SECTION 1028 -- ASPHALTIC CONCRETE

1028.01 -- Description

1. Asphaltic concrete is a Contractor-designed mix.

2. a. Before production of asphaltic concrete, the Contractor shall submit, in writing, a tentative job mix formula for approval to the NDR Flexible Pavement Engineer at the Lincoln, Nebraska Central Laboratory.

b. The job mix formula shall identify the mineral aggregates and mineral filler, if needed, with the value of the percent passing each specified sieve for the individual and combined materials.

c. A 30 kg bag of each of the individual mineral aggregates shall also be submitted to the NDR Materials and Tests Division at this time. Each sample shall be marked to clearly indicate the type of material, name of the producer, and pit location.

d. (1) The Contractor shall submit a proportioned 7.0 kg sample of the combined dry materials to be used in the mixture.

(2) Submitted with this sample shall be a copy of the mix design values as prepared by the Contractor.

(3) This mix design shall include at a minimum:

(I) The bulk specific gravity of the combined aggregate.

(ii) The effective specific gravity.

(iii) The target asphalt cement content.

(iv) The supplier and grade of asphalt cement.

(v) The maximum specific gravity of the combined mixture (Rice).

(vi) The average bulk specific gravity of the compacted Marshall specimens.

(vii) The calculated minimum asphalt content.

e. For recycled mixes, the Contractor may submit a sample of the Reclaimed Asphalt Pavement (RAP) in advance of the samples required above for determination of asphalt content, gradation, and bulk specific gravity of the RAP material. The Contractor shall include with the mix design of recycled mixes the percent of added asphalt cement and the percent of total asphalt cement.

f. The 30 kg aggregate sample and the 7 kg asphalt mix sample should be delivered to the NDR Central Laboratory in Lincoln, Nebraska at least 10 NDR work days before production of asphaltic concrete.

3. Asphaltic Cement and Recycled Asphalt Pavement Proportions:

a. Virgin Asphaltic Concrete Mixtures:

(1) The asphalt cement to be used in all virgin asphaltic concrete mixtures shall be asphalt cement AC-10.

b. Recycled Asphaltic Concrete Mixtures:

(1) In recycled asphaltic concrete mixtures with a percent of Reclaimed Asphalt Pavement (RAP) of 25 or less, the asphalt cement shall be AC-10.

(2) In recycled asphaltic concrete mixtures with a percent of Reclaimed Asphalt Pavement (RAP) of greater than 25 percent, the asphalt cement shall be AC-5.

c. State Maintenance Patching:

The asphalt cement used in the "State Maintenance Patching" shall be the same type used in the asphaltic concrete mixtures that is being produced at the time the patching material is procured.

4. Authorized mix target field values are shown in Table 1028.01.

5. Quality Control Program:

a. The Contractor shall establish, provide, and maintain an effective Quality Control (QC) Program. The QC Program shall detail the methods and procedures that will be taken to assure that all materials and completed construction conform to all contract requirements.

b. Although guidelines are established and certain minimum requirements are specified herein and elsewhere in the contract, the Contractor shall assume full responsibility for placing a pavement course that meets the target field values.

c. The Contractor shall establish a necessary level of control that will:

(1) Adequately provide for the production of acceptable quality materials.

(2) Provide sufficient information to assure both the Contractor and the Engineer that the specification requirements can be met.

(3) Allow the Contractor as much latitude as possible in developing control standards.

d. (1) The Contractor shall develop and provide the Engineer a copy of the QC Program at the preconstruction conference.

(2) The Contractor shall not begin any construction or production of materials until the QC Program has been approved by the Engineer.

e. The QC Program shall address, as a minimum, the following items:

(1) QC organization chart.

(2) The mix design.

(3) Submittals schedule.

(4) Inspection requirements.

(i) Equipment.

(ii) Asphalt concrete production.

(iii) Asphalt concrete placement.

Table 1028.01

Mix Design Criteria Target Field Values*	
Mix Type	**Criteria **, ***, ******
Type 11	1. 4.0% target field air voids. 2. 80% crushed value for combined mineral aggregate. 3. 75 blow Marshall design. 4. A maximum of 60% limestone in the mix.
Type 12	1. 4.0% target field air voids. 2. 60% crushed value for the combined mineral aggregate. 3. 75 blow Marshall design. 4. A maximum of 60% limestone in the mix.
Type 13	1. 4.0% target field air voids. 2. 80% crushed value for the combined mineral aggregate. 3. 75 blow Marshall design. 4. A minimum of 50% quartzite, granite or crushed gravel meeting 100% crushed value criteria.
Type 14	1. 4.0% target field air voids. 2. 60% crushed value for the combined mineral aggregate. 3. 50 blow Marshall design. 4. A maximum of 60% limestone in the mix.
Type 15	1. 4.0% target field air voids. 2. 80% crushed value for the combined mineral aggregate. 3. 50 blow Marshall design. 4. A minimum of 50% quartzite, granite or crushed gravel meeting 100% crushed value criteria.
Type 16	1. 3.5% target field air voids. 2. Roadway mix constructed under traffic and parking areas. 3. 20% crushed value for the combined mineral aggregate. 4. 50 blow Marshall design. 5. A maximum of 60% limestone in the mix.
Type 17	1. 3.5% target field air voids. 2. 50 blow Marshall design. 3. A maximum of 60% limestone in the mix.

* The Contractor shall calculate the target asphalt content.

** VMA requirements:
Band “A” (12.5 mm) mix -- minimum VMA = Air Voids (%) +12%
Band “B” (19.0 mm) mix -- minimum VMA = Air Voids (%) + 11%

		Band “B” (19.0 mm)	Band “A” (12.5 mm)
***	Maximum Dust/AC (Lab Design)	1.2	1.2
	Maximum Cold Feed Value	1.4	1.4

**** Target field air voids tolerance is ±1%

(5) QC testing plan.

(6) Documentation of QC activities.

(7) Requirements for corrective action when QC and/or acceptance criteria are not met.

(8) Any additional elements deemed necessary.

(9) A list, with the name, manufacturer model number, and purchase date, for all test equipment used during laboratory testing.

(10) A description of maintenance and calibration procedures, including the frequency that the procedures are performed.

f. The QC organization chart shall consist of the following minimum personnel:

(1) Program Administrator:

(i) The Program Administrator shall be a full-time employee of the Contractor or a Subcontractor (Consultant) hired by the Contractor.

(ii) The Program Administrator shall have a minimum of 5 years of experience in highway construction.

(iii) The Program Administrator shall have full authority to institute any and all actions necessary for the successful implementation of the Quality Control Program to ensure compliance with the contract plans and specifications.

(iv) The Program Administrator's qualifications and NDR training shall be described in the QC Program.

(2) Quality Control Technicians:

(I) The quality control technicians shall report directly to the Program Administrator and shall perform all quality control tests as required by the contract.

(ii) The QC technicians shall be certified by the NDR Materials and Tests Division.

(iii) Certification at an equivalent level by a state or nationally recognized organization may be acceptable.

(iv) The QC technician's credentials and NDR training records shall be submitted to the NDR Materials and Tests Division.

g. (1) Inspections shall be performed daily to ensure continuing compliance with contract requirements until completion of the work.

(2) QC test results and periodic inspections shall be used to ensure the mix quality and to adjust and control mix proportioning.

h. QC Testing Plan:

(1) The testing plan shall contain a statistically-based procedure of random sampling for acquiring test samples in accordance with NDR T 572.

(2) The Contractor may add any tests that are necessary to adequately control production.

(3) All QC test results shall be documented by the Contractor with a copy provided to the Engineer within 1 week after the tests are complete.

(4) Copies of all forms to be used shall be included in the QC Testing Plan.

i. Corrective Action Requirements:

(1) The Contractor shall establish and utilize QC charts for individual QC tests. The requirements for corrective action shall be linked to the control charts.

(2) The Contractor's QC Program shall detail how the results of QC inspections and tests will be used to determine the need for corrective action.

(3) (i) A clear set of rules to determine when a process is out of control and the type of correction to be taken to regain process control will be provided.

(ii) As a minimum, the plan shall address the corrective actions that will be taken when measurements of the following items or conditions approach the specification limits:

(I) Cold feed gradation.

(II) AC oil content.

(III) Air voids.

(IV) Voids in the Mineral Aggregate (VMA).

(V) Crushed content of Crushed Mineral Aggregate (CMA).

(VI) Aggregate - Asphalt cement stripping.

(VII) Rutting.

(VIII) Surface voids on roadway.

1028.02 -- Material Characteristics

1. The type of asphalt cement shall be shown in the plans or special provisions.

2. Combined aggregate gradations shall be within the ranges shown in Table 1033.04.

3. The mix design target field values are shown in Table 1028.01.

4. Mix adjustments shall be made by the Contractor when:

a. Air voids, VMA, or asphalt content do not meet the currently approved criteria.

b. Surface voids create a surface and/or texture which does not meet the criteria of Sections 502 and 503.

c. Pavement does not meet any other design criteria.

5. Mix adjustments at the plant are authorized within the following limits without redesigning the initially approved mix:

a. The adjustment must produce a mix with the percent air voids required.

b. Asphalt content shall not be less than the calculated minimum.

c. All adjustments must be reported to the Engineer.

Table 1028.02

Asphalt and Aggregate Adjustments	
Sieve Size	**Adjustments**
19.0 mm, 25.0 mm.....	±4%
9.50 mm, 12.5 mm.....	±4%
4.75 mm, 2.00 mm, 300 µm	±3%
75 µm	±1%
Other	
Asphalt Content.....	±0.2% (but never less than the calculated minimum)

d. The adjustment values in Table 1028.02 will be the tolerances allowed for adjustments resulting from production control chart moving averages.

e. No adjustments will be allowed beyond the gradation limits in Table 1033.04.

6. Sampling and Testing:

a. All samples shall be identified by a system approved by the Engineer.

b. All Marshall samples and companion samples shall be identified, stored, and retained by the Contractor for the Department until the samples are picked up by the Department.

c. (1) The asphalt concrete mixture shall be randomly sampled from the roadway, behind the paver, before compaction.

(2) At least one QA/QC sample shall be tested for every 1000 Mg of plant produced mix with a maximum of 4 tests per day.

(3) Additional sampling and testing for the Contractor's information may be performed at the Contractor's discretion.

(4) At the project start-up and when a substantial aggregate proportion or other major mix change has been made, it is recommended that at least 1 sample be taken from the first 500 Mg of production.

d. Samples should not be taken from the first 100 Mg of mix produced each day or after a significant mix change.

e. (1) The mass of the sample shall be at least 20 kg and shall be transported to the test facility in an insulated container.

(2) Samples shall be split in accordance with approved NDR quartering procedures.

(3) One part shall be compacted immediately while still hot (additional heating may be required to raise the temperature of the sample to compaction temperature).

(4) The second part of the sample will be for NDR use.

(5) At least once for every 5000 Mg produced, a portion of the hot sample selected by the Engineer shall be allowed to cool to ambient temperature and then be reheated to compaction temperature and compacted (NDR T 245). The Contractor and the Department shall reheat and test the same sample.

(6) Correlation factors will be developed to compare the bulk specific gravity of hot compacted samples to reheated compacted samples.

f. Each production sample shall be tested as follows:

(1) Three Marshall specimens shall be prepared and compacted in accordance with NDR T 245 - Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.

(2) (i) Bulk Specific Gravity (Gmb) shall be determined for each specimen in accordance with NDR T 166 - Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface - Dry Specimens.

(ii) The 3 specimen results are averaged for each sample.

(iii) If an individual specimen result deviates by more than 0.02 from the average of the 3 specimens, that result shall be thrown out and the remaining 2 results shall be averaged.

(3) One Theoretical Maximum Specific Gravity (Gmm) test for each production sample of uncompacted mixture shall be determined in accordance with NDR T 209 - Maximum Specific Gravity of Bituminous Paving Mixtures.

(4) (i) The Combined Aggregate Bulk Specific Gravity (Gsb) shall be determined from the individual aggregate component bulk specific gravities.

(ii) NDR T 584 - Specific Gravity and Absorption of Fine Aggregate

(iii) NDR T 585 - Specific Gravity and Absorption of Coarse Aggregate.

$$Gsb = \frac{P1 + P2 + P3 + P4 + Pn}{\frac{P1}{G1} + \frac{P2}{G2} + \frac{P3}{G3} + \frac{P4}{G4} + \frac{Pn}{Gn}}$$

P1, P2.....Pn = Mass or percentages of aggregates

G1, G2..... Gn = Bulk specific gravities of individual aggregate components.

NOTE: Gsb need not be recomputed for each production sample, but only after a significant aggregate proportion change.

(5) The Effective Specific Gravity (Gse) of the aggregate shall be determined by the following:

$$Gse = \frac{100 - Pb}{\frac{100}{Gmm} - \frac{Pb}{Gb}}$$

where:

Pb = percent of asphalt cement by total mass of mix (use Design Target value at start-up; thereafter, use tank stab values).

Gb = specific gravity of asphalt cement from shipping tickets.

Gmm = theoretical maximum specific gravity of mix.

Note: On the first 2 production days, use laboratory (target Pb values) Gse. Starting on the 3rd production day, Gse will be determined on the plant produced mix (tank stab Pb values) and will be redetermined whenever there is a significant aggregate proportion change.

(6) The asphalt content is as follows:

$$\text{Percent AC} = \frac{100 \times Gb \{(Gse/Gmm) - 1\}}{(Gse - Gb)}$$

Gb = specific gravity of asphalt cement from Certified Shipping Tickets.
Gse = effective specific gravity of aggregate.
Gmm = theoretical maximum specific gravity of paving mixture.

(7) The laboratory air voids shall be determined in accordance with the following:

$$Pa = \frac{100 (Gmm - Gmb)}{Gmm}$$

where: Pa = Air voids in compacted mixture, percent of total volume.
Gmm = Theoretical Maximum Specific Gravity.
Gmb = Bulk Specific Gravity as determined.

(8) The Voids in the Mineral Aggregate (VMA) shall be determined as follows:

$$VMA = 100 - \frac{Gmb \times Ps}{Gsb}$$

where: VMA = voids in mineral aggregate (percent of bulk volume).
Gsb = bulk specific gravity of the combined aggregate.
Gmb = bulk specific gravity of compacted mixture as determined.
Ps = aggregate, percent by total mass of mixture.
Ps = (100-Pb)

NOTE: VMA need not be recomputed as long as AC content is equal to or greater than the minimum percentage and laboratory air voids (Pa) are within the target tolerance range.

(9) The minimum asphalt content value for each job mix will be determined in accordance with the following:

$$\text{Min. Percent AC} = \frac{\{(Gb)(Gse)(VMA-Vt) + (Gb)(100-VMA)(Gse-Gsb)\}(100)}{(Gb)(Gse)(VMA-Vt)+(Gb)(100-VMA)(Gse-Gsb)+(Gse)(Gsb)(100-VMA)}$$

where:
- Gb = specific gravity of the asphalt cement
- Gsb = bulk specific gravity of the combined aggregate
- Gse = effective specific gravity of the combined aggregates
- VMA = voids in mineral aggregate
- Vt = design target air voids

NOTE: Recomputed only when Gsb or Gse are recomputed.

(10) The percent of asphalt cement shall be determined for each production day or portion of a day. The percent of asphalt is based on the total mix's mass taken with the tank stab.

(11) Except as noted in this Subsection, all sampling and testing shall be done as prescribed in the NDR *Materials Sampling Guide*.

g. Testing Documentation:

(1) All test results and calculations shall be recorded and documented on data sheets approved by the Engineer.

(2) Specific test results shall be recorded on a daily summary sheet approved by the Department to facilitate the computation of moving test averages.

(3) Moving averages shall be based on 4 consecutive test results, except for the theoretical maximum specific gravity (Rice) which will be based on a moving average of 3 tests.

h. QC Charts:

(1) QC charts shall be posted at the asphalt production site and kept current with both individual test results and moving average values.

(2) Control charts shall include a target value, working limits, and specification limits.

(3) As a minimum, the following values shall be plotted on Engineer approved control charts as indicated below:

(I) Laboratory Marshall density (each point being an average of 3 specimens).

(ii) Cold feed aggregate gradations (moving average of last 4 tests):

(a) 4.75 mm sieve to nearest 1 percent

(b) 2.00 mm sieve to nearest 1 percent

(c) 75 µm sieve to nearest 0.1 percent

(iii) Asphalt cement content shall be plotted to nearest 0.1 percent (running average of the last 4 tests).

(iv) The theoretical maximum specific gravity (Rice) (running average of the last 3 tests).

(v) Laboratory Marshall air voids shall be plotted to nearest 0.1 percent.

(vi) The laboratory Marshall air void shall be determined by using the moving theoretical maximum specific gravity (Rice) tests values corresponding to a particular set of Marshall specimens. (The first moving average point for maximum specific gravity (Rice), which is at the third production test point, shall be used on the 1st, 2nd, and 3rd set of Marshall specimens for air void determination.)

(4) Individual test results shall be plotted in black for each test point.

(I) A solid black line shall connect the points.

(ii) The moving average for each test variable shall be plotted in red.

(iii) A dashed red line shall connect the points.

(iv) The Department's acceptance test results shall be plotted with green asterisks.

(v) Allowed tolerances shall be indicated on the control charts using green dotted lines.

i. Correlation Testing:

(1) Department personnel will select, at random, a split-portion of one or more of the daily hot mix production samples. Some or all of the samples selected will be tested in the NDR Branch Laboratory. The Department will test as many of the samples as necessary to establish a correlation. The Department will normally test one sample per day and provide the results to the Contractor in a timely manner.

7. a. In response to tests results, the Contractor shall notify the Engineer whenever the process approaches the *Specification* limits.

b. Two consecutive moving average points outside the *Specification* limits shall be cause to cease operations.

c. The Contractor shall assume the responsibility to cease operations.

d. The process shall not be started again without approval of the Engineer.

e. Failure to cease operations after 2 consecutive moving average points fall outside the *Specification* limits shall subject all subsequent material to be rejected.

f. After a significant process adjustment, such as aggregate proportion changes or changes in asphalt cement content, it may be necessary to begin a new moving average determination, as is done at the beginning of a project. This may be necessary anytime it would take a number of new test results to purge the results of the previous process out of the moving average value.

8. Verification of Contractor's Tests Results:

a. The Contractor's sample testing of laboratory air voids, voids-mineral aggregate, aggregate gradation, aggregate bulk specific gravity, and compacted in-place density shall be verified by comparison to Department acceptance tests.

b. These verifications will include:

(1) Test methods.

(2) Calculation errors.

(3) Laboratory equipment.

(4) Technician training.

(5) Sampling procedures.

c. If it is determined that the Contractor was responsible for faulty test results, then any retesting will be performed at no additional cost to the Department.

d. During construction, the Contractor shall sample the uncompacted asphaltic concrete in accordance with NDR T 168.

9. Asphalt Concrete Density Samples:

a. The samples shall be cut by the Contractor the first day of work following placement of the mixture.

b. Normally, 5 samples for determination of density and thickness will be taken from each lot (2500 Mg) in the bottom layer at locations selected in accordance with NDR T 572.

c. In every subsequent layer, an additional core shall be taken for thickness measurement within 3 m of each core location in the bottom layer.

d. The thickness cores from the subsequent layers above the bottom layer shall also serve as density samples as outlined in the standard sampling method.

e. Density samples shall be tested by the Department in accordance with the NDR T 166 or NDR T 587.

f. The voidless density for each lot (2500 Mg) shall be calculated using NDR T 571.

g. The average density of the lot shall be used to compute the pay factor for density in accordance with Table 1028.03 or Table 1028.04. Exceptions to the sampling and testing of core samples for the determination of density are as follows:

(1) When the nominal layer thickness is 25 mm or less, the sampling and testing of density for this layer will be waived.

(2) When the average thickness of the 5 cores for a lot is 25 mm or less, the testing of density samples for this lot will be waived.

(3) When the nominal layer thickness and the average of the original 5 cores for a lot are both more than 25 mm, but some of the cores are less than 25 mm thick, additional cores shall be cut at randomly selected locations to provide 5 samples of more than 25 mm thickness for the determination of the pay factor for density.

h. For the first lot (2500 Mg) of asphaltic concrete produced on a project and for asphaltic concrete used for temporary surfacing, the pay factor for density shall be computed in accordance with Table 1028.03. After the completion of the first lot, the pay factor for density shall be computed in accordance with Table 1028.04.

i. (1) If, at the completion of the project, the final lot consists of less than 2500 Mg of asphaltic concrete, a minimum of 3 samples, or 1 sample for each 500 Mg or fraction thereof, whichever is greater, shall be taken and tested for density.

(2) The test results shall be averaged and the pay factor based on the values shown in Table 1028.04.

(3) Should the average of less than 5 density tests indicate a pay factor less than 1.00, additional density samples shall be taken at randomly selected locations and the pay factor based on the average of the 5 tests.

Table 1028.03

Acceptance Schedule Density of Compacted Asphaltic Concrete (First Lot)	
Average Density (5 Samples, Percent of Voidless Density)	**Pay Factor**
Greater than 90.0	1.00
Greater than 89.5 to 90.0	0.95
Greater than 89.0 to 89.5	0.70
89.0 or Less	0.40 or Reject

Table 1028.04

Acceptance Schedule Density of Compacted Asphaltic Concrete (Subsequent Lots)	
Average Density (5 Samples, Percent of Voidless Density)	**Pay Factor**
Greater than 92.4	1.00
Greater than 91.9 to 92.4	0.95
Greater than 91.4 to 91.9	0.90
Greater than 90.9 to 91.4	0.85
Greater than 90.4 to 90.9	0.80
Greater than 89.9 to 90.4	0.70
89.9 or Less	0.40 or Reject

j. If requested by the Contractor, 1 complete set of check cores or 1 check core for any individual low density test in the original set, taken not later than on the second day of work following the completion of the lot, will be allowed in lots with a density pay factor of less than 1.00. The average density obtained by substituting the check tests for the original tests shall be used to establish the density pay factor for the lot.

k. At the conclusion of the project or after the nominal plan thickness has been constructed on any section of the project, the Contractor shall, at locations determined by the Engineer, cut core samples of sufficient depth to represent the total thickness of all layers constructed.

l. The surfaces from which core samples have been taken shall be restored by the Contractor with hot asphaltic concrete mixture no later than the next succeeding day of plant operation or by tamping previously cut core samples into the void if the plant is no longer operational.

m. Thickness cores are paid for as an "established" contract unit price, which is shown in the bid proposal Schedule of Items.

n. Density cores are subsidiary to "Asphaltic Concrete, Type _____".

10. Contractor's Lab Equipment:

a. The Contractor shall calibrate and correlate the testing equipment according to the procedures prescribed for the individual tests and conduct tests in conformance with specified testing procedures.

b. The Contractor shall have the following equipment (or approved equal) available in the field laboratory:

(1) The required Marshall Compaction Device shall consist of 3 parts:

(I) Humboldt Triple Hammer Mechanical Compactor, Model H 1356. This mechanical hammer rotates the mold during compaction and has a beveled face on the hammer.

(ii) Compaction Pedestal, Model 1347.3M.

(iii) Automatic Counter, Model H 1334.

(2) To test maximum theoretical specific gravity of uncompacted mixture, equipment recognized by ASTM D 2041 or AASHTO T 209 will be acceptable. (Must use vacuum pump and mercury manometer to draw proper vacuum. Must use mechanical vibrating table to aid removal of entrapped air.)

(3) To test density of compacted hot mix asphalt, a minimum 6000 gm balance, 0.1 gm resolution, with under body connect and water container large enough to conveniently place specimen in the basket and completely submerge the basket and specimen without touching the sides or bottom is required.

(4) Field Laboratory and Office (suggested size 2.5 m x 13.5 m) which contain the following:

Air conditioner.
Dedicated phone (where available).
FAX machine.
Xerox type copy machine.
Sample storage.
Work table.
Bulletin board.
Running water.
Desk and chair.
Separate power supply.
Incidental spoons, trowels, pans, pails.

(5) Diamond saw for cutting cores.

(6) Diamond core drill (150 mm & 100 mm diameter core).

(7) Oven, 175°C minimum, sensitive ±3.0°C.

(8) USA Standard Series Sieves for coarse and fine aggregate with appropriate shakers (300 mm recommended).

(9) Extractor for Marshall Specimens.

11. The Contractor shall provide qualified technicians to operate the field laboratory.