DIVISION 1000

Material Details

SECTION 1001 -- GENERAL INSTRUCTIONS AND REQUIREMENTS

1001.03 -- NDR Approved Products List

Paragraph 5. of Subsection 1001.03 is void and superseded by the following:

5. a. Suppliers and vendors with materials that may qualify for addition to the NDR Approved Products List may use the New Products Evaluation Request Form found at our Department website, or should contact the Physical Testing Section, NDR Materials and Research Division, at (402) 479-4746, for the required material and/or documentation submittal requirements.

b. Products may also be submitted on-line, through the Department's web site.

SECTION 1002 -- PORTLAND CEMENT CONCRETE

1002.02 -- Material Requirements

Paragraph 5.d. of Subsection 1002.02 is void and superseded by the following:

d. Class A, Flaked Calcium Chloride shall be added at a rate not to exceed 2.0 percent of the weight of the cement for Grade 1 or 1.6 percent of the weight of the cement for Grade 2.

Table 1002.03 in Subsection 1002.02 is void and superseded by the following table:

Table 1002.03

Table of Acceptable Concrete Class Substitutions	
Class Specified	**Acceptable Class for Substitution**
BX	AX, 47B, 47BD, or 47B-HE
AX	47B, 47BD or 47B-HE
47B	47BD, or 47B-HE

In Paragraph 7.b. of Subsection 1002.02, delete reference to 47-HE-3,625 and 47-HE-25 concrete.

Table 1002.02 in Subsection 1002.02 is void and superseded by the following:

English
Table 1002.02

Concrete Proportions										
Class of Concrete (1), (6), (7)	Cementitious Material (pounds per cubic yard)				Percent Air Content (2)		Slump (millimeter) (7)		Percent Coarse Agg. to Total Agg.	Water/ Cementitious Ratio Max.
	Total Min.	Portland Cement Min.	Fly Ash Max.	Silica Fume Min.	Min.	Max.	Min.	Max.	(3)	(4)
47B-3500	564	480	98		5.0	7.5		3	30±3	0.48
BX-3000	564	480	98		5.0	7.5		3	(5)	0.48
47BD-4000	658	560	113		5.0	7.5	0.75(8)	4	30±3	0.42
47B-Special 3500	611	520	106		5.0	7.5		3	30±3	0.48
AX-3500	658	560	113		5.0	7.5		3	(5)	0.48
PR1-3500	752	752	Exclude		4.0	7.0		7	30±3	0.36
PR3-3500	799	799	Exclude		4.0	7.0		3	30±3	0.45
Overlay Concrete SF-3500	589	564	Exclude	25	4.0	7.0		5	50±3	0.36
Overlay Concrete HD-3500	823	823	Exclude		5.5	7.5	0.60	1	50±5	0.45
47B-HE-3500	564	565	Exclude		5.0	7.5		7	30±3	0.40
47B-P-3500 & 47-PHE-3500	658 to 705	560 to 598	113 to 121		3.0	6.0		7	30 to 60	0.45

(1) Each class shall identify the minimum strength requirement. (For example, 47B-3500, where the last four digits indicate the strength in pounds per square inch. In the chart, a strength of 3500 psi is indicated for 47B-3500; however, other strengths may be authorized elsewhere in the contract. The classes shown in the chart are typical examples.)

(2) As determined by ASTM C 138 or ASTM C 231.

(3) Coarse aggregate shall be limestone unless otherwise specified.

(4) The Contractor is responsible to adjust the water/cement ratio so that the concrete supplied achieves the required compressive strength without exceeding the maximum water/cement ratio. The maximum water/cement ratio for any pavement concrete is 0.45. All ratios greater than 0.45 apply only to structures like bridge abutments, piers, or foundations.

(5) Single aggregate (sand-gravel) used for these classes of concrete.

(6) All classes of concrete shall be air-entrained.

(7) The maximum slump may be exceeded by use of water reducer, high range water reducer, or both. Any increase in slump must be preapproved by the Engineer.

(8) When bridge curb is placed with slip form equipment, there is no minimum slump requirement.

Metric
Table 1002.02M

Concrete Proportions

Class of Concrete (1), (6), (7)	Cementitious Material (kilograms per cubic meter)				Percent Air Content (2)		Slump (millimeter) (7)		Percent Coarse Agg. to Total Agg.	Water/ Cementitious Ratio Max.
	Total Min.	Portland Cement Min.	Fly Ash Max.	Silica Fume Min.	Min.	Max.	Min.	Max.	(3)	(4)
47B-24	335	285	58		5.0	7.5		75	30±3	0.48
BX-20	335	285	58		5.0	7.5		75	(5)	0.48
47BD-28	390	332	67		5.0	7.5	20_8	100	30±3	0.42
47B-Special-24	363	308	63		5.0	7.5		75	30±3	0.48
AX-24	390	332	67		5.0	7.5		75	(5)	0.48
PR1-24	446	446	Exclude		4.0	7.0		175	30±3	0.36
PR3-24	474	474	Exclude		4.0	7.0		75	30±3	0.45
Overlay Concrete SF-24	349	335	Exclude	15	4.0	7.0		125	50±3	0.36
Overlay Concrete HD-24	488	488	Exclude		5.5	7.5	15	25	50±5	0.45
47B-HE-24	335	335	Exclude		5.0	7.5		175	30±3	0.40
47B-P-24 & 47-PHE-24	390 to 418	332 to 354	67 to 71		5.0	7.5		175	30 to 60	0.45

(1) Each class shall identify the minimum strength requirement. (For example, 47B-24, where the last two digits indicate the strength in Megapascals. In the chart, a strength of 24 MPa is indicated for 47B-24; however, other strengths may be authorized elsewhere in the contract. The classes shown in the chart are typical examples.

(2) As determined by ASTM C 138 or ASTM C 231.

(3) Coarse aggregate shall be limestone unless otherwise specified.

(4) The Contractor is responsible to adjust the water/cement ratio so that the concrete supplied achieves the required compressive strength without exceeding the maximum water/cement ratio. The maximum water/cement ratio for any pavement concrete is 0.45. All ratios greater than 0.45 apply only to structures like bridge abutments, piers, or foundations.

(5) Single aggregate (sand-gravel) used for these classes of concrete.

(6) All classes of concrete shall be air-entrained.

(7) The maximum slump may be exceeded by use of water reducer, high range water reducer, or both. Any increase in slump must be preapproved by the Engineer.

(8) When bridge curb is placed with slip form equipment, there is no minimum slump requirement.

1002.03 -- Procedures

Paragraph 3. of Subsection 1002.03 is void and superseded by the following:

3. When the pavement is constructed under a Quality Control/Quality Assurance specification, the Contractor shall have a furnished testing laboratory on the project site. In the event the concrete is obtained from a commercial supplier, the supplier shall have a furnished testing laboratory at the site where the concrete is produced.

Paragraph 4. of Subsection 1002.03 is amended by adding the following sentence and subparagraphs a., b., and c.

The concrete plant's manufacturer mixing times may be used if the Contractor submits a letter which certifies:

a. What the tolerances are for the plant's drum, paddles, screws and other essential parts;

b. The parts are within the manufacturer's tolerances;

c. The plant is able to mix the concrete as the manufacturer stipulated at the manufacturer's recommended mixing times.

SECTION 1004 -- PORTLAND CEMENT

1004.02 -- Material Characteristics

Paragraph 1. of Subsection 1004.02 is void and superseded by the following:

1. Type I, Type II and Type III portland cement shall conform to the requirements in ASTM C 150 with the following additional requirements:

a. Portland cement shall not contain more than 0.60 percent equivalent alkali.

b. Processing additions may be used in the manufacture of the cement, provided such materials have been shown to meet the requirements of ASTM C 465 and the total amount does not exceed 1 percent of the weight of portland cement clinker.

SECTION 1021 -- EPOXY COATED REINFORCING STEEL

1021.02 -- Material Characteristics

Paragraph 7. of Subsection 1021.02 is void and superseded by the following:

7. A film thickness after curing of 7 to 12 mils (180 to 300 µm) shall be applied in a uniform, smooth coat with no discontinuities, except as provided herein. Thickness of the film shall be measured on a representative number of bars from each production lot by the same method outlined in ASTM G 12 for measurement of film thickness of pipeline coatings on steel.

Paragraph 8. of Subsection 1021.02 is amended by changing the second sentence as follows:

The average number of holidays per foot (300 mm) shall not exceed one holiday per foot (300 mm) of coated bar.

SECTION 1022 -- DOWEL BARS

1022.02 -- Acceptance Requirements

Subsection 1022.02 is amended by renumbering the paragraph as Paragraph 1. and adding the following:

2. In addition to these certificates, two 6-foot (2 m) samples of the coated bar (for tension testing and bend testing) of each size bar and each heat number shall be sent to the NDR Materials and Tests Laboratory, Lincoln, Nebraska. These bars will be properly identified with tags showing the size and heat number.

SECTION 1028 -- ASPHALTIC CONCRETE

Section 1028 is void and superseded by:

SECTION 1028 -- SUPERPAVE ASPHALTIC CONCRETE

1028.01 -- Description

1. a. Superpave Asphaltic Concrete is a Contractor-designed mix.

b. The Contractor will be required to define properties using a gyratory compactor that has met the Superpave evaluation test procedures, during mix design and production.

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 blended materials.

c. (1) The Contractor shall submit 6 gyratory pucks prepared for moisture susceptibility and 3 proportioned 20 lb. (10,000-gram) samples of the blended mineral aggregates to be used in the mixture to the NDR Materials and Research Central Laboratory at least 10 NDR working days before production of asphaltic concrete. These samples will be used to correlate the Contractor's Superpave mix design test results.

(2) Submitted with these samples shall be a copy of the Contractor's results for all Superpave mix design tests.

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

(i) The bulk specific gravity of the blended aggregate. (The bulk specific gravity shall be determined from an unwashed sample.)

(ii) The target binder content.

(iii) The supplier and grade of PG Binder.

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

(v) The average bulk specific gravity and air voids at N initial (Nini), N design (Ndes) and N maximum (Nmax) of the compacted gyratory specimens.

(vi) Voids in the Mineral Aggregate (VMA) and Voids Filled with Asphalt (VFA) at Ndes.

(vii) Fine Aggregate Angularity (FAA), Coarse Aggregate Angularity (CAA), Flat and Elongated Particles and Clay Content of the aggregate blend.

(viii) Location description and/or legal descriptions and producers of materials used in the mix.

d. Before the mix design is approved, the Materials and Research Laboratory shall verify all properties.

3. PG Binder in Recycled Asphalt Pavement:

a. The Contractor may approach the State with a proposal to supplement the virgin aggregates of the asphaltic concrete mix with a Contractor's specified percentage of recycled asphalt pavement (RAP). The State may accept or reject the proposal based on whether the mix design meets the specified criteria of the asphaltic concrete proposed. The RAP may come from the project or an existing stockpile. The Contractor is responsible for investigating the quality and quantity of the RAP material.

b. In recycled asphaltic concrete mixtures, the allowable maximum percent of Reclaimed Asphalt Pavement (RAP) will be as shown in Table 1028.01. If the Contractor elects to exceed these values, the Contractor will be required to lower the minimum pavement design temperature of the PG Binder, one grade, according to AASHTO MP1.

Table 1028.01

Asphaltic Concrete Type	Percent, Maximum RAP
SPS	50
SP0	45
SP1	35
SP2	25
SP3	25
SP4	15
SP5	15

4. 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 conforms 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 no less than 10 NDR working days prior to the preconstruction conference or no less than 10 NDR working days prior to beginning production of project materials.

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

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.

(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 and manufacturers model number, 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 personnel:

(1) A 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 experience in highway construction.

(iii) The Program Administrator need not be on the job site at all times but shall have full authority to institute any and all actions necessary for the successful implementation of the QC Program.

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

(2) One or more 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 Research 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 Research Division.

(v) The Contractor may have a non-certified technician working under the direct supervision of a certified technician for no more than one construction season.

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 include the NDR statistically based procedure of random sampling for acquiring test samples.

(2) The Contractor may add any tests 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. Daily review by the Engineer will be allowed if requested.

(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) Plant produced mix gradations at laydown.

(II) Binder content.

(III) Air voids.

(IV) VMA

(V) VFA

(VI) FAA AASHTO T 304
CAA ASTM D 5821

(iii) Corrective actions that will be taken when the following conditions occur:

(I) Rutting

(II) Segregation

(III) Surface voids

1028.02 -- Material Characteristics

1. The type of PG Binder shall be shown in the plans or special provisions.

2. Aggregates:

a. Aggregates for use in superpave asphaltic concrete shall be tested on an individual basis.

b. With the exception of Asphaltic Concrete Type SPS the blended mineral aggregate shall not contain more than 60 percent limestone on the final surface lift of asphaltic concrete.

c. Crushed rock material for use in asphaltic concrete, 1/4 inch (6.35 mm) down, screenings and manufactured sand shall have a Sodium Sulfate loss of not more than 12 percent by mass at the end of 5 cycles. One 20-lb. (10-kg) sample shall be taken by NDR personnel at the project for every 5,000 tons (4500 Mg) of aggregate used, with a minimum of one per project for quality testing.

d. Quartzite, granite, and chat shall conform to the requirements of Subsection 1033.02, Paragraph 4, a. (8). One 60-lb. (30 kg) sample shall be taken by NDR personnel at the project every 3,000 tons (2700 Mg) of aggregate used, with a minimum of one per project for quality testing.

e. Crushed rock (Limestone) and Dolomite shall conform to the requirements of Subsection 1033.02, Paragraph 4.a. (4), (5) and (6). Sampling size and frequency shall adhere to the current NDR Materials

Sampling Guide. (Dolomitic aggregate can be adversely affected by burn ovens resulting in erroneous reading for asphalt content and gradation unless corrected for.)

f. Amend Paragraph 4.a. (7) of Subsection 1033.02 to provide that soundness tests shall not be required for fine sand.

g. Amend Subsection 1033.02 to provide that once the satisfactory quality of aggregates from a source has been established, sufficient additional soundness tests will be performed to insure the continued satisfactory quality of the material.

h. The coarse aggregate angularity value of the blended aggregate material shall meet or exceed the minimum values for the appropriate asphaltic concrete type shown in these provisions and position within the pavement structure according to Table 1028.02.

Table 1028.02
Coarse Aggregate Angularity
(ASTM D 5821)

Asphaltic Concrete Type	Depth from the Surface	
	4 inches (100 mm) or less	Greater than 4 inches (100 mm)
SPS	35	--
SP0	55	--
SP1	55	--
SP2	65	--
SP3	75	50
SP4	85/80*	60
SP5	95/90*	80/75*

* Denotes two faced crushed requirements

(1) For any asphaltic concrete that is placed at a depth greater than 4 inches (100 mm) from the surface, the Contractor shall have the option of using the more stringent requirements under the coarse aggregate angularity heading "4 inches (100 mm) or less", for the full depth of the Superpave mixture.

i. The fine aggregate angularity value of the blended aggregate material from the fine and coarse aggregates shall meet or exceed the minimum values for the appropriate asphaltic concrete type shown in these provisions and position within the pavement structure according to Table 1028.03.

Note: The specific gravity for calculation of the Fine Aggregate Angularity (FAA) shall be based on material passing the No. 8 (2.36 mm) sieve and retained on the No. 100 (150 μm) sieve.

Table 1028.03
Fine Aggregate Angularity
(AASHTO T304 Method A)

Asphaltic Concrete Type	Depth from the Surface	
	4 inches (100 mm) or less	Greater than 4 inches (100 mm)
SPS	--	--
SP0	--	--
SP1	40	--
SP2	40	40
SP3	40	40
SP4	45	43
SP5	45	45

(1) For any asphaltic concrete that is placed at a depth greater than 4 inches (100 mm) from the surface, the Contractor shall have the option of using the more stringent requirements under the fine aggregate angularity heading "4 inches (100 mm) or less", for the full depth of the Superpave mixture.

j. The coarse aggregate shall not contain flat and elongated particles exceeding the maximum value for the appropriate asphaltic concrete type category shown in these provisions according to Table 1028.04.

Table 1028.04
Flat and Elongated Particles
(ASTM D 4791)

Asphaltic Concrete Type	Percent, Maximum
SPS	25
SP0	10
SP1	10
SP2	10
SP3	10
SP4	10
SP5	10

Criterion based on a 5:1 maximum to minimum ratio.

k. The sand equivalent of the blended aggregate material from the fine and coarse aggregates shall meet or exceed the minimum values for the appropriate asphaltic concrete type shown in these provisions according to Table 1028.05.

Table 1028.05
Clay Content Criteria
(AASHTO T 176)

Asphaltic Concrete Type	Sand Equivalent, Minimum
SPS	30
SP0	40
SP1	40
SP2	40
SP3	45
SP4	45
SP5	45

l. The blended aggregate shall conform to the gradation requirements specified below for the appropriate nominal size.

(1) It is recommended that the selected blended aggregate gradation does not pass through the restricted zones as specified in the following control points for nominal size. Superpave mix designs with FAA

values less than 45 will not be approved if the blended aggregate gradation passes through the restricted zone.

Table 1028.06
Gradation Control Points for 0.375 Inch (9.5 mm) Nominal Size

	Control Points (percent passing)		Restricted Zone Boundary (percent passing)	
English Sieve (Metric)	**Minimum**	**Maximum**	**Minimum**	**Maximum**
1/2 inch (12.5 mm)	100.0			
3/8 inch (9.5 mm)	90.0	100.0		
No. 4 (4.75 mm)		90.0		
No. 8 (2.36 mm)	32.0	67.0	47.2	47.2
No. 16 (1.18 mm)			31.6	37.6
No. 30 (600 µm)			23.5	27.5
No. 50 (300 µm)			18.7	18.7
*No. 200 (75 µm)	2.0	10.0		

* see note following Table 1028.08

Table 1028.07
Gradation Control Points for 0.5 Inch (12.5 mm) Nominal Size

	Control Points (percent passing)		Restricted Zone Boundary (percent passing)	
English Sieve (Metric)	**Minimum**	**Maximum**	**Minimum**	**Maximum**
3/4 inch (19 mm)	100.0			
1/2 inch (12.5 mm)	90.00	100.00		
3/8 inch (9.5 mm)		90.00		
No. 8 (2.36 mm)	28.0	58.0	39.1	39.1
No. 16 (1.18 mm)			25.6	31.6
No. 30 (600 µm)			19.1	23.1
No. 50 (300 µm)			15.5	15.5
* No. 200 (75 µm)	2.0	10.0		

* see note following Table 1028.08

Table 1028.08
Gradation Control Points for 0.75 Inch (19 mm) Nominal Size

	Control Points (percent passing)		Restricted Zone Boundary (percent passing)	
English Sieve (Metric)	**Minimum**	**Maximum**	**Minimum**	**Maximum**
1 inch (25 mm)	100.0			
3/4 inch (19 mm)	90.0	100.0		
1/2 inch (12.5 mm)		90.0		
No. 8 (2.36 mm)	23.0	49.0	34.6	34.6
No. 16 (1.18 mm)			22.3	28.3`
No. 30 (600 µm)			16.7	20.7
No. 50 (300 µm)			13.7	13.7
* No. 200 (75 µm)	2.0	8.0		

* Dust to binder ratio is the ratio of the percentage by weight of aggregate finer than the No. 200 (75 µm) sieve to the effective asphalt content expressed as a percent by weight of total mix. Effective asphalt content is the total asphalt used in the mixture less the percentage of absorbed asphalt. The dust to binder ratio shall be between 0.6 and 1.2. This shall be verified during mix design approval.

m. The combined mineral aggregate for Asphaltic Concrete, Type SPS, shall be an aggregate or a combination of aggregates, and mineral filler if needed. The field target air voids shall be a minimum of 1.5 percent with maximum field air voids of 5.0 percent, based on the moving average of four tests.

Table 1028.09
Gradation Control Points for Type SPS

	Control Points (percent passing)	
English Sieve (Metric)	**Minimum**	**Maximum**
1 inch (25 mm)	100.0	
3/4 inch (19 mm)	94	100.0
1/2 inch (12.5 mm)	81	94
No. 8 (2.36 mm)	42	70
No. 16 (1.18 mm)	29	43
No. 30 (600 µm)	19	34
No. 50 (300 µm)	11	20
* No. 200 (75 µm)	2	8

n. Mineral filler shall consist of pulverized soil, pulverized crushed rock, broken stone, gravel, sand-gravel, sand or a mixture of these materials that conforms to the following requirements.

Table 1028.10
Mineral Filler for Type SPS

	Min.	Max.
Total Percent Passing the No. 50 (300 µm) Sieve	95	100
Total Percent Passing the No. 200 (75 µm) Sieve	80	100
Plasticity Index (material passing the No. 200 (75 µm) Sieve, except soil	0	3
Plasticity Index for Soil	0	6

3. 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) at or near the project location:

(1) An AASHTO approved gyratory compactor and molds.

(2) An AASHTO approved Asphalt Content Ignition Oven.

(3) Rice equipment

(4) FAA equipment

(5) To test density of compacted asphaltic concrete, 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.

(6) QC Laboratory (suggested size 8 ft. x 45 ft.) (2.4 m x 13.7 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.

(7) Diamond saw for cutting cores.

(8) Diamond core drill (6 inch (150 mm) and 4 inch (100 mm) diameter core.

(9) Oven, 347°F (175°C) minimum, sensitive ±5°F. (±2°C).

(10) USA Standard Series Sieves for coarse and fine aggregate with appropriate shakers (12 inch (300 mm) recommended).

(11) Personal Computer and Color Printer.

1028.03 -- Acceptance Requirements

1. Volumetric Mix Design

a. The job mix formula shall be determined from a mix design for each mixture. A volumetric mixture design in accordance with the latest edition of the Asphalt Institute Publication, SP-2, will be required. However, the mixture for the Superpave specimens and maximum specific gravity mixture shall be short-term aged for two hours.

(1) Practice for Short and Long-Term Aging of Hot Mix Asphalt (HMA), AASHTO TP2

(2) Practice for Volumetric Analysis of Compacted Hot Mix Asphalt, AASHTO PP19

(3) Method for Preparing and Determining the Density of Hot Mix Asphalt Specimens by Means of the SHRP Gyratory Compactor, AASHTO TP4

b. The optimum binder content shall be the binder content that produces 4.0 percent air voids at Ndes. The design shall have at least four points, including a minimum of two points above and one point below the optimum. The amount of uncompacted mixture shall be determined in accordance with AASHTO T209.

c. Changes in the types or sources of aggregates shall require a new job mix formula, mix design and moisture susceptibility test. The new proposed job mix formula shall be in accordance with the requirements as stated above and submitted 5 working days prior to use for approval.

d. Each Superpave mixture shall be tested for moisture susceptibility in accordance with AASHTO T283. The loose mixture shall be short-term aged for two hours in accordance with AASHTO TP2. The 6-inch specimens shall be compacted in accordance with AASHTO TP4 to seven percent air voids and evaluated to determine if the minimum Tensile Strength Ratio (TSR) of 80 percent has been met. If the mixture has not met the minimum TSR value, an anti-stripping additive shall be added to the mix at a dosage rate, such that the mix will meet the minimum TSR of 80 percent. All data shall be submitted with the mix design for approval. Moisture susceptibility testing is not required for Asphaltic Concrete Type SPS.

(1) Moisture susceptibility tests will be for mix design approval only. If tests for mix design approval indicate the need for an anti-striping additive, then the Contractor shall be compensated for the cost of the additive needed.

e. Design Criteria:

(1) The target value for the air voids of the asphaltic concrete design shall be 4 percent at the Ndes number of gyrations.

Table 1028.11
Gyratory Compaction Effort
(Average Design High Air Temperature ≤39 degrees C)

Asphaltic Concrete Type	Nini	Ndes	Nmax
SPS	6	40	62
SP0	6	50	74
SP1	7	68	104
SP2	7	76	117
SP3	7	86	134
SP4	8	96	152
SP5	8	109	174

(2) The design criteria for each mixture shall be determined from Tables 1028.12, 1028.13, and 1028.14.

Table 1028.12

Mix Criteria	SPS,SP0,SP1	SP2	SP3,SP4,SP5
Voids In Mineral Aggregate	See Table 1028.13		
Voids Filled with Asphalt	See Table 1028.14		
%Gmm at Nini	91.5*	90.5	89.0
%Gmm at Nmax	98.0*	98.0	98.0

* No specification requirement for SPS, only %Gmm at Ndes = 95 to 98.5

Table 1028.13
Voids in Mineral Aggregate
Criteria at Ndes

Nominal Maximum Aggregate Size (Metric)	Minimum VMA, Percent*
3/8 inch (9.5 mm)	15.0
1/2 inch (12.5 mm)	14.0
3/4 inch (19 mm)	13.0
1 inch (25 mm)	12.0
1 1/2 inch (37.5 mm)	11.0

* No specification requirement for SPS

Table 1028.14
Voids Filled with Asphalt
Criteria at Ndes

Asphaltic Concrete Type	Design VFA, Percent
SPS	N/A
SP0	70 – 80
SP1	70 – 80
SP2	65 – 78
SP3	65 – 78
SP4	65 – 75
SP5	65 – 75

2. The Contractor shall make Mix adjustments when:

a. Air voids, VMA, VFA, FAA, CAA or Binder 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 in the 1997 English and Metric Edition of the Standard Specifications.

c. Pavement does not meet any other design criteria.

d. Rutting occurs.

3. Mix adjustments at the plant are authorized within the limits shown in Table 1028.15 without redesigning the initially approved mix:

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

b. All adjustments must be reported to the Engineer.

Table 1028.15

Aggregate Adjustments	
Sieve Size	**Adjustments**
1 inch (25 mm), 3/4 inch (19 mm), 1/2 inch (12.5 mm), 3/8 inch (9.5 mm)	± 6%
No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 µm), No.50 (300 µm)	± 4%
No. 200 (75 µm)	± 2%

c. The adjustment values in Table 1028.15 will be the tolerances allowed for adjustments from the NDR verified mix design “Combined Gradation” target values which resulted from production or mix design adjustments, but cannot deviate from Superpave gradation criteria, or pass through the restricted zone when the mix FAA value is less than 45.

4. Sampling and Testing:

a. The Contractor shall take samples at locations identified by the Engineer, according to the NDR statistically-based procedure. The samples shall be approximately 75 pounds (34 kg), transported to the test facility in an insulated container and split according to NDR T-248.

b. All samples and companion samples within a Lot shall be identified, stored, and retained by the Contractor until the NDR has completed the verification testing process.

c. (1) The sample shall be taken from the roadway, behind the paver before compaction.

(2) At least one QC sample shall be tested for every 750 tons (680 Mg) of plant produced mix.

(i) If, at the completion of the project, the final lot consists of less than 3,750 tons (3,400 Mg)of asphaltic concrete, 1 sample for each 750 tons (680 Mg) or fraction thereof, shall be taken and tested.

(3) Additional sampling and testing for the Contractor's information may be performed at the Contractor's discretion. Any additional testing will not be used in pay factor determination.

(4) At the project start-up and when a substantial aggregate proportion or other major mix change has been made, at least 1 sample shall be taken from the first 300 tons (270 Mg) of production.

(5) At least one CAA and FAA sample shall be taken and tested daily by the Contractor. The FAA and CAA may be sampled from the blended cold feed material but in addition the Contractor will be required to test FAA and CAA from a roadway sample using an ignition oven sample for correlation. If the coarse portion of the blend is all ledge rock the CAA tests can be waived. If the samples tested with the ignition over meets the CAA and FAA minimum requirement, then the cold feed sample does not have to be tested.

(6) For projects using RAP material the FAA shall be established as follows:

A RAP sample will be processed through an ignition oven and then combined with the proportioned amount of virgin aggregate defined by the mix design and then proceeding with the FAA testing.

d. Samples should not be taken from the first 110 tons (100 Mg) of mix produced or after a significant mix change.

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

f. Each production sample shall be tested as follows:

(1) (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.

(iv) At the Contractor's request, upon evidence that the 3 Bulk Specific Gravity specimens are exhibiting consistency in their results, The Materials and Research Central Laboratory may reduce the number of specimens to 2.

(2) 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.

(3) (i) The Blended Aggregate Bulk Specific Gravity (Gsb) shall be determined from the individual aggregate component bulk specific gravity's.

(ii) AASHTO T 84 - Specific Gravity and Absorption of Fine Aggregate.

(iii) AASHTO T 85 - Specific Gravity and Absorption of Coarse Aggregate.

Table 1028.16

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

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

G1, G2 ..... Gn = Bulk specific gravity's of individual aggregate components.

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

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

Table 1028.17

$$Gmb(corr)@Nany = Gmb(meas)@Nmax \times \left(height@Nmax \div height@Nany \right)$$

$$\%Gmm(corr)@Nany = 100 \times \left(Gmb(corr)@Nany \div Gmm(meas) \right)$$

$$\%\ Air\ Voids@Nany = 100 - \%Gmm(corr)@Nany$$

$$VMA@Ndes = 100 - \left(Gmb(corr)@Ndes \times Ps \div Gsb \right)$$

$$VFA@Ndes = 100 \times \left((VMA@Ndes - \%\ Air\ Voids@Ndes) \div VMA@Ndes \right)$$

Measured = (meas)

Corrected = (corr)

(5) The percent of PG Binder shall be determined for each production day or portion of a day. The percent of PG Binder is based on the total weight of the PG Binder used, based on the tank stab, divided by the total asphaltic concrete mix's weight.

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

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 provided by the NDR 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 single test results.

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 for review by the Engineer.

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

(3) As a minimum, the following values shall be plotted or reported on NDR provided forms as indicated below:

(i) Laboratory Gyratory density (each point being an average of 3 specimens) will be reported.

(ii) Ignition oven or cold feed aggregate gradations for all Superpave sieves will be reported.

(iii) PG Binder content shall be plotted to the nearest 0.1 percent by ignition oven results in accordance with AASHTO TP 53.

(iv) The theoretical maximum specific gravity (Rice) to the nearest 0.001 percent will be reported.

(v) Laboratory Gyratory air voids at Ndes shall be plotted to nearest 0.1 percent. Laboratory Gyratory air voids, at Nini, Ndes and Nmax shall be reported to nearest 0.1 percent.

(vi) FAA and CAA of the asphaltic concrete for both cold feed and ignition oven samples will be reported to the nearest 0.1 percent.

(vii) VMA content shall be plotted to nearest 0.1 percent and VFA shall be reported to the nearest 0.1 percent.

i. Independent Assurance (IA) Review of Testing:

(1) The Contractor will allow NDR personnel access to their laboratory to conduct IA review of technician testing procedures and apparatus. Any deficiencies discovered in testing procedures will be noted and corrected.

(2) During IA review, NDR personnel and the Contractor will split a sample for the purpose of IA testing. The sample(s) selected will be tested in the NDR Branch Laboratory. Any IA test results found to be outside of defined testing tolerances will be noted. The Contractor must then verify the testing apparatus and make connections if the apparatus is out of tolerance.

(3) Testing Tolerances

(i) Asphaltic Concrete and Asphaltic Concrete Aggregates.

Test	Tolerance
Asphalt Content by Ignition Oven	0.5%
Gyratory Density	0.02
Maximum Specific Gravity	0.015
Bulk Dry Specific Gravity (for Mix Design)	0.028
FAA	0.5%
CAA	10.0%

(4) Aggregate Gradation (Blended Aggregate)

Size Fraction Between Consecutive Sieves, %	Tolerance
0.0 to 3.0	2%
3.1 to 10.0	3%
10.1 to 20.0	5%
20.1 to 30.0	6%
30.1 to 40.0	7%
40.1 to 50.0	9%

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

b. Two consecutive points outside the *Specification* limits or a (50% or reject) 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 points fall outside the *Specification* limits shall subject all subsequent material to be rejected.

6. Verification Sampling and Testing:

a. The NDR will select and test at random one of the sublot samples (750 tons, 680 Mg) within a Lot (3750 tons, 3400 Mg) for verification and report results in a timely manner.

b. The results of Contractor QC testing will be verified by NDR verification tests. On any given Lot, if the results of Air Void verification testing and its companion QC testing are within 1.4 percent air voids, the Air Void verification for the entire Lot is complete and the Contractor test results will be used to determine the pay factors. If the Air Void verification test results and the companion QC test results are outside the above tolerance, the results from the verification test will be used to determine the pay factor for that sublot. Any or all of the remaining four NDR sublot samples may be tested and the NDR sublot test results may be applied to the respective sublots and the resulting pay factors will apply.

c. When verification test results show a consistent pattern of deviation from the QC results, the Engineer may cease production and request additional verification testing or initiate a complete IA review.

d. If the project personnel and the Contractor cannot reach agreement on the accuracy of the test results, the Materials and Research Laboratory will be asked to resolve the dispute, which will be final.

7. Acceptance and Pay Factors

a. Acceptance and pay factors for Asphaltic Concrete Type SPS will be based on compacted in place average density.

b. Acceptance and pay factors for Asphaltic Concrete Type SP0, SP1, SP2, SP3, SP4 and, SP5 will be based on single test air voids, running average air voids and compacted in place average density.

(1) These three individual pay factors will be multiplied by each other to determine a total pay factor for each sublot [(750 tons) (680 Mg)].

8. Asphaltic Concrete Air Voids

a. Normally, 1 sample for testing will be taken from each sublot [(750 tons) (680 Mg)] at locations determined by the Engineer.

b. The pay factors for the single test air voids and moving average of four air voids pay factors will be determined in accordance with table 1028.18.

c. If the average air voids pay factor is (50% or reject) the NDR will have the first option of accepting or rejecting the asphaltic concrete represented in this sublot. If the NDR accepts this sublot the Contractor will have the second option of replacing this asphaltic concrete for no pay on the removal and for whatever pay factor that applies to the replacement.

d. In the case of removal, the foremost limits of the removal will be defined as the tonnage (mass) at which the production and placement was halted and a design change was made. The rear limits will be at the tonnage (mass) where linear interpolation with the previous test return to an accepted range and out of rejection limits or at the limit(s) of the defective material as determined by additional core samples taken and tested by the Contractor which show result(s) in an acceptable range and out of rejection limits to the satisfaction of the Engineer.

Table 1028.18

Acceptance Schedule Air Voids - N_{des}		
Air voids test results	**Moving average of four**	**Single test**
Less than 1.5%	Reject	Reject
1.5% to less than 2.0%	Reject	50%
2.0% to less than 2.5%	50% or Reject	95%
2.5% to less than 3.0%	90%	100%
3.0% to less than 3.5%	100%	100%
3.5% to 4.5%	102%	102%
Over 4.5% to 5.0%	100%	100%
Over 5.0% to 5.5%	95%	100%
Over 5.5% to 6.0%	90%	95%
Over 6.0% to 6.5%	50% or Reject	90%
Over 6.5% to 7.0%	Reject	50%
Over 7.0%	Reject	Reject

9. Asphalt Concrete Density Samples:

a. Density tests will be performed by the Contractor under direct observation of NDR personnel. The Contractor will establish the method of testing in the preconstruction conference and shall be tested in accordance with the NDR T 166 or NDR T 587. The Contractor will insure that the proper adjustment bias and/or correction factors are used and accessible to NDR personnel along with all other inputs when NDR T 587 is selected. All disputed values determined using NDR T 587 shall be resolved using NDR T 166.

b. Density of samples shall be determined by comparing the specific gravity of the core sample to the Maximum Specific Gravity (Rice) as follows:

$$\% \text{ Density} = \frac{\text{Specific Gravity of Core}}{\text{Maximum Mix Specific Gravity (Rice)}} \times 100$$

where:

$$\text{Sp. Gr. of Core} = \frac{\text{Wt. of Core in Air}}{\text{Wt. of SSD Core - Wt. of Core in Water}}$$

$$\text{Maximum Mix Specific Gravity (Rice)} = \frac{\text{Wt. of Mix in Air}}{\text{Wt. of Mix in Air - Wt. of Mix in Water}}$$

Note: The Maximum Mix Specific Gravity (Rice) value used to calculate the density of each core shall be the average value determined by the Contractor for the day's production that the core represents. If only 1 or 2 Maximum Mix Specific Gravity (Rice) values are determined in a given day then the value used will be the moving average value at the end of that day's testing.

c. Either 4 inch (100 mm) or 6 inch (150 mm) diameter core samples shall be cut by the Contractor the first day of work following placement of the mixture.

d. Normally, 1 sample for determination of density will be taken from each sublot (750 tons) (680 Mg) at locations determined by the Engineer.

e. The theoretical maximum density for each lot (3,750 tons) (3,400 Mg) shall be calculated using AASHTO T 209.

f. The average density of the lot shall be used to compute the pay factor for density. Exceptions to the sampling and testing of core samples for the determination of density are as follows:

(1) When the nominal layer thickness is 1 inch (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 1 inch (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 1 inch (25 mm), but some of the cores are less than 1 inch (25 mm) thick, additional cores shall be cut at randomly selected locations to provide 5 samples of more than 1 inch (25 mm) thickness for the determination of the pay factor for density.

g. For the first lot (3,750 tons) (3,400 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 1028.19. After the completion of the first lot, the pay factor for density shall be computed in accordance with Table 1028.20.

h. (1) If, at the completion of the project, the final lot consists of less than 3,750 tons (3400 Mg) of asphaltic concrete, a minimum of 3 samples, or 1 sample for each 750 tons (680 Mg) or fraction thereof, whichever is greater, shall be taken and tested for density.

(2) The test results shall be averaged and the density pay factor based on the values shown in Table 1028.20.

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

Table 1028.19

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 1028.20

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

i. If requested by the Contractor, one complete set of check tests or one check test for any individual low density test in the original set, taken no later than the working day following placement, or not later than when traffic will allow 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.

SECTION 1029 – ASPHALT CEMENT

The Department has stopped using the term "Asphalt Cement" and will use the term "Performance Grade Binder" to mean asphalt cement. All references to "Asphalt Cement" should be changed to "Performance Graded Binder".

SECTION 1033 -- AGGREGATES

1033.02 -- Material Characteristics

Table 1033.07 is amended to provide that the gradation limit for the No. 4 (4.75 mm) sieve shall have a target value of 78 and a tolerance of ± 17.

In Paragraph 4.a.(8) of Subsection 1033.02, add chat as an acceptable aggregate and change "Asphalt Concrete Types 13 and 15" to "Asphalt Concrete". Also delete Paragraph (9) and Paragraph (11).

In Paragraph 6.b. of Subsection 1033.02, change the soundness limit from 12 percent to 5 percent.

SECTION 1035 -- CORRUGATED METAL PIPE

Section 1035 is void and superseded by the following:

SECTION 1035 -- CORRUGATED METAL PIPE

1035.01 -- Description

Corrugated metal pipe, pipe-arches, and underdrains shall be zinc-coated (galvanized) steel, aluminum-coated steel, or Grade 10/10 polymer pre-coated steel.

1035.02 -- Material Characteristics

1. Corrugated metal pipe, pipe-arches, and underdrains shall conform to the applicable requirements of AASHTO M 36 or ASTM A 929.

2. Zinc-coated steel or aluminum-coated steel materials shall not be mixed in any installation.

3. Bolts, nuts, washers and all other hardware items used with coupling bands shall be galvanized in accordance with AASHTO M 232 (ASTM A 153) or mechanically galvanized in accordance with AASHTO M 298 (ASTM B 695) Class 50.

4. In the repair of damaged coating on elbows, pipe and special fittings which are fabricated by methods which damage their coating, both the interior and exterior surfaces of the damaged area shall be thoroughly cleaned and all traces of welding flux and weld spatter shall be removed. The cleaned area shall then be painted with zinc-rich paint at the fabricating plant, in accordance with Section 1061.

5. The mass of metallic coating may be determined by the use of magnetic thickness gages in accordance with ASTM E 376. In cases of dispute, additional samples shall be tested in accordance with AASHTO T 65 or AASHTO T 213, as applicable.

6. Unless otherwise specified on the plans, the minimum sheet thickness for metal culverts shall be as follows:

Table 1035.01
Steel and Aluminum Culvert Thickness

Nominal Diameter Inches (mm)	Sheet Thickness Inches (mm)
8 thru 24 (200 – 600)	0.057 (1.45)
30 thru 36 (760 – 900)	0.072 (1.83)
42 thru 54 (1060 –1370)	0.101 (2.57)
60 thru 72 (1520 – 1830)	0.129 (3.28)
Over 72 (1830)	0.159 (4.04)

7. Coupling or connecting bands with projections (often referred to as dimple bands) are not acceptable.

1035.03 -- Acceptance Requirements

Corrugated metal pipe will be accepted based on the requirements of this Section and sampling and testing requirements as prescribed in the *NDR Materials Sampling Guide.*

SECTION 1036 -- METAL FLARED-END SECTIONS

Section 1036 is void and superseded by the following:

SECTION 1036 -- METAL FLARED-END SECTIONS

1036.01 -- Description

Flared-end sections for corrugated metal pipe shall be zinc-coated (galvanized) steel or aluminum-coated steel.

1036.02 -- Material Characteristics

1. Material used in the manufacturing of flared-end sections shall conform to the applicable requirements of AASHTO M 36 or ASTM A 929.

2. Metal flared-end sections shall be of the design shown on the plans.

3. Bolts, nuts, washers and all other hardware items used with coupling bands shall be galvanized in accordance with AASHTO M 232 (ASTM A 153) or mechanically galvanized in accordance with AASHTO M 298 (ASTM B 695) Class 50.

4. In the repair of damaged coating on flared-end sections which are fabricated by methods which damage their coating, both the interior and exterior surfaces of the damaged area shall be thoroughly cleaned and all traces of welding flux and weld spatter shall be removed. The cleaned area shall then be painted with zinc-rich paint at the fabricating plant, in accordance with Section 1061.

5. The mass of metallic coating may be determined by the use of magnetic thickness gages in accordance with ASTM E 376. In cases of dispute, additional samples shall be tested in accordance with AASHTO T 65 or AASHTO T 213, as applicable.

6. Unless otherwise specified on the plans, the minimum sheet thickness for fabricating metal flared-end sections shall be as follows:

Table 1036.01
Steel and Aluminum Flared-End Thickness

Nominal Diameter Inches (mm)	Sheet Thickness Inches (mm)
12 thru 24 (300-600)	0.057 (1.45)
30 thru 36 (760-900)	0.072 (1.83)
42 thru 84 (1060-2100)	0.101 (2.57)

7. Coupling or connecting bands with projections (often referred to as dimple bands) are not acceptable.

1036.03 -- Acceptance Requirements

Metal flared-end sections will be accepted based on the requirements of this section and sampling and testing requirements as prescribed in the *NDR Materials Sampling Guide*.

SECTION 1037 -- REINFORCED CONCRETE PIPE, MANHOLE RISERS, AND FLARED-END SECTIONS

Section 1037 is void and superseded by the following:

SECTION 1037 -- REINFORCED CONCRETE PIPE, MANHOLE RISERS, AND FLARED-END SECTIONS

1037.01 -- Description

This *Specification* provides NDR criteria for Reinforced Concrete Pipe (Round, Elliptical, Pipe-Arch), Reinforced Concrete Manhole Risers, and Concrete Flared-End Sections.

1037.02 -- Material Characteristics

1. Each flared-end or pipe section shall have all AASHTO required markings indented, scribed, or marked with permanent water-proof marking paint on the inside top (lift hole side) of each section at the time of manufacture. Furthermore, each section shall also have as a minimum requirement, the class and date of manufacture scribed or indent printed on the outside of the pipe.

2. Reinforced concrete pipe shall be the class as permitted by the NDOR plans and Specifications.

3. a. Round reinforced concrete pipe shall conform to the requirements of AASHTO M 170 with the exception of the minimum

circumferential reinforcing (in^2/ft (mm^2/m) of pipe wall) for 15, 21 and 24 inch (380, 460, 530, 600 mm) Class III pipe, as shown below.

b. AASHTO M 170 Specifications are modified as follows:

c. Only single inner cage, circular reinforcing is allowed for Class III, 15, 18, 21, and 24 inch (380, 460, 530, 600) round RCP as shown:

Table 1037.01

Pipe Size (in) [mm]	Class	Minimum Circumferential Reinforcing (in^2/ft of Pipe Wall) (cm^2/m)
15 [380]	III	0.08 (1.7)
18 [460]	III	0.10 (2.1)
21 [530]	III	0.12 (2.5)
24 [600]	III	0.14 (3.0)

4. Reinforced concrete arch pipe shall conform to the requirements of AASHTO M 206.

5. Reinforced concrete elliptical pipe shall conform to the requirements of AASHTO M 207.

6. Precast reinforced concrete manhole risers, steps, and tops shall conform to the requirements of AASHTO M 199.

7. Concrete flared-end sections shall be of the design shown in the plans and in conformance with the applicable requirements of AASHTO M 170, Class II pipe, AASHTO M 206, Class A-II pipe, or AASHTO M 207, Class HE-II pipe for the diameter of pipe on which it is to be installed.

1037.03 -- Acceptance Requirements

Reinforced concrete pipe, manhole risers, and flared-end sections will be accepted based on the requirements of this Section and sampling and testing requirements in accordance with the *NDR Materials Sampling Guide.*

SECTION 1038 -- PLASTIC PIPE

Section 1038 is void and superseded by the following:

SECTION 1038 -- PLASTIC PIPE

1038.01 -- Description

High density polyethylene (HDPE), polyvinyl chloride (PVC) , and other NDR approved plastic pipes are authorized for use as stipulated in the contract documents.

1038.02 -- Material Characteristics

1. High density polyethylene (HDPE) pipes and fittings shall conform to the following Specification requirements for the size required:

Table 1038.01
Polyethylene Pipe

Size	Specification	Description
15 to 36 in (375 to 900 mm)	AASHTO M 294	Corrugated Polyethylene, Type C or S (Cell Class 335420C)
18 to 36 in (450 to 900 mm)	ASTM F 894	Profile, CP, OP, RSC 160 (Cell Class 335434C)

2. Polyvinyl Chloride (PVC) [Cell Classification 12454C or 12364C (as determined by ASTM D-1784) if applicable] pipe and fittings shall conform to the following Specification requirements for the size required:

Table 1038.02
Polyvinyl Chloride Pipe

English Size (Metric)	Specification	Description
18 to 36 in (450 to 900 m)	ASTM F 679	Gravity Sewer Pipe & Fittings
15 to 36 in (375 to 900 m)	ASTM F 794	Profile Gravity Sewer Pipe & Fittings, CP,OP, Series 46
15 to 36 in (375 to 900 m)	ASTM F 949	Corrugated Sewer Pipe w/smooth Interior with Fittings
15 in (375 m)	ASTM D 2680	Composite Sewer Pipe
15 in (375 mm)	ASTM D 3034	Type PSM Sewer Pipe & Fittings, SDR 35

3. Plastic pipe for underdrains shall conform to the requirements of AASHTO M 252, ASTM F 405, ASTM F 794 or ASTM F 949 for perforated or non-perforated pipe. Perforations for ASTM F 794 PVC pipe shall be slotted as per ASTM F 949.

4. Metal flared-end sections shall conform to the requirements in Section 1036.

5. A 6-foot (2 m) sample of each size and type of plastic pipe shall be sent to the NDR Materials and Tests Laboratory in Lincoln for testing, before being incorporated into the project.

1038.03 -- Acceptance Requirements

Plastic pipe will be accepted based on the requirements of this Section and sampling and testing requirements in accordance with the *NDR Materials Sampling Guide.*

SECTION 1041 -- DRAIN TILE

1041.01 -- Description

Paragraph 1. of Subsection 1041.01 is void.

SECTION 1043 -- FLAP GATES

1043.03 -- Acceptance Requirements

Subsection 1043.03 is void and superseded by the following:

Flap gates approved for use are shown in the plans.

SECTION 1044 -- BAR GRATES FOR FLARED END SECTIONS

Section 1044 is void and superseded by the following:

SECTION 1044 -- BAR GRATES FOR FLARED END SECTIONS

1044.01 -- Description

This specification covers bar grates for use with metal and reinforced concrete flared-end sections.

1044.02 -- Material Characteristics

1. Bar grates shall be constructed as prescribed in the plans. Bar grates shall be fabricated from plates and round smooth bars complying with the requirements of ASTM A 36/A 36M or ASTM A 575, Grade 1020.

2. Coatings

a. Paint

(1) Two separate coats of paint shall be applied to the grates in accordance with Section 709.

(2) The first coat shall be inorganic zinc-silicate primer.

(3) The second coat shall be brown or beige paint.

(4) All painting may be done in the shop.

(5) All paint shall comply with the requirements of Section 1077.

b. TGIC Polyester Coating

(1) Acceptable coating materials are on the NDR Approved Products List.

(2) Apply the coating as recommended by the manufacturer (3 mil (76 um) minimum).

c. Galvanized

(1) Hot-dip galvanized in accordance with ASTM A 123.

1044.03 -- Acceptance Requirements

Bar grates will be accepted on the basis of a fabricator's certificate showing compliance with these Specifications.

SECTION 1058 -- HIGH TENSILE BOLTS, NUTS, AND WASHERS

1058.02 -- Material Characteristics

Paragraph 1.a. of Subsection 1058.02 is void and superseded by the following:

a. The minimum tensile strength for bolts with a diameter that is equal to or less than 1 inch (25 mm) shall be 150,000 psi (10300 MPa). Bolts with diameters that are larger than 1 inch (25 mm) shall have a minimum tensile strength equal to 120,000 psi (8200 MPa).

SECTION 1064 -- FENCES

1064.02 -- Material Characteristics

Paragraph 1.b.(2) of Subsection 1064.02 is void and superseded by the following:

(2) Tubular steel pipe shall conform to the requirements of ASTM F 1083 Schedule 40 pipe. Pipe shall be coated in accordance with ASTM F 1043, Types A or C.

The last sentence of Subparagraph 1.c.(1) is void and superseded by the following:

Posts shall be coated in accordance with ASTM F 1043, Types A or C.

The last sentence of Subparagraph 1.c.(2) is void and superseded by the following:

Posts shall be coated in accordance with ASTM F 1043, Types A or C.

The last sentence of Subparagraph 1.c.(3) is void and superseded by the following:

Top rails and braces shall be coated in accordance with ASTM F 1043, Types A or C.

Paragraph 2.a. of Subsection 1064.02 is void and superseded by the following:

a. The woven wire fence fabric shall be 47 inches (1190 mm) high, have 10 horizontal wires, and have stay wires spaced on 6-inch (150 mm) centers. The intermediate line wires shall have a minimum breaking strength of 685 pounds (3050 N). The top and bottom wires shall have a minimum breaking strength of 1030 pounds (4590 N).

Paragraph 2.b.(1) of Subsection 1064.02 is void and superseded by the following:

(1) Zinc-coated steel woven wire fence fabric shall conform to the requirements of ASTM A 116 except that the minimum zinc coating shall be 0.80 oz/ft^2 (244 g/m^2).

In the Metric Edition only; Paragraph 2.c.(2) of Subsection 1064.02, change the reference to "Paragraph 2." to "Paragraph 1.b.":

Paragraph 3.a.(1)(ii) of Subsection 1064.02 is void and superseded by the following:

(ii) At his/her option, the Contractor may furnish two-strand high tensile strength steel barbed wire, 0.067 inch (1.70 mm)in diameter, meeting the requirements of ASTM A 121 except that the minimum zinc coating shall be 0.80 oz/ft^2 (244 g/m^2). The barbs shall be 4 point, 16-½ gauge (0.058 inch) (1.47 mm), at 5-inch (125 mm) centers.

Paragraph 3.a.(2) of Subsection 1064.02 is void and superseded by the following:

(2) Aluminum-coated steel barbed wire shall be 12-½ gauge (0.099 inch) (2.51 mm) in diameter conforming to the requirements of ASTM A 585. The barbs shall be 4 point, 14 gauge (0.080 inch) (2.03 mm) at 5-inch (125 mm) centers.

SECTION 1065 -- POLYSTYRENE BOARD FILLERS

1065.03 -- Acceptance Requirements

Subsection 1065.03 is void and superseded by the following:

Polystyrene board and hard board will be considered acceptable for use when the Contractor submits a manufacturer's certificate of compliance for the conformance with these Specifications, and approval for use is given by the Materials and Research Division.

SECTION 1071 -- POST AND FASTENERS FOR HIGHWAY SIGNING

1071.02 -- Material Characteristics

Paragraph 1.b. of Subsection 1071.02 is void and superseded by the following:

c. Steel posts for signs shall be made from hot-wrought carbon steel or rail steel conforming to the requirements specified in ASTM A-702 (Steel B).

Paragraphs 2.a., 2.b., 2.c., 2.d., and 2.e. of Subsection 1071.02 are void.

1071.03 -- Acceptance Requirements

Paragraph 2. of Subsection 1071.03 is void.

SECTION 1073 -- ROADWAY LIGHTING, SIGN LIGHTING, AND TRAFFIC SIGNALS

1073.02 -- Material Characteristics

Paragraph 7.a. of Subsection 1073.02 is void and superseded by the following:

a. Roadway lighting luminaires and lamps acceptable for use on State projects will be shown in the plans.

Paragraph 8.a. of Subsection 1073.02 is void and superseded by the following:

a. Components comprising the various types of lighting control centers acceptable for use on State projects will be shown in the plans.

Paragraph 9.a. of Subsection 1073.02 is void and superseded by the following:

a. Photoelectric controls acceptable for use on State projects will be shown in the plans.

Paragraph 19. (Vehicle Signals:) of Subsection 1073.02 is amended to include the following:

e. Vacuum formed backplates are not required for signal heads with T51A, T51B, T52A, and T52B signal faces.

f. All 12” (300 mm) red and green vehicle signal indications, except signals on span wires and optically programmed signal heads, shall be of the LED type.

g. All 8” (200 mm) yellow vehicle signal indications shall be of the LED type.

h. All LED signals shall be limited to those on the NDR Approved Products List.

Paragraph 20. (Pedestrian Signals:) of Subsection 1073.02 is void and superseded by the following:

a. Pedestrian signals shall be a single section housing with a 12” (300 mm) high rectangular lens, with sun visor and mounting hardware.

b. The lens shall be made of vandal-resistant, polycarbonate or acrylic plastic.

c. The international “DON’T WALK” symbol shall be displayed on the left side of the lens, and the international “WALK” symbol on the right side of the lens.

d. The “DON’T WALK” symbol shall be orange and the “WALK” symbol shall be white. The background or field around the symbols shall be black.

e. “DON’T WALK” indications shall be of the LED type.

f. “WALK” indications may be LED or incandescent.

g. All LED signals shall be limited to those on the NDR Approved Products List.

Paragraph 35. is added as follows:

35. Coaxial Cable:

a. Coaxial cable shall be 75 ohm RG 59/U Type or RG 11/U Type.

b. The conductor shall be solid or stranded copper. Minimum conductor size shall be 22 AWG for installations where the distance between the controller cabinet and the video camera is less than 200 feet (60 m); 20 AWG for distances less than 2000 feet (610 m); and 14 AWG for distances less than 3000 feet (910 m).

c. The insulation shall be polyethylene.

d. The shield shall be braided bare copper.

e. The jacket shall be black polyethylene or black polyvinylchloride.

f. The finished outside diameter of the cable shall not exceed 0.405 inch (10 mm).

g. The contractor shall furnish and install a BNC connector on each end of the cable.

Paragraph 36. is added as follows:

36. Optical Detector Cable

a. Optical Detector Cable shall meet the requirements of IPCEA-S-61-402/NEMA WC 5, Section 7.4, 600 volt control cable, 75 degrees Celsius, Type B.

b. The cable shall contain 3 conductors, each of which shall be #20AWG (7x28) stranded, tinned copper with 25 mil (630 µm) minimum average thickness low-density polyethylene insulation. Insulation shall be color-coded: 1-yellow, 1-blue, 1-orange.

c. The shield shall be aluminized polyester film with a nominal 20% overlap. A #20AWG (7x28) stranded, tinned, bare drain wire shall be placed between the insulated conductors and the shield and in contact with the conductive surface of the shield.

d. The jacket shall be black PVC with minimum ratings of 600 volts and 175°F (80°C) and a minimum thickness of 45 mils (1100 um). The jacket shall be marked as required by IPCEA/NEMA.

e. The finished outside diameter of the cable shall not exceed 0.35 inch (9 mm).

f. The capacitance as measured between any conductor and the other conductors and the shield shall not exceed 40 pico farads per foot at 1000 Hz.

SECTION 1075 -- TIMBER AND LUMBER

1075.05 -- Sawn Wood Guardrail Posts and Offset Blocks for Safety Beam Guardrail Terminal Systems

Paragraph 1.b. of Subsection 1075.05 is amended to provide that wood offset blocks shall be either Douglas Fir (Coast Region), Southern Yellow Pine (either major or minor species), or Ponderosa Pine.

Paragraphs 1.d. and 2.d. of Subsection 1075.05 are amended to provide that the composite offset blocks shall be successfully crash tested according to NCHRP 350.