in successive graduated spreads and four penetration applications of emulsified asphalt in the amount per square yard ordered, and shall be constructed on the approved completed choked and bonded stone, or similar, base course in accordance with these specifications and in conformity with the lines, grades and typical cross section shown on the plans.

-1.2 The sequence of operations, and the amount of material in each, shall be in accordance with the following Table I. At the start of and during progress of the work, the weights of materials in the individual operations shall be varied and adjusted as ordered by the engineer in writing but the total weight per square yard of mineral aggregate, including supplemental stock piles, in all cases shall be as stated above. The gallons of bituminous material in the individual operations and/or in the total pavement shall be varied and adjusted as ordered by the engineer in writing either at the start of operations or during progress of the work.

TABLE I

| | Amounts per Square Yard | | | | |
|---|---|---|---|---|---|
| | Bit. Material Gal. | Coarse Aggregate | Choker Stone | Filler Aggregate | Mineral Chips |
| First Spreading | | 200 lb. | | | |
| Second Spreading | | | 15 lb. | | |
| First Application | 1.25 | | | | |
| Third Spreading | | | | 15 lb. | |
| Second Application | 1.00 | | | | |
| Fourth Spreading | | | | | 10 lb. |
| | | Liquid Seal and Cover | | | |
| Third Application | 0.20 | | | | |
| Fifth Spreading | | | | 25 lb. | |
| Fourth Application | 0.20 | | | | |
| Sixth Spreading | | | | | 15 lb. |
| Supplemental Stock-piles | | | | | 10 lb. |
| Totals | 2.65 | | | | 290 lb. |

-2.1 Materials. The aggregate shall be crushed stone. Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter.

The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

The crushed stone furnished respectively for "Coarse Aggregate," "Choker Stone," "Filler Aggregate" and "Mineral Chips" shall all be produced from the same source and shall meet the respective requirements for abrasion and toughness using A.A.S.H.O. Methods T-3 and T-5, specified in Table II and the grading requirements using A.A.S.H.O. Method T-27, specified in Table III.

TABLE II

| Percentage of wear (T-3) not more than | 6 | Toughnes (T-5) not less than | 6 |
|---|---|---|---|

TABLE III

| | Coarse Aggregate | Choker Stone | Filler Aggregate | Mineral Chips |
|---|---|---|---|---|
| | 2-inch | Half-inch | 1-inch | Three-eighths |
| | Percent Passing - Square Openings | | | |
| 2 inch | 100 | | | |
| 1-1/2 inch | 35-70 | | | |
| 1 inch | 0-15 | | 100 | |
| 3/4 inch | | | 90-100 | |
| 1/2 inch | | 100 | | |
| 3/8 inch | | 90-100 | 0-15 | 100 |
| No. 4 | | 0-25 | | 90-100 |
| No. 8 | | 0-5 | | 0-15 |

-2.2 Bituminous Material. The bituminous material furnished under this specification shall be an emulsified asphalt.

Those materials only which have been demonstrated by service tests as satisfactory for the intended use will be acceptable. Only one kind, type and grade of material shall be used in any one contract.

The emulsified asphalt shall be homogeneous and shall show no separation of asphalt at the time of use, provided that separation has not been caused by freezing after delivery, and provided further that this requirement shall not apply if the material is held more than 30 days and when tested using A.A.S.H.O. Method T-59 shall meet the following requirements:

Emulsified Asphalt

| | Minimum | Maximum |
|---|---|---|
| Viscosity, Furol at 77°F. | 20 | 100 |
| Settlement, 5-day | | 3% |
| Demulsibility, using 35 ml. 0.02 N. $NaCl_2$ solution | 50% | 100% |
| Sieve Test | | 0.20% |
| Residue by Distillation | 55% | 60% |
| Pene. of Residue | 100 | 200 |
| Soluble Residue ($CS_2$) | 95% | |
| Ash | | 2% |
| Ductility of Residue | 40 | |
| Specific Gravity | 1.00 | |
| Temp. of Application °F. | 60 | 120 |

-2.3 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed.

A sample of the emulsified asphalt that the contractor proposes to use in his work taken from not less than a 20,000 gallon lot of factory material, together with a statement as to its source and character and the crude petroleum from which manufactured must be submitted and approved before use of the material begins. No emulsified asphalt other than that represented by the sample submitted and approved shall be used.

-2.4 Field Laboratory. The contractor shall provide a field laboratory in which to house and use the testing equipment. This laboratory is to be maintained for the exclusive use of the engineer and inspectors, and shall be located in accordance with the engineer's instructions.

-3.1 Construction Methods. Performance methods employed and all equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory thereafter shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

-3.2 The equipment outfit used by the contractor shall be made up of suitable units including tractor-drawn or motor bladers, approved distributors and rollers, supplemented by spreading and smoothing apparatus, long base maintainers, steel brush or broom drag, and other necessary equipment designed and operated to avoid causing, as well as to remedy, corrugations and irregularities and to produce a true riding surface of uniform texture.

-3.3 Tank wagons and trucks used for the transportation or application of bituminous material shall have either a steam or air-kerosene, or equivalent, system for the cleaning of lines and pumps. Distributors used in applying bituminous material shall have tires of sufficient width that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire. Pneumatic dual tires are required, except that for reasonable cause the engineer by written order may waive this particular requirement.

-3.4 Distributors shall be equipped with suitable manifold and other appliances so designed as to distribute evenly the material specified with an effective positive control at all times. Sufficient and proper screens shall be installed between the tank and the nozzles, and the same shall be cleaned frequently to prevent clogging of the nozzles.

The distributor shall be so designed as to keep a constant and uniform pressure upon the bituminous material as it passes through the nozzles, and shall be equipped with devices and charts to provide at all times for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface. Distributors shall be equipped with approved thermometers reading temperature of tank contents and tachometers reading speeds in feet per minute.

All self-powered distributors or trucks or other hauling units shall have sufficient power to maintain a constant and uniform speed over the aggregate under all construction conditions. The equipment shall be so designed and articulated that uniform application of bituminous material may be made in controlled amounts, ranging from 0.05 to 2.0 gallons per square yard of surface and at pressures of 20 to 75 pounds per square inch and to a width of at least 15 feet.

-3.5 Rollers. All rolling required by this specification shall be done with 3-wheel power rollers weighing not less than 10 tons with a compression on the rear wheels of at least 300 pounds per lineal inch of tire width. A sufficient number of rollers shall be furnished on the work to provide one roller for each 200 tons of macadam laid per 8-hour day. The rear wheels shall be cylinders rolling about a common axis.

-3.6 Conditioning of Existing Base Course. The base course upon which this pavement is to be constructed shall be swept thoroughly clean and, in case of a waterbound base course, in such manner as to expose embedded aggregate to a depth of not more than 1/4-inch. This sweeping shall be done within 500 feet immediately in advance of spreading.

Except where there are curbs or headers before placing any aggregate the shoulders shall be constructed to the height of the finished pavement and of a width sufficient to carry the roller. The shoulders shall be true to alignment.

-3.7 Spreading Coarse Aggregate. Upon this conditioned base course the coarse aggregate shall be spread in the amount of 200 pounds per square yard. It shall be spread by means of approved stone spreaders or by other approved mechanical methods. Where there are no suitable concrete curbs, gutters or other equivalent guides, edge liners or side forms shall be set having a base width of not less than three inches and of the height of the loose material involved for the given weight per square yard. The forms shall be securely fastened together at their ends and shall be securely staked in such manner that there shall be no deviation greater than 1/2-inch horizontally from the line and that a true grade will be formed parallel to the profile grade shown on the plans. A testing templet cut to the crown of the finished course and resting on the side forms shall be furnished by the contractor and used to assure uniformity of depth and trueness of profile and crown. The side forms shall be backed with earth or other suitable material on the berm side, to a width of not less than two feet. After the coarse aggregate has been spread and before rolling, the side forms may be removed. The channel thus created between the aggregate spread and the earth backing shall be filled with earth or other suitable material which will compact to the final height of the course. Under the direction of the engineer the spread shall be lightly dragged with the long base drag so manipulated as to improve the uniformity and regularity of the work. Such drag shall be at least 15 feet long.

Any thin, flat or oversized aggregate that appears on the surface at any time during the process of construction shall be removed therefrom. The coarse aggregate shall have a uniform distribution of size and all patches or areas of fine or undersized material shall be removed and replaced with suitable material before dragging and rolling. This correction shall be accomplished by hand picking wherever ordered and shall be continued after the initial rolling until the appearance and texture are uniform and all ridges are removed.

-3.8 Rolling. The coarse aggregate shall be dry rolled until the aggregate is compacted and keyed together. Rolling shall start at the side and progress toward the center parallel with the center line of the roadway, uniformly lapping each preceding track by at least 1/2 of the width of a rear wheel and continuing until the material does not creep or wave ahead of the roller. The rolling shall stop before the voids are closed enough to prevent free and uniform penetration of the bituminous material; any irregularities greater than 3/8-inch in 10 feet or greater than 1/2-inch when tested with an 18-foot straightedge applied parallel to the center line of the pavement shall be loosened and reshaped with the same size and kind of material as that of which this course is constructed, and again rolled as required above. Material which crushes under the roller so as to prevent the free and uniform penetration of the bituminous material shall be removed and replaced by suitable material. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade and shall present a texture which will allow of uniform penetration of the bituminous material.

Along curbs, headers and other structures, and all places not accessible to the roller, the course shall be thoroughly tamped with machine or hand tampers. Hand tampers shall weigh not less than 50 pounds and shall have a face area of not more than 100 square inches.

Any aggregate in this or any subsequent spread which becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed, replaced with clean aggregate and rerolled.

-3.9 Spreading Choker Stone. After the coarse aggregate has been spread and compacted, choker stone, in the amount of 15 pounds per square yard, shall be spread by mechanical equipment so as to fill the voids in the coarse layer to within approximately one inch of the surface thereof and shall be lightly broomed and, if ordered by the engineer, rolled lightly.

After the coarse aggregate has been spread, choked and rolled and prior to applying the bituminous material, test holes shall be dug in each 200 linear feet of pavement to determine the depth of aggregate in place, which shall be measured and recorded carefully for purposes of information. Three test holes shall be dug along a transverse section selected by the engineer in each and every successive 200-foot section. On the first 200-foot section and for each alternating 200-foot length thereafter, one test hole shall be dug at the center of the pavement and one on each side approximately 6 inches from the edges. On the remaining 200-foot sections one test hole shall be dug at the center and one on each side at the quarter points. These alternating series shall be continued throughout the length of the job. The Government also reserves the right to make such additional tests of the completed spread as may be deemed necessary to satisfy the engineer that the requirements as to uniformity of thickness have been fulfilled.

The test holes shall be dug and refilled by the contractor under the direct supervision of the inspector, which work shall be considered as included in the contract unit price for the pavement.

-3.10 First Application of Bituminous Material. Over the clean surface of the coarse aggregate, "choked" as required above, an application of the emulsified asphalt, warmed if necessary, shall be made in the amount of 1.25 gallons per square yard of surface unless increased by written order. No bituminous material shall be applied unless the atmospheric temperature is at 40°F., or above, and in no case shall bituminous material be applied when conditions do not permit satisfactory penetration and adhesion. If the condition of the aggregate is such that dampening is deemed advantageous by the engineer, and upon his order, the course shall be sprinkled and any marks left by wheels of sprinkling apparatus shall be removed before the application of the bituminous material. When the atmospheric temperature is between 40°F. and 65°F. the temperature of the asphalt as it is being applied shall be not less than 100°F.

The bituminous material shall be distributed over the surface by approved pressure distributors operating under a pressure at the nozzles of 20 to 75 pounds per square inch, as may be directed. The length of road treated before covering shall be gaged according to the labor and equipment on hand for doing the work and as regulated by the engineer.

In order to insure uniform distribution at the junction of two loads, when the last of any load starts to thin, distribution shall be shut off, and upon resuming distribution building paper shall be spread over the latter portion of the previous application and the distributor shall lap back over this paper sufficiently to start the sprayers full force when the uncovered surface is reached. This building paper shall then be removed and destroyed. If building paper is not available a trough or other equivalent accessory may be used to collect the bituminous material until the full pressure of the distributor is obtained.

-3.11 Spreading Filler Aggregate. After the emulsified asphalt has broken and attained sufficient tackiness, 15 pounds of filler aggregate per square yard shall be spread uniformly over the penetrated area to fill the remaining voids, broom dragged and rolled thoroughly. In general, unless otherwise ordered, this spreading shall be accomplished by a powered mechanical spreader. The filler aggregate shall be added in small amounts as may be most effective while the rolling continues until the coarse aggregate is filled and keyed firmly. No filler aggregate shall be distributed over any portion of the work which has not received the first application of bituminous material and in no case shall the filler aggregate be dumped directly on either the treated or untreated aggregate.

-3.12 Second Application. There shall be an elapsed time of at least 8 hours between the first and second application unless otherwise directed by the engineer. A second application of asphalt emulsion shall be applied under the same conditions and in the same manner prescribed above, in the amount of 1-1/4 gallons to each square yard of surface area previously penetrated.

-3.13 Spreading Chips. After the above application of emulsion has "broken" and attained sufficient tackiness, the surface shall be uniformly covered with mineral chips in the amount of 10 pounds per square yard and broom dragged. Rolling shall progress during the broom dragging and be continued until the pavement is compacted thoroughly and uniformly.

The mineral chips shall be added in small amounts while the rolling continues. Brooms shall be used in distributing the material and only a quantity sufficient for filling the voids shall be spread and any excess shall be avoided. Before the rolling proceeds, any surplus bituminous material on the shoulders shall be removed in order to permit rolling the shoulders in conjunction with the surface. The surface shall then be rolled until the bituminous binder and the whole work is rolled to refusal and has become bonded to form a stable pavement. The time, extent and manner of rolling shall be subject to the direction of the engineer. Care shall be taken in spreading this material to secure uniformity of surface. Sweeping the surface with push brooms shall be resorted to if, in the opinion of the engineer, it is necessary.

-3.14 First Seal Coat. Not less than 24 hours after the surface has been compacted as above, it shall be swept clean and a seal coat of approximately 0.20 of a gallon of emulsified asphalt per square yard of surface area shall be applied. As soon as the emulsion "breaks" it shall be uniformly covered with clean filler aggregate in the amount of 25 pounds per square yard, so as to take up all excess bituminous material, after which it shall be broom dragged and rolled. If the chips show excessive crushing under the roller, the engineer may order this rolling to be omitted.

-3.15 Second Seal Coat. Before traffic is allowed over the first seal coat, a second seal coat of approximately 1/5 of a gallon of emulsified asphalt per square yard of surface area shall be applied. Before the emulsion "breaks" it shall be uniformly covered with clean stone chips in the amount of 15 pounds per square yard so as to take up all excess bituminous material, after which it shall be broomed with a broom drag and thoroughly rolled. The finished surface shall be uniform and shall conform to the grades and cross sections given.

-3.16 Supplemental Stockpiles. Mineral chips for supplemental stockpiles shall be furnished by the contractor in the amount of 10 pounds per square yard of completed pavement. These mineral chips shall be of the same quality specified for use in the surface course. They shall be neatly piled on the side of the road at such points as may be designated by the engineer.

-3.17 Testing Surface. The finished surface of the bituminous macadam pavement shall conform so nearly to that required by the plans that it will nowhere vary more than 1/4-inch when tested with a 10-foot straightedge applied to the surface parallel to the center line of the pavement or from a templet conforming to the cross section shown on the plans. In making the test, the straightedge shall be advanced by increments of 1/2 its length and measurements shall be taken of the greatest space found between its lower edge and the pavement surface; such measurements at no point shall exceed 1/4-inch. The entire pavement shall be thus tested at the center line and the quarter and third points, and elsewhere as ordered. Such portions of the completed pavement as are defective in finish, compression, or composition or that do not comply in all respects with the requirements of these specifications shall be taken up, removed and replaced with suitable material properly laid in accordance with these specifications.

If at any time before the work is accepted any soft or imperfect places or spots shall develop in the surface, all such places shall be removed and replaced with new material and then rolled until compacted thoroughly and until the joints or edges at

which the new work connects with the old becomes invisible. All such removal and replacing of unsatisfactory surfacing shall be done at the expense of the contractor and the additional tonnage involved shall not be included in the pay tonnage.

-4.1 Method of Measurement. The tonnage to be paid for shall be the number of tons of aggregate of all gradings furnished and placed in the pavement, together with that in supplemental stockpiles.

If local stone or stone not shipped by rail is used it shall be weighed on scales furnished by and at the expense of the contractor. Said scales shall be sealed at the expense of the contractor as often as is necessary to insure their accuracy.

If the stone is shipped by rail or trucks, the actual car weights or quarry weights may be accepted, but scales shall be used as above, if so directed. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous material to be paid for shall be the number of gallons, measured at 60°F., or converted to this temperature in accordance with A.S.T.M. D206-34 and actually used as ordered in the accepted work.

-5.1 Basis of Payment. The tonnage and gallonage, determined as provided above, shall be paid for at the contract unit prices per ton bid for "EM Four Application Macadam" and per gallon bid for "EM Penetration Emulsified Asphalt," which prices and payments shall constitute full compensation for furnishing all material, hauling, placing, rolling, for applying bituminous material and finishing, and for all labor, equipment, tools and incidentals necessary to complete the item.

Class E-2 Bituminous Pavements

## 134 TYPE BO FOUR APPLICATION MACADAM PAVEMENT (Hot Asphalt)

134-1.1 Description. This item shall consist of a pavement composed of a total of 290 pounds of crushed stone per square yard placed in successive graduated spreads and four penetration applications of bituminous material in the amount per square yard ordered, and shall be constructed on the approved completed choked and bonded stone, or similar, base course in accordance with these specifications and in conformity with the lines, grades and typical cross section shown on the plans.

-1.2 The sequence of operations, and the amount of materials in each, shall be in accordance with the following Table I. At the start of and during progress of the work, the weights of materials in the individual operations shall be varied and adjusted as ordered by the engineer in writing but the total weight per square yard of mineral aggregate, including supplemental stockpiles, in all cases shall be as stated above. The gallons of bituminous material in the individual operations and/or in the total pavement shall be varied and adjusted as ordered by the engineer in writing either at the start of operations or during progress of the work.

TABLE I

| | Amounts per Square Yard | | | | |
|---|---|---|---|---|---|
| | Bit. Material Gal. | Coarse Aggregate | Key Rock | Mineral Chips | Screenings |
| First Spreading | | 200 lb. | | | |
| First Application | 1.10 | | | | |
| Second Spreading | | | 24 lb. | | |
| Second Application | 0.20 | | | | |
| Third Spreading | | | | 18 lb. | |
| | Liquid Seal and Cover | | | | |
| Third Application | 0.30 | | | | |
| Fourth Spreading | | | | | 12 lb. |
| Fourth Application | 0.30 | | | | |
| Fifth Spreading | | | | 18 lb. | |
| Sixth Spreading | | | | | 8 lb. |
| Supplemental Stockpiles | | | | 10 lb. | |
| Totals | 1.90 | | | | 290 lb. |

-2.1 Materials. The aggregate shall be crushed stone. Crushed stone shall consist of clean, hard, tough, durable fragments, reasonably free from flat, elongated, soft or disintegrated pieces, dirt or other objectionable matter.

The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

The crushed stone furnished respectively for "Coarse Aggregate," "Key Rock," "Mineral Chips" and "Screenings" shall all be produced from the same source and shall meet the respective requirements for abrasion and toughness using A.A.S.H.O. Methods T-3 and T-5, specified in Table II and the grading requirements using A.A.S.H.O. Method T-27 specified in Table III.

TABLE II

| | | | |
|---|---|---|---|
| Percentage of wear (T-3) not more than | 6 | Toughness (T-5) not less than | 6 |

TABLE III

| | Coarse Aggregate | Key Rock | Mineral Chips | Screenings |
|---|---|---|---|---|
| | 2-inch | 1-inch | 1/2-inch | No. 4 |
| | Square Openings - Percent Passing | | | |
| 2 inch | 100 | | | |
| 1-1/2 inche | 35-70e | | | |
| 1 inche | 0-15e | 95-100 | | |
| 3/4 inche | | | 100 | |
| 1/2 inche | | 0-15 | 95-100 | |
| No. 4 | | | 0-5 | 95-100 |
| Dust | | | | Removede |

-2.2 Bituminous Material. The hot bituminous material furnished under this specification shall be an asphalt prepared from the distillation of asphaltic petroleum.

Those materials only which have been demonstrated by service tests as satisfactory for the intended use will be acceptable. Only one kind, type and grade of material shall be used in any one contract.

The asphalt shall be homogeneous, free from water, shall not foam when heated toe 347°F. and shall meet the following requirements:

| Designation | A.A.S.H.O. Test | AP-1 Min. | AP-1 Max.e |
|---|---|---|---|
| Specific Gravitye | T-43e | 1.000e | |
| Flash Point °F. | T-48 | 347 | |
| Softening Point °F.e | T-53 | 95 | 131e |
| Penetration | T-49 | 120 | 150e |
| Bitumen $CS_2$ | T-44 | 99.5% | |
| (a) Organic insolse | | | 0.2% |
| Loss at 325°F. | T-47 | | 1% |
| (a) Pene. Drop | T-49 | | 40% |

Petroleum asphalt for any one contract shall not vary more than 0.020 in specific gravity nor more than 18°F. in softening point within the test limits above specified. Noe mineral matter other than that naturally contained in the asphalt shall be present.

Cut-back asphalt for seal shall be RC-2 or RC-3 as prescribed for "Heavy Armor Coat" or emulsified asphalt as prescribed for seal for "Type EM Four Application Macadam Pavement."e

-2.3 Sources of Supply. Approval of sources of supply of the mineral aggregate shalle be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed.

A sample of the asphalt that the contractor proposes to use in his work, together with a statement as to its source, character and the crude petroleum from which manufacturede must be submitted and approved before use of the materials begins. No asphalt other than that represented by the sample submitted and approved shall be used.

-2.4 Field Laboratory. The contractor shall provide a field laboratory in whiche to house and use the testing equipment. This laboratory is to be maintained for the exclusive use of the engineer or inspectors, and shall be located in accordance with the engineer's instructions.

-3.1 Construction Methods. Performance methods employed and all equipment, tools and machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory hereafter shall be changed and improved as required by the engineer. All equipment, tools and machinery used must be maintained in a satisfactory working condition.

-3.2 The equipment outfit used by the contractor shall be made up of suitable unitse including long base tractor-drawn or motor bladers, approved distributors and rollers, supplemented by spreading and smoothing apparatus, long base maintainers, steel brush or

broom drag, and other necessary equipment designed and operated to avoid causing, as well as to remedy, corrugations and irregularities and to produce a true riding surface of uniform texture. If directed by the engineer broom drags shall be furnished in two weights, the heavier for the coarse and the lighter for use with the screenings.

-3.3 The heating equipment supplied shall be of adequate capacity to heat properly the bituminous material. Heating of cars, tanks or distributors must be accomplished without introducing steam or moisture into the bituminous material. The use of any agitating accessory to aid in the heating will be prohibited if, in the opinion of the engineer, it injures or in any way changes the characteristics of the bituminous material. Any heating system or accessory which results in coking or burning of the material shall be the cause for disapproval of the equipment. Approved thermometers shall be supplied by the contractor.

-3.4 Tank wagons and trucks used for the transportation or application of bituminous material shall have either a steam or air-kerosene, or equivalent, system for the clearing of lines and pumps. Evidence of fluxing with kerosene or emulsification by steam shall be sufficient cause for rejection of the delivery. Distributors shall have tires of sufficient width that the load produced on the road surface shall be not greater than 650 pounds per inch width of tire. Pneumatic dual tires are required, except that for reasonable cause the engineer by written order may waive this particular requirement.

-3.5 Distributors shall be equipped with suitable manifold and appliances so designed as to distribute evenly heated material at the temperature specified with an effective positive control of the heating and temperature at all times. Sufficient and proper screens shall be installed between the tank and the nozzles, and the same shall be cleaned frequently to prevent clogging of the nozzles. Distributors shall be provided with an auxiliary water tank and with an auxiliary set of nozzles for the water soap or water spray, one nozzle opposite every other oil spray nozzle and arranged to discharge just ahead of the line of oil spray nozzles, or an equivalent accessory.

The distributor shall be so designed as to keep a constant and uniform pressure upon the bituminous material as it passes through the nozzles and shall be equipped with devices and charts to provide at all times for accurate and rapid determination and control of the amount of bituminous material being applied per square yard of surface. Distributors shall be equipped with thermometers reading temperature of tank contents and tachometers reading speeds in feet per minute.

All self-powered distributors or trucks or other hauling units shall have sufficient power to maintain a constant and uniform speed over the aggregate. The equipment shall be so designed and articulated that uniform application of bituminous material may be made in controlled amount, ranging from 0.05 to 1.5 gallons per square yard of surface and to a width of at least 15 feet and pressures from 25 to 75 pounds per square inch.

-3.6 Rollers. All rolling required by this specification shall be done with 3-wheel power rollers weighing not less than ten tons, with a compression on the rear wheels of at least 300 pounds per lineal inch of tire width. A sufficient number of rollers shall be furnished on the work to provide one roller for each two hundred tons of macadam laid per eight-hour day. The rear wheels shall be cylinders rolling about a common axis.

-3.7 Conditioning of Existing Base Course. The base course upon which this pavement is to be constructed shall be swept thoroughly clean and, in case of a water-bound base course, in such manner as to expose the embedded aggregate to a depth of not more than 1/4 inch. This sweeping shall be done within 500 feet immediately in advance of spreading.

Except where there are curbs or headers and before placing any aggregate, the shoulders shall be constructed to the height of the finished pavement and of a width sufficient to carry the roller. The shoulders shall be true to alignment.

-3.8 Spreading Coarse Aggregate. Upon this conditioned base course the coarse aggregate shall be spread in the amount of 200 pounds per square yard. It shall be spread by means of approved stone spreaders or by other approved mechanical methods. Where there are no suitable concrete curbs, gutters or other equivalent guides, edge liners or side forms shall be set having a base width of not less than three inches and of the height of the loose material required for the given weight per square yard. The forms shall be securely fastened together at their ends and shall be securely staked in such manner that there shall be no deviation greater than 1/2 inch horizontally from the line and that a true grade will be formed parallel to the profile grade shown on the plans. A testing templet cut to the crown of the finished course and resting on the side forms shall be provided by the contractor and used to secure uniformity of depth and

trueness of profile and crown. The side forms shall be backed with earth or other suitable material on the berm side to a width of not less than 2 feet. After the coarse aggregate has been spread and before rolling, the side forms may be removed. The channel thus created between the aggregate spread and the earth backing shall be filled with earth, or other approved material, which will compact to the final height of the course. Under the direction of the engineer the spread shall be lightly dragged with the long base drag so manipulated as to improve the uniformity and regularity of the work. Such drag shall be at least 15 feet long.

Any thin, flat or oversized aggregate that appears on the surface at any time during the process of construction shall be removed therefrom. The coarse aggregate shall have a uniform distribution of sizes and all patches or areas of fine or undersized material shall be removed and replaced with suitable material before rolling. This correction shall be accomplished by hand picking wherever ordered and shall be continued after the initial rolling until the appearance and texture are uniform and all ridges are removed.

-3.9 Rolling. The coarse aggregate shall be dry rolled until the aggregate ise compacted and keyed together. Rolling shall start at the side and progress toward the center parallel with the center line of the roadway, uniformly lapping each preceding track by at least 1/2 of the width of a rear wheel and continuing until the material does not creep or wave ahead of the roller. The rolling shall stop before the voids are closed enough to prevent free and uniform penetration of the bituminous material; any irregularities of surface greater than 3/8 inch in ten feet or greater than 1/2 inch in 18 feet when tested with a straightedge applied parallel to the center line of the pavement shall be loosened and reshaped with the same size and kind of material as that of which this course is constructed, and again rolled as required above. Material which crushes under the roller so as to prevent the free and uniform penetration of the bituminous material shall be removed and replaced by suitable material. The compacted coarse aggregate shall present a firm, even surface, true to the cross section shown on the plans and parallel to the finished grade and shall present a texture which will allow of uniform penetration of the bituminous material.

Along curbs, headers and other structures and all places not accessible to the roller, the course shall be thoroughly tamped with machine or hand tampers. Hand tampers shall weigh not less than 50 pounds and shall have a face area of not more than 100 square inches.

Any aggregate in this or any subsequent spread which becomes coated or mixed with dirt or clay prior to the application of the bituminous material shall be removed, replaced with clean aggregate and rerolled.

After the stone has been spread and rolled and prior to applying any bituminous material, test holes shall be dug in each 200 linear feet of pavement to determine the depth of aggregate in place, which shall be measured and recorded carefully for purposes of information. Three test holes shall be dug along a transverse section selected by the engineer in each and every successive 200-foot section. On the first 200-foot section and for each alternating 200-foot section thereafter, one test hole shall be dug at the center of the pavement and one on each side approximately 6 inches from the edges. On the remaining 200-foot section the test hole shall be dug at the center and one on each side at the quarter points. These alternating series shall be continued throughout the length of the job. The Government also reserves the right to make such additional tests of the completed spread as may be deemed necessary to satisfy the engineer that the requirements as to uniformity of thickness have been fulfilled.

The test holes shall be dug and refilled by the contractor under the direct supervision of the inspector, which work shall be considered as included in the contract unit price per ton of pavement.

-3.10 First Application of Bituminous Material. Over the clean surface of thee coarse aggregate placed as required above, an application of hot bituminous material heated to not less than 300°F. nor more than 350°F. for asphalt shall be made in the quantity of 1.10 gallons per square yard of surface unless increased by written order. No bituminous material shall be applied unless the entire depth of the course is thoroughly dry and the atmospheric temperature is at 40°F. or above, and in no case shall bituminous material be applied when conditions do not permit satisfactory penetration and adhesion.

The hot bituminous material shall be distributed over the surface by approved pressure distributors operating under a pressure at the nozzles of 25 to 75 pounds per square inch as may be directed. The length of road treated before covering shall be gaged according to the labor and equipment on hand for doing the work and as regulated by the engineer.

In order to insure uniform distribution at the junction of two loads, when the last of any load starts to thin, distribution shall be shut off and upon resuming distribution building paper shall be spread over the latter portion of the previous application and the distributor shall lap back over this paper sufficiently to start the sprayers full force when the uncovered surface is reached. This building paper shall then be removed and destroyed. If building paper is not available a trough or other equivalent accessory may be used to collect the bituminous material until the full pressure of the distributor is obtained.

-3.11 Spreading Key Rock. Immediately after the application of the hot bituminous material, key rock in the amount of 24 pounds per square yard shall be spread thinly over the surface as will completely fill the voids in the previous surface. In general, unless otherwise ordered, this spreading shall be accomplished by a powered mechanical spreader. If so directed the key rock shall be added in small amounts, or increments, as may be most effective while the rolling continues until the coarse aggregate is filled and keyed firmly. The surface shall then be rolled, care being taken that the rolling starts while the surface is still warm, until the bituminous binder is set up and the whole work is rolled to refusal and has become bonded to form a stable pavement. The time, extent and manner of rolling shall be subject to the direction of the engineer.

Continuous care shall be taken in spreading this material to secure uniformity of surface texture. Sweeping the surface with push brooms or broom dragging shall be resorted to if in the opinion of the engineer it is necessary. No key rock shall be distributed over any portion of the coarse aggregate which has not received the first application of bituminous material and in no case shall the key rock be dumped directly on either the treated or untreated coarse aggregate.

-3.12 Second Application of Bituminous Material. After completion of the above operation the key rock has been rolled, the pavement shall be swept clean of all loose material and treated with a second application of hot bituminous material under the same conditions and in the same manner as specified for the first application above except that the rate of application shall be 0.20 gallons per square yard, as directed by the engineer. Bituminous material when applied shall have a temperature of not less than 300°F. nor more than 350°F. for asphalt. The contractor shall not allow the bituminous material to be overheated or burned. Bituminous material shall be applied only under weather conditions as required for the first application.

-3.13 Spreading Chips. Immediately after the above application mineral chips in the amount of 18 pounds per square yard shall be spread evenly over the surface by suitable mechanical equipment including broom dragging as directed. The spreading of the mineral chips shall be followed by a thorough rolling and brooming of the course. The rolling shall be continued until the interstices are filled and the course is solidly keyed and compacted. A portion of the mineral chips may be reserved until after the initial passage of the roller and then spread over the surface and the course again broomed and rolled, the brooming and rolling being continued until the voids in the surface are uniformly filled and until the surface is of uniform texture throughout.

The chips are to be added in only such quantities as are required to fill the interstices in the coarser rock. They should not be added in quantities sufficient to form a mat or separate course on top of the coarser rock, and, if so added by mistake, the excess materials shall be removed by blading and brooming.

-3.14 Seal Coat. The surface of the work shall be swept clean. Hot bituminous material shall be applied at a rate of 0.30 gallons per square yard and while still hot, screenings shall be spread over the surface in the amount of 12 pounds per square yard and the surface broomed and rolled.

After the first course of the seal coat has been applied in the manner above described, the pavement shall be subjected to traffic for a period of about two weeks. After that period has elapsed, the surface shall be swept clean. Following this, there shall be applied emulsified asphalt or heavy cut-back asphalt, whichever is required by the Bid Schedule, in the amount of 0.30 gallons per square yard. The application of the bituminous material shall be followed immediately by mineral chips spread in the amount of 18 pounds per square yard. The surface shall then be broom dragged and rolled until the aggregate is bonded and the surface well compacted and of uniform texture. When this result is obtained screenings shall be spread over the surface in the amount of 8 pounds per square yard.

-3.15 Water or Water Soap Penetration Spray. In any application, where deemed of advantage by the engineer, and so ordered in writing, a water or water soap mixture shall be sprayed through the auxiliary nozzles or other auxiliary in the amount of 7 percent of the amount of bituminous material being spread. The liquid soap if ordered shall not exceed one percent of the water soap mixture.

-3.16 Supplemental Stockpiles. Chips for supplemental stockpiles shall be furnished by the contractor and shall be of the same quality used in the pavement. They shall be piled neatly on the side of the road at such points as may be designated by the engineer. The amount placed in these piles shall be at the rate of 10 pounds per square yard of completed pavement.

-3.17 Testing Surface. The finished surface of the bituminous macadam pavement shall conform so nearly to that required by the plans that it will nowhere vary more than 1/4 of an inch from a 10-foot straightedge applied to the surface parallel to the center line of the pavement or from a templet conforming with the cross section shown on the plans. In making this test the straightedge shall be advanced by increments of 1/2 its length, measurements taken of greatest space between its lower edge and the pavement surface, which shall at no point exceed 1/4 inch. The entire pavement shall be thus tested at the center line, and the quarter and third points and elsewhere as ordered. Such portions of the completed pavement as are defective in finish, compression or composition or that do not comply in all respects with the requirements of these specifications shall be taken up, removed and replaced with suitable material laid properly in accordance with these specifications.

If at any time before the work is accepted any soft or imperfect places or spots shall develop in the surface, all such places shall be removed and replaced with new material and then rolled until compacted thoroughly and until the joints or edges at which the new work connects with the old become invisible. All such removal and replacing of unsatisfactory surfacing shall be done at the expense of the contractor and the additional tonnage involved shall not be included in the pay tonnage.

-4.1 Method of Measurement. The tonnage to be paid for shall be the number of tons of aggregate of all gradings furnished and placed in the pavement together with that placed in the supplemental stockpiles.

If local stone or stone not shipped by rail is used it shall be weighed on scales furnished by and at the expense of the contractor. Said scales shall be sealed at the expense of the contractor as often as is necessary to insure their accuracy.

If the stone is shipped by rail or trucks, the actual car weights or quarry weights may be accepted, but scales shall be used as above, if so directed. The unit of measure shall be the ton of 2,000 pounds.

The gallonage of bituminous material to be paid for shall be the number of gallons, measured at 60°F., or converted to this temperature in accordance with A.S.T.M. D206-34 and actually used as ordered in the accepted work.

-5.1 Basis of Payment. The tonnage and gallonage, determined as provided above, shall be paid for at the contract unit prices per ton bid for "EO Four Application Macadam" and per gallon for "EO Asphalt," and "EO Cut-back Asphalt" or "EO Emulsified Asphalt," which prices and payments shall constitute full compensation for furnishing all material, for hauling, placing, rolling, for applying bituminous material and finishing and for all labor, equipment, tools and incidentals necessary to complete the item.

Class F Bituminous Pavements

## 140 TYPE F-1 DENSE GRADED PLANT MIX SURFACE COURSE

140-1.1 Description. This item shall consist of a surface course, composed of mineral aggregate mixed in a central plant with a medium or rapid curing cutback asphalt, constructed in accordance with these specifications and finished in conformity with the lines, grades and typical cross section shown on the plans, with a seal coat if so called for by the Bid Schedule. It shall be placed on a subgrade (or base) conditioned in accordance with the specifications for "Reconditioning of Used Roadbed" and "Bituminous Prime Coat."

-1.2 Master Grading. The mineral aggregate for the surface course shall be graded to meet the following primary course composition limits by weight, Grading A or Grading B, whichever is called for by the Bid Schedule. The seal coat aggregate shall meet the grading limits for cover aggregate as tabulated below.

| | Primary Course Grading A | Primary Course Grading B | Cover Aggregate |
|---|---|---|---|
| | Percent Passing - Square Openings | | |
| 1 inch | 100 | 100 | |
| 3/4 inch | 75-100 | 75-100 | |
| 1/2 inch | | | 100 |
| 3/8 inch | | | 90-100 |
| No. 4 | 35- 60 | 50- 75 | 0- 25 |
| No. 10 | 25- 50 | 35- 60 | 0- 5 |
| No. 40 | 15- 35 | 15- 45 | |
| No. 200 | 2- 10 | 5- 15 | 0- 2 |

-1.3 Job Grading. Within the above master grading requirements for "Primary Course" the grading of the job material furnished shall be held to a uniformity such that the fractions of aggregate passing the Numbers 4, 10 and 200 sieves will remain constant throughout any one 8-hour "run" within the following respective tolerances of variation from the average percent of the "run."

Material passing No. 4 sieve $\pm$ 5
Material passing No. 10 sieve $\pm$ 5
Material passing No. 200 sieve $\pm$ 2

Samples taken from the plant shall be tested for conformity with these requirements.

-1.4 Determination of Proportion of Bituminous Material. The amount of bituminous material used shall be as designated by the engineer. In arriving at the percent or proportion of bituminous material he will make use of the following formula with, however, such adjustments for surface characteristics, absorption and other special properties of the aggregate as in his judgment the job materials and special project conditions make necessary:

$$\frac{5P}{6} = .02a + 0.45b + \begin{cases} 0.15c \text{ for } 15\% & \text{passing No. 200} \\ 0.18c \text{ for } 10\% & \text{passing No. 200} \\ 0.20c \text{ for } 5\% \text{ or less} & \text{passing No. 200} \end{cases}$$

Wherein P = Percent of bituminous material by weight
a = Percent of aggregate retained on No. 10 sieve
b = Percent of aggregate passing No. 10 sieve and retained on the No. 200 sieve
c = Percent of aggregate passing No. 200 sieve

-2.1 Materials. Aggregate shall consist of screened gravel, crushed to size as necessary, or crushed stone, in either case composed of sound, tough, durable pebbles or fragments of rock and shall contain or have incorporated in it sand, stone dust or other inert finely divided mineral material, the whole meeting the grading requirements as set out in articles -1.2 and -1.3. If gravel is used not less than 50 percent of the material retained on the Number 4 sieve, as indicated by samples tested, shall have at least one fractured face.

Gravel shall have a percent of wear of not more than 20 for uncrushed pieces and not more than 30 for crushed pieces, using A.A.S.H.O. Method T-4, and stone present shall have a percent of wear of not more than 8, using A.A.S.H.O. Method T-3, and all material shall be free from clay balls and adherent films of clay or other matter that will prevent a thorough coating of the particles with a tenacious film of the bituminous material. Oversized gravel shall not be wasted but shall be crushed until graded to size. The aggregate shall be of such nature that when once thoroughly coated with the bituminous material proposed for the work the coating will not slough off upon contact with water.

The mineral aggregate shall have a swell of not more than 1.5 percent when subjected to the Swell Test.

That portion of the total aggregate passing the Number 40 sieve shall have a Plasticity Index of not more than 8 when determined by the physical tests as described in Public Roads, Vol. 12, No. 8, issue of October 1931.

Conformity of all material to the grading requirements hereinabove prescribed shall be determined by the Washed Mechanical Analysis performed in the following manner. The Swell Test and the Washed Mechanical Analysis shall each be made and the Plasticity Index determined as prescribed for "Type B-1 Dense Graded Road Mix Surface Course."

-2.2 Bituminous Material. The bituminous material to be used shall be one or more of the following described "Medium Curing Cut-back Asphalt," or "Rapid Curing Cut-back Asphalt" as called for in the Bid Schedule for the primary course and one of the following described "Rapid Curing Cut-back Asphalts" for the seal coat. The cut-back asphalt shall be composed of a suitable petroleum distillate and asphalt base. It shall be homogeneous and free from water. The particular grades shall be selected by the engineer from tables II and III given below and each shall meet the respective requirements set out in the table for that grade.

Table II Medium Curing Cut-back Asphalts

| Designation | A.A.S.H.O. | MC-3 | | MC-4 | | MC-5 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point, °F. | T-48 | 150 | | 150 | | 150 | |
| Viscosity, Furol | T-72 | | | | | | |
| at 140°F., sec. | | 300 | 500 | 500 | 800 | | |
| 180°F., sec. | | | | | | 170 | 280 |
| Total Distillate | T-78 | | | | | | |
| (% by vol.) | | | | | | | |
| 437°F. | | | 2 | | 1 | | 1 |
| 600°F. | | 8 | 20 | | 16 | | 14 |
| 680°F. | | | 25 | | 25 | | 20 |
| Pene. Residue | T-49 | 100 | 300 | 100 | 300 | 100 | 300 |
| Duct. Residue, 77°F. | T-51 | 60 | | 60 | | 60 | |
| Sol. Residue $CS_2$ | T-44 | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application, °F. | | 155 | 185 | 165 | 195 | 175 | 205 |

Table III Rapid Curing Cut-back Asphalts

| Designation | A.A.S.H.O. | RC-2 | | RC-3 | | RC-4 | |
|---|---|---|---|---|---|---|---|
| | | Min. | Max. | Min. | Max. | Min. | Max. |
| Flash Point, °F. | T-48 | 80 | | 80 | | 80 | |
| Viscosity, Furol | T-72 | | | | | | |
| at 122°F., sec. | | 200 | 400 | | | | |
| 140°F., sec. | | | | 275 | 400 | 700 | 1400 |
| Total Distillate | T-78 | | | | | | |
| (% by vol.) | | | | | | | |
| 437°F. | | 10 | | 3 | | 0.5 | |
| 600°F. | | 20 | | 14 | | 7 | |
| 680°F. | | | 35 | | 30 | | 25 |
| Pene. Residue, | T-49 | 60 | 120 | 60 | 120 | 60 | 120 |
| Duct. Residue, 77°F. | T-51 | 60 | | 60 | | 60 | |
| Sol. Residue $CS_2$ | T-44 | 99.5% | | 99.5% | | 99.5% | |
| Temp. of Application, °F. | | 125 | 155 | 145 | 175 | 170 | 200 |

-2.3 Sources of Supply. Approval of sources of supply of the mineral aggregate shall be obtained from the engineer prior to delivery of material. Samples of each shall be submitted as directed.

Samples of the bituminous materials that the contractor proposes to use in his work, together with a statement as to their source and character must be submitted and approved before use of the material begins.

Sampling, testing, shipment, reports and inspection at delivery shall be as required for "Type B-1 Dense Graded Road Mix Surface Course."

-3.1 Construction Methods. The methods employed in performing the work and all equipment, tools and other plant machinery used for handling materials and executing any part of the work shall be subject to the approval of the engineer before the work is started and whenever found unsatisfactory shall be changed and improved as required by the engineer. All equipment, tools, machinery and plant used must be maintained in a satisfactory working condition.

-3.2 Plant and Machinery. The mixing plant used by the contractor in the preparation of the bituminous mixture shall comply with the following requirements:

All plant screens shall be designed, constructed and operated so as to screen all aggregates to their specified sizes and proportions and shall have a capacity, when operated at normal speed, slightly in excess of the maximum capacity of the mixer.

The plant shall have a storage bin, protected from the weather, of sufficient capacity to furnish the necessary amount of all aggregates up to the maximum rated capacity of the plant with no undue periods of waiting for material.

The bins shall be divided into at least two compartments so proportioned as to insure adequate storage of appropriate fractions of the aggregate. To insure this provision, compartment spaces should be adjustable within reasonable limits. Each compartment shall be provided with an overflow pipe which shall be of such size and at such location as to prevent all backing up of material into other compartments.

The plant shall contain a drier suitably designed to heat and dry the aggregate to specification requirements and to agitate it continuously during heating. The drier shall be capable of preparing aggregates to the full rated capacity of the plant. The mixer shall be of adequate capacity, preferably a pug mill type. Accurate thermometers shall be furnished, suitable for determining the temperature of the mix.

The plant shall be provided with weighing equipment of sufficient and satisfactory capacity. The weighing equipment shall be constructed with the necessary devices that will permit any working part thereof that gets out of adjustment to be readjusted easily so that the equipment will function properly and accurately. All weighing equipment shall be sealed at the expense of the contractor as often as the engineer may deem necessary to assure accuracy. The bituminous material is to be heated, preferably by steam coils and in any case the equipment shall be of such design that steam will not be introduced directly into the bituminous material.

-3.3 Distributors used for applying the seal coat shall comply with all the requirements for distributors prescribed under Article -3.1 of the specification for "Type B-1 Dense Graded Road Mix Surface Course." Equipment for applying the cover aggregate shall also be as prescribed for that item.

-3.4 Preparation of Mineral Aggregate. It is important that the aggregate be in a uniform and dry condition at the time of mixing and if the moisture content is more than one percent the aggregate shall be dried before being conveyed to the plant bins for batching. The aggregate shall be screened into two or more fractions and conveyed into separate compartments ready for batching and mixing.

-3.5 Preparation of Bituminous Mixture. Before being delivered to the road the mineral aggregate shall be mixed with the bituminous material at a central mixing plant.

The dry mineral aggregate, prepared as above prescribed, shall be combined in uniform batches by weighing and conveying into the mixer the proportionate amounts of each fraction of aggregate required to meet the specified grading. The required quantity of bituminous material for each batch shall be measured by weight using scales attached to the asphalt bucket, and introduced into the mixer at a temperature suitable for efficient mixing. Mineral aggregate shall also be heated if found necessary to secure complete coating of all particles. The mixing shall continue for at least 30 seconds, and for such longer period as will serve to coat all the particles completely.

Additional fines and/or filler, if required to meet the grading requirements as set up under articles-1.2 and -1.3, shall be proportioned and blended with the mineral aggregate before screening into the separate compartments. Filler may be added to the aggregate at the mixing plant by premixing it thoroughly with the other fine aggregates or by feeding it into either the hot or cold elevator. Spreading filler over the top of the aggregate pits or dumping it into the hopper at crushing plants will not be permitted.

-3.6 Transportation and Delivery of Mixture. The mixture shall be transported from the paving plant to the work in tight pneumatic tired vehicles previously cleaned of all foreign materials and when directed by the engineer each load shall be covered with canvas or other suitable material of sufficient size and thickness to protect it from bad weather conditions. Hauling shall be distributed over the entire width of the subgrade.

-3.7 Preparation of Existing Surface. The existing roadbed shall be prepared as specified under the item "Reconditioning of Used Roadbed." Ditches shall be trimmed and cleaned of all slides, stones and other debris. All ruts and irregularities shall be eliminated, and a smooth, compacted surface shall be maintained up to the time of placing the bituminous plant mixed surface course.

Separate payment will not be made for preparation of existing surface except that where the Bid Schedule calls for a bid on "Reconditioning of Used Roadbed," such work shall be done and paid for under that item.

-3.8 Prime Coat. In advance of laying down the surfacing mixture, the subgrade shall be primed as specified under the item "Bituminous Prime Coat." After the priming material has penetrated the surface, and not less than four hours after application, the treated area shall be covered where ordered by the engineer, with windrowed surfacing material reserved from the original surface or sand or other approved material in sufficient quantity to absorb any excess liquid asphalt and prevent picking up by passing vehicles. If the typical section for the bituminous plant mixed surface course requires a thickened edge, the trench for the thickened edge shall, if ordered by the engineer, be cut and compacted before the prime coat is applied.

-3.9 Procedure with Thickened Edge. If required by the typical section, provision shall be made for a thickened edge of the surfacing. A triangular cut shall be made with a blade grader at each edge of the subgrade. In making the cut the excavated material shall be thrown to the shoulder in a small windrow against which the bituminous mixture shall be spread.

-3.10 Placing Bituminous Mixture, Laying Down and Compacting. The bituminous mixture shall be laid only upon an approved underlying course, which is, in the opinion of the engineer, sufficiently dry and only when weather conditions are suitable. Immediately in advance of the placing of the mixture, the roadway shall be cleaned of all loose or deleterious material. If required by the engineer, the surface shall be swept. If the typical section requires a thickened edge, the trench shall be cleaned of all loose material and debris.

The depositing, laying down and compacting of the bituminous mixture shall progress in sections not more than one mile in length. Depositing, spreading and compacting shall commence at the point or points farthest from the mixing plant, and progress continuously toward the plant, unless otherwise ordered by the engineer. Hauling over material already deposited and spread will not be allowed until the material has been compacted thoroughly in the manner hereinafter specified.

Following the depositing, the mixture shall be aerated, if and as necessary according to the conditions and at the discretion of the engineer, by windrowing it back and forth across the road. At the end of each day's work, or when work is interrupted by weather conditions, all mixture not completely spread shall be bladed to a windrow and not allowed to remain in a partially spread condition on the roadway over night or until work is resumed.

When the mixture is in proper condition it shall be spread to the full width of the course in the following manner. Approximately one-half of the mixed material shall be bladed out for the full width in a uniform layer, the remaining mixture being left in windrows of approximately equal amounts near the edges of the bituminous course. The area between the windrows shall then be rolled without overlap. Following this rolling the remaining mixture shall be bladed out similarly, rolled to the full width of pavement and finished to the true grade and cross section required. The interval between laying down the successive layers shall be as directed by the engineer. Special attention shall be given to the compaction of the outer quarters of the pavement, during the process of laying, to provide for equal compaction on these and the center quarters of the road. During the compaction process the surface shall be dragged or planed with the long base drag or similar equipment, and smoothed as needed to fill ruts, remove irregularities and produce a true riding surface. Any high, low or porous spots that may have developed in the pavement shall be corrected as necessary by remixing with the blader or by the removal or addition of bituminous mixture. The surface shall then be thoroughly rolled until hard and compact, with an 8 to 10 ton roller.

Rolling shall be longitudinal and shall commence at the outer edge of the road overlapping the shoulders and progress toward the center of the road, overlapping each succeeding passage an amount not less than one-third the width of the roller. Under no circumstances shall the center of the road be rolled first.

After the surface has set up sufficiently the edges of the mat shall be trimmed neatly to line. The shoulders shall be completed and shaped as called for, and properly rolled. The gutters shall be cleaned and shaped in conformity with the typical cross section.

-3.11 Operating under Unfavorable Weather Conditions. Placing of bituminous mixture shall not be done when the atmospheric temperature is below 50°F. nor when the base is wet, nor during rainy or foggy weather, provided, however, that if the mixture has been warmed and has a temperature of not less than 150°F. nor more than 225°F. it may be laid at atmospheric temperatures of 30°F. or higher. The contractor shall furnish, and keep on the work at all times one or more accurate thermometers suitable for determining the temperature of the bituminous mixture. If the moisture content of the mixture, after it has been spread on the roadbed but before final rolling, exceeds 1½ percent, the mixture shall be bladed and rebladed and allowed to dry out before it is finally spread. If blading and reblading of the mixture fail to reduce the moisture content below that above specified, the mixture shall be scarified, turned and respread until the moisture content does not exceed 1½ percent by weight of dry aggregate.

-3.12 Testing Plant Mixed Surface. The completed plant mixed surface shall be compacted thoroughly, smooth and even, true to grade and cross section, and free from ruts, bumps, depressions or irregularities. When a straightedge ten feet long is laid on the finished surface and parallel with the center line of the road, the surface shall vary in no place more than 1/4 inch from the lower edge of the straightedge. It shall be maintained in that condition until accepted for traffic, or until completion of contract.

-3.13 Seal Coat. When the Bid Schedule contains an item for seal coat the road surface shall be open to traffic for at least two weeks and shall then be swept clean. Application shall be only when the roadway is dry and the atmospheric temperature 50°F. or higher. Bituminous material for seal coat shall be applied in the amount of one-sixth to one-fourth gallon per square yard. When the desired stage of tackiness is attained cover aggregate shall then be spread in the amount of 10 to 20 pounds per square yard. The aggregate shall contain not more than 3 percent of moisture. The exact amount of bituminous material and cover aggregate shall be determined by the engineer. Immediately after spreading the cover aggregate the surface shall be rolled. This shall be followed by alternate brooming with a broom drag and rolling until the cover material is embedded and the surface is thoroughly compacted and uniform in texture.

-3.14 Accommodating Public Traffic. Up to the time of delivering the surfacing mixture on the subgrade the road shall be maintained continuously in serviceable condition proper for accommodation of traffic and shall be kept open at all times. During the depositing, laying down and compacting of the surfacing the work shall be conducted in such a way that traffic can proceed along the work at low speed at all times. Suitable warning signs illuminated at night by lanterns or flares shall be provided to mark the places where the surfacing ends and the places where surfacing is not thoroughly compacted. The contractor shall provide flagmen and a light car and driver to conduct public traffic through portions of the roadway where one way traffic control is directed by the engineer.

The contractor in his operations shall keep the road free from obstructions of any nature and shall not allow traffic to be blocked by material dumped in piles, or otherwise, nor by equipment in operation, except that he may, at his own expense, arrange temporary detours to take traffic around the immediate area where placing is actually in progress. Such detours shall return the traffic conveniently to the sections where placing is not in progress.

In areas where the condition of the work is unavoidably such that vehicles will be subject to inconvenience and to damage due to spattering with oil or bituminized aggregate and similar causes, the contractor, at his own expense, shall arrange convenient detours. These detours shall be limited to brief intervals and short distances as directed by the engineer.

During the application of any required seal coat, traffic shall be routed either over the one-half width not being treated or over convenient detours at the expense of the contractor and as directed by the engineer. Where one-half width operations are in progress the other half of the road shall be kept clear and open for controlled traffic and shall be handled as described under "Traffic Control" in the specifications for "Bituminous Prime Coat."

-3.15 Supplemental Material. When directed by the engineer, plant mixed material shall be placed in stockpiles, at locations selected by the engineer, at the rate of 40 tons per mile of road. Cover aggregate, when directed by the engineer, shall be placed in stockpiles at the points directed by the engineer and at the rate of 20 tons per mile of road.

-4.1 Method of Measurement. The tonnage of bituminous mixture to be paid for shall be the number of tons actually used in the work together with that placed in stockpiles and shall be determined by weighing on scales furnished by and at the expense of the contractor. The scales shall be satisfactory to the engineer and shall be sealed at the expense of the contractor as often as the engineer may deem necessary to insure their accuracy. The unit of measure shall be the ton of 2,000 pounds. The bituminous treated material shall be weighed after mixing and no deduction will be made for the weight of the bituminous material in the mixture.

The tonnage of cover aggregate to be paid for shall be the number of tons of cover aggregate actually used in the seal coat together with untreated aggregate placed in stockpiles or otherwise used as ordered shall be weighed separately from the bituminous mixture.

The gallonages of bituminous material to be paid for shall be the number of gallons each of medium curing asphalt and of cut-back asphalt measured at 60°F. or converted to this temperature in accordance with A.S.T.M. Specification D 206-34 actually used as ordered in the accepted work. When so called for in the Bid Schedule, the unit for measuring the bituminous material shall be the ton of 2,000 pounds.

-5.1 Basis of Payment. The quantities, determined as provided above, shall be paid for at the respective contract unit prices per ton bid for "Class F - Dense Plant Mixture" or "Class F - Cover Aggregate" per gallon or per ton bid for "Medium Curing Cut-back Asphalt for Class F" or "Rapid Curing Cut-back Asphalt for Class F," as the case may be, which prices and payments shall be full compensation for furnishing and preparation of all material, laying down, rolling and finishing the course to profile grade and cross section, including all weigh and testing houses furnished, and for all labor, equipment, tools and incidentals necessary to complete the item, including all work, all rollers and material furnished for patching and conditioning the subgrade or base, except where the Bid Schedule calls for "Reconditioning of Used Roadbed."

Where the Bid Schedule calls for "Reconditioning of Used Roadbed" and or "Bituminous Prime Coat," all work done and equipment and materials furnished under these items shall be paid for as provided in the respective items named, otherwise all such work done on the subgrade or existing road, together with rollers and other equipment shall not be paid for directly but shall be considered as subsidiary to and included under the several pay items named in the paragraph above.