MATERIALS

100.1 GENERAL

The contents of Section 100 pertain to materials which are common on public works construction items. For convenience selected materials in this section will be referenced in the appropriate construction activity. Materials which are incidental to only one construction activity will be defined in the activity's section.

100.2 CONTENTS

SECTION 101

PORTLAND CEMENT CONCRETE

101.1.1 GENERAL

Portland cement concrete, prestressed concrete, post tensioned concrete, shotcrete, gunite, and light weight structural concrete shall consist of a mixture of Portland cement, aggregates, water, and admixtures, proportioned, batched and delivered as specified herein. All materials and design mixes used in Portland cement concrete, either batched at or delivered to a project shall be certified in accordance with the requirements of Section 13 of these specifications. Each design mix submitted and authorized for use under this Specification shall be identified by a design mix number, unique to that design mix. If either a change in material(s) or material supplier(s) from that specified in the authorized design mix occurs during a project, authorized use of the job mix formula on the project may be canceled as directed by the ENGINEER. A concrete design mix shall not be used on a project without written authorization of The ENGINEER. A design mix, upon request by a concrete supplier, may be authorized by the Department of Municipal Development for use on City and City-related projects for a period of 14 months from the date of sampling of reference aggregates in the design mix.

101.1.2 For construction and reconstruction projects requiring Portland Cement Concrete continuous placement(s) equal or greater than either 100 cubic yards of concrete per day, the CONTRACTOR shall have a full time Portland Cement Concrete construction supervisor on site to direct the construction operations. The supervisor shall be certified either as an ACI certified Concrete Field Testing Technician Grade I, or the equivalent National Institute for Certification of Engineering Technologies Technician, with Specialty Concrete Work Elements Level I 82001, 82002, and Level II 84002, 84003, 84004, 84010. The supervisor shall be identified by the CONTRACTOR at the preplacement conference and shall be the contact person for the ENGINEER during concrete construction.

101.1.3 Pre-Placement Conference

A Pre-Placement Conference shall be held by the CONTRACTOR, as directed by the ENGINEER, no later than seven (7) calendar days prior to the start of construction for concrete continuous placement(s) equal or greater than either 100 cubic yards of concrete per day. The following meeting agenda/assigned responsibilities shall be accomplished at the conference.

I. ENGINEER/OWNER
- A. Scope of the project.
- B. Identify construction management team and contact telephone numbers.
- C. Review CONTRACT requirements for construction.
- D. Review Quality Assurance Program.

II. CONTRACTOR
- A. Review construction schedules.
  1. Placement schedules.
  2. Proposed construction schedule for duration of the project.
- B. Identify construction personnel and contact telephone numbers.
  1. Contractor Staff
  2. Sub-Contractor (s)
  3. Supplier (s)
  4. Safety Manager
- C. Present construction placement procedure plans.
  1. Equipment Schedule
  2. Concrete Design Mix
  3. Construction methodology
  4. Concrete pumping plan
  5. Traffic Control Plan
  6. Quality Control Plan

III. DISCUSSION AND COMMENT

101.2 REFERENCES

101.2.1 American Society for Testing and Materials (Latest Edition) (ASTM)

C31 Making & Curing of Concrete Test Specimens in the Field

C33 Specification for Concrete Aggregates

C39 Test for Compressive Strength of Cylindrical Concrete Specimens

C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

C78 Test for Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)

C94 Specification for Ready-Mixed Concrete

C125 Definition of Terms Relating to Concrete and Concrete Aggregates

C138 Air Content (Gravimetric), Unit Weight, and Yield of Concrete

Hardened Concrete

C143 Test for Slump of Portland Cement Concrete
specification. If required, certification

C150 Specification for Portland Cement

C172 Sampling Fresh Concrete

C173 Test for Air Content of Freshly Mixed Concrete by the Volumetric Method

C192 Making & Curing of Concrete Test Specimens in the Laboratory

C227 Test for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar Bar Method)

C231 Test for Air Content of Freshly Mixed Concrete by the Pressure Method

C260 Specification for Air Entraining Admixtures for Concrete

C330 Specification for Lightweight Aggregates for Structural Concrete

C441 Test for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to Alkali-Aggregate Reaction

C494 Specification for Chemical Admixtures in Concrete

C567 Unit Weight of Structural Lightweight Concrete

C617 Capping Cylindrical Concrete Specimens

C618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

C685 Specification for Concrete Made by Volumetric Batching & Continuous Mixing

C803 Test for Penetration Resistance of Hardened Concrete

C805 Test for Rebound Number of

D2419 Sand Equivalent Value of Soils and Fine Aggregates

101.2.2 American Concrete Institute (Latest Editions)

ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.2	Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 318-89	Building Code Requirements for Reinforced Concrete

101.2.3 This Specification:

SECTION 337	PORTLAND CEMENT CONCRETE PAVEMENT
SECTION 340	PORTLAND CEMENT CONCRETE CURBS, GUTTERS, WALKS, DRIVEWAYS, ALLEYS, INTERSECTIONS, SLOPE PAVING, AND MEDIAN PAVING
SECTION 346	TEXTURED CONCRETE
SECTION 349	CONCRETE CURING
SECTION 420	TRAFFIC SIGNAL AND STREET LIGHTING CONDUIT, FOUNDATIONS AND PULL BOXES
SECTION 510	CONCRETE STRUCTURES
SECTION 512	PRECAST PRESTRESSED MEMBERS
SECTION 602	PORTLAND CEMENT CONCRETE FOR CHANNEL LINING AND DIKE AND DAM SURFACING
SECTION 701	TRENCHING, EXCAVATION AND BACKFILL
SECTION 800	INSTALLATION OF WATER TRANSMISSION, COLLECTOR AND DISTRIBUTION LINES
SECTION 900	SANITARY AND STORM SEWER FACILITIES

SECTION 101

PORTLAND CEMENT CONCRETE

SECTION 915 STORM DRAINAGE APPURTENANCES

SECTION 1500 MONUMENTS

101.3 PORTLAND CEMENT

101.3.1 Portland cement to be used or furnished under this Specification shall comply either with the requirements of ASTM C150, Types I LA, II LA, III LA, and V LA, cements, or as specified herein, in the Supplementary Technical Specifications, Drawings, or as approved by The ENGINEER. The CONTRACTOR shall submit certification of compliance signed by the cement manufacturer, identifying the cement type and source (plant location), stating the Portland cement furnished to the project, and or used in the concrete delivered to the project complies with this Specification. If required, certification of the Portland cement used for each day's concrete placement shall be submitted to The ENGINEER for each type of cement and each design mix used on the project.

101.3.2 Portland cement specified in an authorized design mix shall be of the same source and type for all concrete batched at and/or delivered to a project under the authorized design mix identification number.

101.3.3 When suitable facilities (such as those recommended by the Concrete Plant Manufacturer's Bureau and/or approved by The ENGINEER) are available for handling and weighing bulk cement, such facilities shall be used. Otherwise, the cement shall be delivered in original unopened bags of the Manufacturer and the type of cement plainly marked thereon, each bag to contain 94 pounds (42.6 kg) of cement.

101.3.4 Cement shall be stored in such a manner as to permit ready access for the purpose of inspection and be suitably protected against damage by contamination or moisture. Should any lot of bulk cement delivered to the site show evidence of contamination, The ENGINEER may require that such lot be removed from the site.

101.3.5 Portland cement shall be measured by weight, lbs, (mass, kg) for concrete produced in accordance with the requirements of ASTM C94 and by volume for concrete produced accordance with the requirements of ASTM C685.

101.4 AGGREGATES:

101.4.1 Aggregates shall comply with the requirements of ASTM C33 and as amended herein, or as specified in the Supplementary Technical Specifications and Drawings, or as approved by the ENGINEER. Aggregates shall be certified to comply with the requirements of this Specification and authorized for use by The ENGINEER before the materials may be incorporated in the construction. Prior to delivery of the aggregates or material containing the aggregates, The CONTRACTOR may be required to furnish samples of the aggregates to The ENGINEER for testing. The CONTRACTOR's daily production aggregate gradations used in concrete shall be submitted to The ENGINEER upon request. Aggregates specified in an authorized design mix shall be of the same source and type for all concrete batched and delivered under the authorized design mix identification number.

101.4.2 In placing materials in storage or in moving them from storage to the mixer, no method shall be employed which may cause the segregation, degradation, or the combining of materials of different grading which will result in any stockpile not meeting specified requirements.

101.4.3.1 Aggregates supplied under this Specification shall be assumed to be "alkali-silica reactive", ASR. Variance from this position for a particular aggregate source may be authorized by The CITY ENGINEER. Application for a variance may be made to The CITY ENGINEER.

101.4.3.2 An aggregate may be classified non-alkali-silica reactive if, when tested in accordance with ASTM C227, using low alkali cement typical to the Albuquerque area, demonstrates an expansion at one (1) year not greater than 0.05%, and the rate of expansion is negative decreasing, based on test measurements at 1 month, 3 months, 6 months, 9 months, and 15 months, as authorized by the CITY ENGINEER.

101.4.3.3 Portland cement concrete design mixes using non alkali-silica reactive aggregates complying with 101.4.3.2 will not be required to be proportioned with Class F fly ash.

101.4.4.1 Coarse aggregates shall meet the gradation limits as specified in Table 2 of ASTM C33. Fine aggregates shall comply with the gradation requirements of ASTM C33, Section 4, Grading. The sand equivalent of fine aggregate, when tested in accordance with ASTM D2419, Sand Equivalent Value of Soils and Fine Aggregates, shall be greater than 75.

101.4.4.2 The maximum size aggregate shall comply with either these specifications, or the requirements of Table 101.A, or the Supplementary Technical Specifications, or the recommendations of ACI 318-89, paragraph 3.3.2, or as required by The ENGINEER.

101.4.5 Aggregates shall be measured by weight (mass) for concrete batched under the requirements of ASTM C94 and by volume for concrete batched in accordance with the requirements of ASTM C685.

TABLE 101.A
MAXIMUM SIZE AGGREGATE

Application	Size in.
I. Pavement, sidewalk, curb and gutter, drive pads, wheel chair ramps, slab on grade, foundations and structures	1
II. Channels, minimum 5% retained on the 1 in. sieve	1-1/2
III. High early release concrete, minimum 5% retained on the ½ in. sieve	¾
IV. Stamped, patterned, stairs and steps Minimum 5% retained on the 3/8 in. sieve	½
V. Formed Concrete	
A. 1/5 the narrowest dimension between sides of forms.	
B. 1/3 the depth of slab.	
C. ¾ of the minimum clear spacing between individual reinforcing bars or wires, bundles of bars, or prestressing tendons or ducts, or reinforcing and forms	

101.5 WATER

Water used in Portland cement concrete shall be clean and free from injurious amounts of oil, acids, alkalis, salts, organic materials, or other substances that may be deleterious to the concrete or reinforcement. Non-potable water shall not be used unless the requirements of ACI 318.3.4.3.2 are met. Water shall be measured by weight or volume for concrete batched under the requirements of ASTM C94 and by volume for concrete batched in accordance with the requirements of ASTM C685.

101.6 ADMIXTURES:

101.6.1 Admixtures shall comply with the requirements of this specification. The CONTRACTOR shall submit a certification of compliance signed by the admixture manufacturer, identifying the admixture and its source (plant location), stating the admixture furnished to the project and/or used in the concrete delivered to the project complies with this Specification. Certification laboratory testing of an admixture shall be submitted by the CONTRACTOR to the ENGINEER upon request. Admixtures specified in an authorized design mix shall be of the same source and type for all concrete batched and delivered as defined under a design mix identification number. Admixtures shall be measured accurately by mechanical means into each batch by equipment and in a method approved by the ENGINEER. An admixture shall not be used on a project without authorization by the ENGINEER.

101.6.2 Air-entraining agent, conforming to ASTM C260, shall be measured accurately by mechanical means into each batch by equipment and in a method approved by The ENGINEER. The air-entraining agent used shall not contain more than 0.035% chloride by weight. Air-entrainment content shall comply with the requirements Table 101.B., the Supplementary Technical Specifications, or the recommendations of ACI 318, latest edition.

TABLE 101.B ENTRAINED AIR CONTENT

Nominal Maximum Size Aggregate, In.	Air Content range (%) min	max
½	5.5	8.5
¾	4.5	7.5
1	4.5	7.5

101.6.3 Chemical admixtures shall conform to either the requirements of ASTM C494, or as specified in the Supplementary Technical Specifications, or as specified by The ENGINEER. Chemical admixtures shall not contain more than 0.035% chloride by weight.

101.6.4.1 Mineral admixtures shall be class "F" fly ash complying with the requirements of ASTM C618 including the requirements of TABLE 4, UNIFORMITY REQUIREMENTS, and the requirements of this Specification.

101.6.4.2 Mineral admixtures, when tested in accordance with ASTM C441, shall conform to the following:

Reduction in expansion @ 14 days, % , min, 100% Reliability	65.0
Mortar expansion @ 14 days, max, %	0.20
Expansion must be less than control sample expansion.	

101.6.4.3 The "Reactivity with Cement Alkalis" shall be determined using new Dow Corning glass rod base for aggregate. If a fly ash does not comply with the above requirement using the specified cement type, it may be authorized if the criteria is met using the low alkali Portland cement typically available to the Albuquerque area, as directed by the ENGINEER.

101.6.4.4 Mineral admixtures used or furnished under this Specification shall be certified quarterly, in a calendar year, to comply with this Specification by the supplier. Certification shall include test results and specifications, source and location.

101.6.4.5 Mineral admixtures shall be measured by weight (mass) for concrete batched under the requirements of ASTM C94 and by volume for concrete batched in accordance with the requirements of ASTM C685.

101.6.5 Accelerating admixtures may be used in Portland cement concrete batched and supplied under this Specification only when approved by The ENGINEER. The accelerating admixture used shall be a non-chloride type. A design mix proportioned with an accelerating admixture shall be submitted as specified in paragraph 101.8.8. and authorized by The ENGINEER, prior to use on a project.

101.7 PROPORTIONING

101.7.1 Portland cement concrete shall be proportioned in accordance with the requirements of ACI 318, latest edition, Chapter 5, either ACI 211.1 or ACI 211.2 (latest editions), and Table 101.C of this Specification, either field experience or trial mixtures, and the construction placement requirements selected by the CONTRACTOR. The CONTRACTOR shall be solely responsible for the Portland Cement Concrete design mix proportions for concrete either batched at, or delivered to, placed and finished at the site. Certification of a design mix and all component materials, including all formulations of a mix and any and all admixtures which may be used under special construction conditions and environments with that mix to include high range water reducers (super-plasticizer), accelerating admixtures and retarders, and any other admixture, shall comply with the requirements of Section 13 of this Specification.

101.7.1.1 Design mix(es) shall be prepared in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, and operated under the direct supervision of a New Mexico registered Professional Engineer.

101.7.1.2 The testing equipment used in the design development testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certificates of calibration shall be maintained at the laboratory for review by The ENGINEER. A copy of the certifications shall be submitted to The ENGINEER upon request. A Portland Cement Concrete design mix shall not be batched at and/or delivered to a job site without written authorization of The ENGINEER.

101.7.1.3 A design mix shall be prepared under the direct supervision of a New Mexico Registered Professional Engineer.

101.7.2 Portland cement shall be proportioned to comply with the requirements specified in Table 101.C, or as specified in the Supplemental Technical Specifications, or Plans, or as authorized by The ENGINEER.

101.7.3 The mineral admixture class F fly ash shall be proportioned by weight of cement to provide a fly ash to portland cement ratio not less than 1:4, not less than 20 per cent of the total cementitious material. Portland cement concrete submitted under this Specification shall be proportioned with Class F fly ash, unless a variance is authorized by the City Engineer.

107.7.4 The water to total cementitious material ratio shall not be greater than specified in Table 101.C, or the maximum determined from a "trial mix" compressive strength vs. water to cementitious ration curve, defined in accordance with ACI 318, latest edition, Chapter 5. The trial mix compressive strength water to cementitious material ratio curve shall be developed with the target slump at design application maximum, ±0.75 inches, and the target entrained air content at design application maximum, ± 0.5 per cent, using materials specified in the design submittal. The cementitious material shall be defined as the total weight of portland cement and Class F fly ash in design mix.

101.7.5.1 A design mix submittal shall include but not be limited to the following information, as directed by the ENGINEER.

A. Certification of compliance of the design mix with the requirements of this Specification in accordance with Section 13 of these specifications by the New Mexico

Registered Professional Engineer in responsible charge of the design mix development;

B. Certification of compliance of design mix's component materials by a manufacturer/supplier. The certification shall include laboratory test results of companion samples of the component material used in the laboratory prepared design mix, verifying the component materials comply with the specifications. For a mix design based on statistical methods, certification(s) of component materials shall be based on results performed within two (2) months of the submittal date.

C. Plastic characteristics of the design mix to include concrete temperature, slump, entrained air content, wet unit weight, yield and cement factor, reported in English and metric units;

D. Performance characteristics of the hardened concrete to include the compressive strength of all test cylinders averaged for a respective test and the corresponding average compressive strength reported in English units;

E. Compressive strength test (3 cylinder tests each point) shall be reported for each water to cementitious material ratio design mix proportioned at 3, 7, 14 and 28 days laboratory cure normal concrete; and, 1 day, 3 days, 7 days and 28 days laboratory cure for high early release concrete.

F. The "trial mix" compressive strength vs. water to cementitious ratio curve graphically plotted to include the water to cementitious ratio for the proposed design mix. A proposed design mix water to cementitious ratio outside the limits of a trial mix curve shall be rejected.

G. When a proposed design mix is based on statistical analysis of historical data, certification that the design mix represented by the historical data was batched with the same or similar materials from the same sources as the materials proposed in the design mix shall be included in the submittal. Under this design certification procedure, the proposal shall include a statistical analysis for a period of 12 months prior to sampling aggregates of the characteristics of a) slump, b) entrained air, and c) f'c@28 day compressive strength test. A compressive strength test shall be the average of two (2) cylinders tested at 28 days. An annual average aggregate gradation analysis may be used if the data represents the 12 month period prior to sampling for a design mix. A minimum of three production gradations per month will be required in the data base, as directed by the ENGINEER.

H. Batch proportions for concrete Made by Volumetric Batching and Continuous Mixing, ASTM C685, shall include 1) component batch weights, 2) component batch volumes, and 3) gate settings for each type of batching equipment the design mix that may be batched.

J. High Range Water Reducing Admixture(s) (hrwra), Superplastizers:

a. A prescription for use of the hrwra in a design mix shall be provided by the CONTRACTOR to include but not limited to the following:

1. Maximum dosage per cubic yard (meter) by standard measure, ozs/yd3;
2. Admixture introduction location (plant or Job site);
3. Minimum mixing after admixture introduction (drum revolution count at mixing speed);
4. Air entrainment dosage adjustment, if required;
5. Base mix water reducing admixture (wra) dosage adjustment, if required;
6. Consistency (slump) targets for before and after admixture introduction;
7. Concrete temperature limitations, if required; and,

b. Laboratory demonstrated performance of the design mix, at the specified maximum admixture dosage, shall be reported, including slump, entrained air content, unit weight, water to cementitious materials ratio, seven (7) and twenty eight (28) day compressive strength (fc), and three (3) days and seven (7) day compressive strength (fc) for high early release concrete. Submittal compressive strength shall be based on the average value of three cylinders required.

K. Accelerating Admixture(s)

a. A prescription for use of the accelerating admixture in a design mix shall be provided by the contractor to include but not limited to the following:

1. Maximum dosage per cubic yard (meter) by standard measure, ozs/yd^3;
2. Concrete temperature limitations, if required;
3. Admixture introduction location, plant or

project;

4. Restrictions of use in combination with other admixtures, as applicable; and,

b. Special considerations for mixing, placing, and curing, as applicable.

L. Color Admixture(s)

a. A prescription for use of a color admixture in a design mix shall be provided by the CONTRACTOR to include but not limited to the following:

1. Maximum dosage per cubic yard(meter) by standard measure, ounces/yd3;
2. Admixture introduction location, plant or project;
3. Restrictions of use in combination with other admixtures; and

b. Special considerations for mixing, placing, and curing, as applicable.

M. Submittal Format

a. A standard design mix submittal may include some or all of the above information as directed by the CONTRACTOR to define use as “optional” admixture(s). The standard design mix code would be the same for applications with and without the optional admixture(s).

b. A specific design mix submittal can be made to include either color, or accelerating, or high range water reducing admixture for use under a specified application only. Separate design mix submittals will be required to include the information specified above.

101.7.5.2 A submittal shall be rejected if it does not include the specified information and samples. A design mix submittal shall be accepted or rejected within ten (10) days of receipt by the ENGINEER.

PORTLAND CEMENT CONCRETE

TABLE 101.C-DESIGN MIX SPECIFICATIONS PORTLAND CEMENT CONCRETE (1,2,3)

Application	Use in Section(s)	f'c @ 28 days (4) minimum psi	Entrained Air Range (11) (%)	Slump, Not to Exceed (5) inches			Portland Cement Min. (lbs/cy)	W:(c+fa) max (7)
				Placement	norm	HRWRA		
Interior Concrete (heated areas): foundations and slab on grade.	510	3,000	(See par.101.7.2)	Hand Place	4	6	423	0.50
Exterior Concrete Structure foundations, slab on grade, sidewalks, wheel chair ramps, steps/stairs, curb & gutter, storm drain drop inlets, storm manhole bases, retaining walls and miscellaneous concrete	340, 346, 420, 510, 511, 701, 800, 1500	3,000	(See par.101.7.2)	Hand Place Slip Formed	4 2	6 3	470	0.45
Pavement, drive pads, manhole and valve collars, valley gutters and cross walks For design of PCCP, use MR= 600 psi	337, 340, 346	4,000	(See par.101.7.2)	Hand Place Slip Formed	4 2	6 3	564	0.40
Hydraulic structures Storm drain structures and channels and water reservoirs	510, 512, 602	4,000	(See par.101.7.2)	Hand Place Slip Formed	4 2	7 3	517	0.40
Sanitary sewer structures and SAS manhole bases	900, 915	4,000	(See par.101.7.2)	Hand Place Slip Formed	4 2	7 3	658 (6)	0.40
Structures: Buildings, bridges/bridge decks, and parking structures (8) (9)	510	4,000	(See par.101.7.2)	Hand Place Slip Formed	4 2	7 3	658 (6)	0.40
High early Release Concrete fcr=3,400 psi@release to service (10)	All applications	4,000 @ 7 days	(See par.101.7.2)	Hand Place Slip Formed	4 2	6 3	Design	Design

1. Use of material(s) not defined by this specification must be approved by the ENGINEER and the COA Materials & Testing Laboratory.
2. Maximum size aggregate shall comply with the requirements of par. 101. 4.4.2.
3. Portland cement concrete shall be proportioned with Class F fly ash complying with the requirements of 101.6.4, proportioned 1: 4, minimum, fly ash to portland cement, by weight (mass).
4. MR-Modulus of Rupture, Compressive Strength (f'c) at 28 days.
5. When authorized by the ENGINEER, a high range water reducing admixture (HRWRA), super plasticizer, may be used to increase slump. When a HRWRA is proposed for use on a project, the design mix shall be proportioned to include the HRWRA. The use of a HRWRA in a design mix that was not originally proportioned with a HRWRA is not acceptable under this specification. Higher slump(s) may be used, as directed by the ENGINEER.
6. If portland cement complying with ASTM C150 Type VLA is used, a minimum of 564 lbs/cy may be used.
7. " w : (c+fa)" is defined as water to cementitious materials ratio. Cementitious material is the sum of the portland cement and fly ash, by weight (mass).
8. Lightweight structural concrete for structures, parking decks, and bridge decks shall be proportioned with a minimum compressive strength of f'c= 4750 psi @ 28 days.
9. Minimum requirements for prestressed/post tensioned concrete. Actual criteria may differ as specified in the plans and supplemental technical specifications.
10. "High Early Release Concrete" is specified where early release of structure to either service or construction loads may be required, as authorized by the ENGINEER. "fcr" is the minimum compressive strength for release, as determined by field cured cylinders. Maximum size aggregate shall be 3/4 inch.
11. Designated interior concrete, placed, finished, cured, and maintained by the Contractor in a temperate environment of 40^{O}F or greater, may be constructed with non-air entrained concrete complying with all other requirements of this specification for the calendar period after April 30 and before October 1, as authorized by the Engineer. Concrete for wet exposures, showers and wash down areas, vehicle repair and storage floors shall not be included in this variance.

101.8 BATCHING

101.8.1 Portland cement concrete shall be batched in accordance with the requirements of either ASTM C94, or ASTM C685, and the requirements of this Specification, as authorized by the ENGINEER. Batching facilities, mixing, and transporting equipment shall be certified within 12 months prior to batching of a design mix. The plant shall be certified by a NM Registered Professional Engineer, to comply with the requirements of this Specification and Section 13. The certification shall have been completed within 12 months of batching an authorized Portland Cement Concrete design mix. Written certification shall be available for review at the plant by the ENGINEER, and, submitted to the ENGINEER upon request.

101.8.2.1 Ready-mix concrete batch plants shall be certified to comply with the requirements of this Specification. Written certification of compliance shall be available for review at the batch plant by The ENGINEER.

101.8.2.2 Central-Mix Batch Plants shall be certified to comply with this Specification and standards of the National Ready-Mix Concrete Association. The central-mixers rated capacity shall be posted at the batch plant in the operator's area.

101.8.2.3 Portable batch plants shall be certified after erection at a project and prior to batching concrete to be used at the project site. The batch plants rated capacity shall be posted at the batch plant in the operator's area.

101.8.2.4 Ready-mix concrete trucks shall be certified to comply with the requirements of this Specification and the "Standards for Operation of Truck Mixers and Agitators of the National Ready-Mix Concrete Association", and the "Truck Mixer Manufacturer Bureau", latest editions. Written certification of compliance shall be carried in/on the vehicle for verification by The ENGINEER. The manufacturers rated capacity, mixing and agitating speeds shall be posted on the truck mixer. Mixers shall have an operable mixer drum revolution counter and water metering system to measure temper water that may be added to a mixer after batching and prior to discharge of a load.

101.8.2.5 Shrink-mixed concrete batching shall be certified to comply with the requirements of this Specification. Written certification of the program to include a) maximum concrete volume defined for the process/equipment, b) minimum time of mixing in the stationary mixer of materials after the addition of all cementitious material, and, c) minimum supplemental mixing revolutions in the transit mix truck. A copy of the certified procedure shall be shall be available at the batch plant for review by The ENGINEER, and submitted upon request. The ENGINEER shall be notified by the CONTRACTOR in writing which concrete supplied to a project is produced with this procedure. Shrink mixed batching shall not be used on a project without authorization by the ENGINEER.

101.8.2.6 Volume batching central mix and concrete mobile trucks shall be certified to comply with this Specification. Certification shall include discharge gate settings/material weight batching references for each material carried and a certified water meter and calibration chart to define water settings. Discharge calibration settings shall be established for each production batching rate and authorized design mix batched. The equipment shall be recalibrated if a change in materials or source of materials occurs. Written certification of compliance shall be carried in/on the vehicle for verification by The ENGINEER.

101.8.2.7 On-site batching and mixing equipment for concrete volumes of less than 1 cubic yard shall conform to the requirements of ASTM C192, and shall be approved by The ENGINEER. On-site batched concrete for volumes less than 1 cubic yard shall be either "Redi-2-Mix", "Quikrete", or equal prepackaged concrete mix. The concrete shall be proportioned with water not to exceed a maximum of 1.5 gallons per 60 lbs./bag or equivalent. Concrete batched under this paragraph shall not be used for finished, interior and/or exterior exposed concrete surfaces.

101.9 MIXING

101.9.1 Concrete batched in accordance with ASTM C94, shall be mixed in accordance with the requirements of that Specification and as follows.

101.9.2 Central-Mixed Plants: Concrete mixed in a stationary mixer and transported to the point of delivery shall be mixed from the time all the solid materials are in the drum. The batch shall be so charged with some water in advance of the aggregates and cementitious materials, and all water shall be in the drum by the end of one-fourth the specified mixing time. Mixing time shall be a minimum of 1 minute for the first cubic yard plus 15 seconds for each additional cubic yard, or fraction there of additional capacity. Where mixer performance tests have been conducted in accordance with ASTM C94, with the mixer to rated capacity, the mixing time may be reduced to the time at which satisfactory mixing defined by the performance tests shall have been accomplished. When the mixing time is so reduced the maximum mixing time shall not

exceed this reduced time by more than 60 seconds for air entrained concrete. Certified concrete uniformity tests shall be conducted in accordance with ASTM C94 and Section 13. If the uniformity requirements are not met, that mixer shall not be used until the condition is corrected.

101.9.3 Shrink-Mixed Concrete: Concrete mixed in a shrink mix production program shall be mixed in accordance with the certified shrink mix program as defined by The CONTRACTOR. Concrete shall be mixed in a stationary mixer not less than the certified minimum mixing time after all ingredients are batched into the drum, and not less than the minimum mixing revolutions specified for the transit mix truck after the load is transferred into the transit mix truck. Mixing in the transit mix truck shall not exceed the maximum requirements of paragraph 101.9.4. Shrink-mixed concrete procedures shall be certified to provide concrete that complies with the uniformity specifications of ASTM C94 as determined by uniformity tests specified in ASTM C94, for the maximum batch volume of concrete defined by The CONTRACTOR. If uniformity requirements are not met for the combination of stationary plant and transit mixers , the shrink mix program shall not be used. Tempering of shrink mix concrete at the job site shall comply with the requirements of 101.10 and 101.11.

101.9.4 Truck-Mixed Concrete: Concrete mixed in a truck mixer shall be mixed after all ingredients including water, are in the drum at least 70 revolutions and not more than 100 revolutions at the mixing speed as defined by the Manufacturer. The mixing speed for the mixer shall be identified on the mixer. Certified concrete uniformity tests shall be conducted on transit mixer trucks in accordance with ASTM C94 and Section 13 annually. If the uniformity requirements are not met, that mixer shall not be used until the condition is corrected. Mixing beyond the number of revolutions at mixing speed found to produce the required uniformity of concrete shall be at the agitation speed defined by the mixer manufacturer. The manufacturer's recommended mixing and agitation speeds shall be posted on the truck mixer.

101.9.5 Volume Batched Concrete: Concrete batched in accordance with ASTM C685, shall be mixed in accordance with the requirements of this Specification and the Manufacturer’s recommendations. The continuous mixer shall be an auger type mixer or any other type suitable for mixing concrete to meet the requirements for uniformity specified in ASTM C685,

101.10 TEMPERING BATCHED CONCRETE

101.10.1.1 The slump of a concrete mix sampled at final discharge shall comply with the requirements of TABLE 101.C. Non complying material shall be removed from the structure as directed by the ENGINEER.

101.10.1.2 A load of concrete may only be tempered with water after the mix cycle is complete when, upon arrival at the job site, the slump of the concrete is less than specified, and the time limit and revolution limit specified in 101.9 are not exceeded.. When additional water is required, the total water in the truck shall not exceed the maximum water to cementitious ratio specified in the authorized design mix when the concrete is discharged. When tempering is required and allowed as defined by the water to cementitious ratio for the design mix, the water shall be injected into the mixer and the drum or blades turned a minimum of 30 revolutions at mixing speed before discharge as long as the revolution limit specified in 101.9 is not exceeded.. Additional water shall not be added to the batch after tempering without authorization by The ENGINEER.

101.10.1.3 When the slump of a sample taken within the time limits specified in 101.9 the specification requirements of TABLE 101.C, the mixer truck may be mixed a minimum of 15 revolutions at mixing speed, as long as the revolution limit specified in 101.9 is not exceeded, sampled and tested. If the slump of the second sample exceeds the maximum specified slump by 0.25 in (6 mm), the load may be rejected as directed by the Engineer.

101.10.2.1 The air content in air entrained concrete, when sampled from the transportation unit at the point of discharge, shall comply with the requirements of this specification. Non complying material shall be removed from the structure as directed by the ENGINEER.

101.10..2.2 When a preliminary sample taken within the time limits specified in 101.9 and prior to discharge for placement shows an air content below the minimum specified level, the CONTRACTOR may add additional air entraining admixture to achieve the specified air content, if the revolutions on the drum counter are less than 300, and the total revolutions, after air entrainment addition will not exceed 300 following mixing a minimum of 30 revolutions at mixing speed after dosage with the admixture. Additional air entraining admixture may not be added to the batch after the initial air entraining admixture tempering. Air entraining admixture shall be batched in accordance with 101.7.2. In addition to sampling and testing for compliance after tempering with the air entraining admixture, a sample

shall be taken during discharge from the second half of the load to verify slump and entrained air compliance through the load with the specification.

101.10.2.3 When the entrained air exceeds the specified requirements, the load may be mixed a minimum of 15 revolutions, sampled and tested, if the drum revolutions do not exceed 300, and will not exceed 300 following mixing. If the entrained air exceeds the specification by 0.1 %, the load may be rejected as directed by the ENGINEER.

101.10.3 High range water reducing admixtures, superplasticizers shall be batched as recommended by the manufacturer.

101.10.4 Aggregates and cementious material may not be used to temper a batched load of Portland Cement Concrete.

101.10.5 All samples shall be tested for slump, entrained air, and unit weight after tempering..

101.10.6 The field dosage amounts of admixtures and water shall be reported on the truck ticket.

101.10.7 The OWNER shall pay for quality assurance sampling and testing specified 101.15, or as directed by the ENGINEER.

101. 11 DELIVERY & DISCHARGE:

101.11.1 Discharge of the concrete shall be completed within 1-1/2 hours or before the drum has revolved 300 revolutions, whichever comes first after the introduction of the mixing water to the cement and aggregates. These limitations may be waived by The ENGINEER if (1) the concrete is proportioned and certified for use after mixing/agitation time in excess of 1-1/2 hrs, or (2) is of such a slump that it can be placed and finished, without the addition of water to the batch after the time limit noted above is exceeded. In hot weather or under conditions contributing to quick stiffening of the concrete, a time less than 1-1/2 hrs. may be specified by The ENGINEER.

101.11.2 The minimum discharge temperature of concrete in cold weather shall be equal or greater than the temperature specified in Table 101.D.

TABLE 101.D – COLD WEATHER CONSTRUCTION
CONCRETE TEMPERATURE, MIN. [1]

Ambient Air Temperature	Thin Sections	Heavy Sections & Mass Concrete [2]
30 to 45 ºF	60 ºF	50 ºF
0 to 30 ºF	65 ºF	55 ºF
Below 0 ºF	70 ºF	60 ºF

[1] The maximum concrete discharge temperature of all concrete, except "high early release concrete", produced with heated aggregates, heated water, or both, shall be 70ºF. The discharge temperature of "high early release concrete" in cold weather shall be 70 ºF - 76 ºF.

[2] Sections having dimensions in all directions greater than 2 feet (24 inches)

101.11.3 The discharge temperature of concrete in hot weather should be kept as cool as possible. Concrete supplied to a project site having a discharge temperature greater than 90 ºF may be rejected by The ENGINEER if the concrete cannot be placed and finished after a single tempering with water as authorized under 101.10. Retarding admixtures may be used to control setting in hot weather. The discharge temperature of "high early release concrete " in hot weather shall be specified by the CONTRACTOR.

101.11.4 The CONTRACTOR shall provide to The ENGINEER with each batch of concrete batched and/or delivered to the job site, before unloading at the site, a delivery batch ticket on which the information specified in TABLE 101.D.2 is printed, stamped or written, certifying said concrete. One copy of the ticket shall be available for the ENGINEER and one copy of the ticket shall be available for the quality assurance testing program.

TABLE 101.D.2
BATCHING TICKET INFORMATION REQUIREMENTS

A. Name of Concrete Supplier

B. Delivery Ticket Number

C. Date of Delivery

D. Contractor

E. Project Name (Optional)

F. Design Mix Number

G. Volume of Concrete in Load

H. Time loaded

J. Batched Weight (mass) of Cement

K. Batched Weight (mass) of Fly Ash

L. Batched Weight (mass) of Fine Aggregate

M. Batched Weight (mass) of Coarse Aggregate(s)

N. Batched Weight (mass) or Volume of Each Admixture

O. Weight or volume of water batched at the plant

P. Design Mix Target Proportions

Q. Weight or volume (gal.) of temper water added at the site

R. Weight or volume of each temper admixture added at the site

S. Signature and name (printed) of CONTRACTOR'S representative who authorized the tempering, if any, at the site and affiliation to project

101.12 PLACEMENT

101.12.1 Portland cement concrete shall be placed to the lines, sections, grades and elevations, with the procedures specified in the CONTRACT documents. The material shall be consolidated to eliminate all voids, internal rock pockets and defects in the finish concrete. Casting subgrade and formed surfaces shall be damp, at the placement of the concrete. Removable forms shall be treated with a form release agent prior to placement of the forms for ease of removal of the forms without damage to the supported concrete. Forms shall be sealed to prevent leakage. Form release agents shall not stain the adjacent concrete. Placement and finishing shall be completed prior to the start of the initial set of the concrete.

101.12.2.1 The CONTRACTOR shall submit a concrete pumping plan to the ENGINEER for review and authorization one week prior to the start of a pumped concrete construction program for placements complying with 101.1.1. The submittal should identify the pump manufacturer, size and type, rated capacity(s) for the line diameter(s) to be used and distance(s) to be pumped.

101.12.2.2 Pumping shall conform to the recommendations of the pump manufacturer. The pump manufacturer's operation manual shall be available on the pump equipment, and submitted to the ENGINEER, upon request.

101.12.2.3 Concrete shall be pumped in a uniform continuous flow to point of discharge, with all lines kept full, during the pumping operation. The CONTRACTOR shall provide either a system for controlled discharge of the concrete, or the last 5 feet of the pump line, immediately prior to the line discharge opening, shall have a slope equal or less than 10:1, horizontal to vertical, during the pumping of concrete, as authorized by the ENGINEER. The concrete shall not be dropped a vertical distance greater than four feet at discharge from the pump line without a tremey. Concrete placed by pump shall conform to the requirements of this specification after discharge from the pump line. Pumping of concrete shall not commence without authorization by the ENGINEER.

101.13 FINISHING

The CONTRACTOR shall finish Portland cement concrete as required by the CONTRACT documents, Supplemental Technical Specifications, or as directed by the ENGINEER.

101.14 CURING CONCRETE

The CONTRACTOR shall cure concrete as required by the CONTRACT documents, SECTION 349 of this specification, the Supplemental Technical Specifications, or as directed by the ENGINEER. A concrete structure or element shall not be released to service loads until it has achieved a minimum of 85% of the design strength, f'c, at the time the structure is placed in service, or the curing program specified in SECTION 349 is completed, or as directed by the ENGINEER. Service loads shall include construction loads, design loads and environmental exposure.

101.15 QUALITY ASSURANCE SAMPLING AND TESTING

101.15.1.1 Quality assurance sampling and testing shall be performed in accordance with the requirements of this Specification, the Supplemental Technical Specifications, or as required by The ENGINEER. Concrete shall be sampled and tested by a technician/engineer certified as either an ACI certified Concrete Field Testing Technician Grade I, or the equivalent National Institute for Certification of Engineering Technologies Technician, with Specialty Concrete Work Elements Level I 82001, 82002, and Level II 84002, 84003, 84004, 84010.

101.15.1.2 Quality assurance testing and analysis shall be performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure

for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, under the direct supervision of a New Mexico Registered Professional Engineer.

101.15.1.3 Testing equipment used in the performance of specified testing shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certification records shall be maintained at the laboratory for review by The ENGINEER. A copy of the certifications shall be submitted upon request to the ENGINEER. Quality assurance testing shall be directed by the ENGINEER and paid by the OWNER

101.15.2.1 Samples will be taken in the field by The ENGINEER, in accordance with ASTM C172, at discharge to the structure/application after all tempering at the job site has been completed.

101.15.2.2 A sample shall be taken for each design mix of concrete placed each day, once for each 100 cu yd of concrete, once for each 5000 sq.ft. area of slabs or walls, or fractions thereof, whichever is greater, or as directed by the ENGINEER. Hi-lo thermometers will be provided by the CONTRACTOR to monitor field curing concrete temperatures and companion test specimens while in the field , as directed by the ENGINEER.

101.15.3 Slump tests will be performed on each quality assurance sample in the field in accordance with ASTM C143. Concrete used for slump tests shall not be used in specimens for strength tests. The slump shall not exceed the maximum value defined in TABLE 101.C plus 0.25 in (6 mm). Slumps shall be reported to the nearest 1/4 inch (1 mm).

101.15.4 Entrained air tests will be performed on each quality assurance sample in accordance with the requirements of ASTM C231 for normal weight concrete, and ASTM C173, light weight concrete as specified in TABLE 101.C. Concrete used for entrained air tests shall not be used in specimens for strength tests. The entrained air shall not be less than the minimum nor greater than the maximum entrained air specified plus 0.1 % . Entrained air shall be reported to the nearest one tenth of one percent.

101.15.5.1 The cement content per cubic yard for a load of concrete shall be determined on each quality assurance sample in accordance with ASTM C138. The unit weight shall be reported to the nearest one tenth of a pound per cubic foot (one kilogram per cubic meter). The cement factor shall be reported to the nearest pound per cubic yard (kilogram per cubic meter).

101.15.5.2 The portland cement content per cubic yard for a load of concrete shall be calculated by dividing the batched weight of the portland cement reported on the truck ticket for the load represented by a quality assurance test sample, by the yield, in cubic yards, determined in 101.15.1. The cement content shall be reported to nearest one pound per cubic yard. The portland cement content shall not be less than the minimum cement content for the application specified in TABLE 101.C.

101.15.5.3 The water to cementitious ratio for a load of concrete sampled and tested under this specification shall be calculated by comparing the total water in a load, by weight, the batched water reported on the load's batch ticket plus any water added in the field, to the sum of the portland cement and fly ash reported on the batch ticket. The weight of the water shall be divided by the weight of the cementitious materials and reported to the nearest one hundredth value (xx.xx). The water to cementitious ratio shall be less than or equal to the water to cementitious ratio for the application specified in TABLE 101.C.

101.15.6 A non- complying field test, slump test, entrained air test, cement content, shall be verified by sampling and testing a second sample from the same load represented by the non-complying sample/tests. If the second sample/tests determine the material is in compliance, the load may be authorized for placement and the all quality assurance tests required shall be performed. If the second test confirms the initial test results, the concrete load may be rejected as directed by the ENGINEER. If the second test confirms the initial sample non complying test, the second sampling and testing shall be paid by the CONTRACTOR, as specified in SECTION 13. The OWNER shall pay for all complying tests.

101.15.7.1 Quality assurance compressive strength concrete specimens/cylinders shall be molded in accordance with ASTM C31. Cylinders shall be sealed metal or plastic molds complying with ASTM C31. The specimens will be submerged in water during the initial field curing at the site when the average ambient temperature is equal or greater than 60 ^{o}F, site conditions permitting, as directed by the ENGINEER. If the initial field cure submersion procedure is not used, high-low thermometers shall be used to monitor the initial field cure temperature of the quality assurance specimens, and the recorded temperatures shall be reported in the sampling and testing report. If the curing temperature recorded on the high-low thermometer exceeds 85 ^{o}F, concrete compressive test

strengths shall be reported as information only, and the lab of record shall revise the initial cure procedure for the assurance specimens to control the curing temperature to less than 85 ºF. Cylinders left in the field longer than the maximum specified time shall be so identified and reported "for information only". A sample may be taken to the testing laboratory for testing and casting provided the cylinders can be molded within 15 minutes after sampling.

101.15.7.2 Strength specimens shall be molded and tested in accordance with ASTM C31, C39, C78 & C93, C192, and this specification. The number and type of compressive strength test cylinders shall be a minimum of four (4) 6"dia. x 12"H cylinders for channel concrete, and normal concrete with nominal maximum size aggregate of 1.5 inch to 2.0 inch. The number and type of compressive strength test cylinders shall be a minimum of four (4) 4" dia x 8" cylinders for normal concrete with nominal maximum size aggregate 1 inch and less. The number and type of cylinders shall be a minimum of six (6) 4" dia x 8" cylinders for high early release concrete compressive strength tests. The number and type of Modulus of Rupture flexure test beams shall be a minimum of three (3) 6"x6"x42" beams or equivalent for Modulus of Rupture Tests, as directed by the ENGINEER. Strength specimens shall be cast using concrete from the same load as the concrete field tests. When 4"dia. x 8" cylinders are used, they shall be cast in two equal lifts, each lift rodded twenty five times with a three eights inch (9.5 mm) diameter rod with a three eights inch (9.5 mm) semi spherical tip. The rodding of a lift placed on a lift of concrete shall penetrate into the top of the preceding lift.

101.15.7.3 When strength tests are required for stripping of forms or release of structure, a minimum of 2 test specimens complying with the specimen type specified in 101.15.7.2 for each test shall be molded and cured at the site under the same conditions as the concrete represented by the specimens. The specimens shall be returned to the Lab at the end of the field curing period and tested in accordance with ASTMC39. The test strength shall be the average of the test strengths of the two specimens. The critical concrete compressive strength (f'c) shall be a minimum of 85% of the specified design strength.

101.15.7.4 Concrete strength test specimens shall be tested at 7 days and 28 days. One specimen shall be tested at 7 days and 2 specimens shall be tested at 28 days, and reported to the ENGINEER. The test strength shall be the average of the test strengths of the two specimens tested at either 28 days, or as specified in the Supplemental Specifications, drawings, or by the ENGINEER.

101.15.7.5 High early release concrete strength test specimens shall be tested at 3, 7, and 28 days for concrete. One specimen shall be tested at 3 days and 2 specimens shall be tested at 7 and 28 days, and reported to the Engineer. The test strength for high early release concrete shall be the average of the test strengths of two specimens tested at 7 days, or as specified in the Supplemental Specifications, drawings.

101.15.8. Not Used.

101.15.9.1 Evaluation and acceptance of concrete shall meet the criteria established in Chapter 5, Section 5.6, "Evaluation and acceptance of concrete," ACI 318-89. Each strength test result shall be the average of two cylinders from the same sample tested at 28 days or the specified age. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength tests results equal or exceed the required f'c and no individual strength test result falls below the required f'c by more than 500 psi. Quality assurance compressive strength specimens sampled and cast when the average ambient temperature is greater than 60 ºF, and cured with an initial field cure procedure other than submersion method specified in Section 101.15.7.1, shall be evaluated using the highest curing temperature recorded by the high-low thermometer provided for the field cure and Table 101.E. The test compressive strength shall be compared to the estimated strength corresponding to the highest initial cure temperature indicated in Table 101.E. An assurance compressive strength test shall be equal or greater than the compressive strength defined by Table 101.E when the initial field cure temperature is equal or greater than 85 ºF and the initial field cure is not the submerged method specified in 101.15.7.1.

101.15.9.2 If individual tests of either laboratory-cured specimens produce strengths more than 500 psi (3.4 MPa) below f'c, or, if tests of field-cured cylinders indicate deficiencies in protection and curing, steps shall be taken to assure that the load-carrying capacity of the structure is adequate. If the presence of low-strength concrete is confirmed and computations indicate that the load-carrying capacity may have been significantly reduced, tests of cores drilled from the area in question shall be required in accordance with ASTM C42, as directed by the ENGINEER. Three cores shall be taken for each case of an individual cylinder test more than 500 psi (3.4 MPa) below f'c or where the average of any set of three consecutive strength test results is below f'c. If the concrete in the structure will be dry under service conditions, the cores shall be air dried (temperature 60 to 80 ºF and relative

humidity less than 60 percent) for seven days before test and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be immersed in water for at least 48 hours and tested wet. If coring is required a coring plan will be prepared by the ENGINEER no later than 42 calendar days after the placement date. Coring shall be completed and a report submitted no later than 56 calendar days after placement. Core sampling for non-complying tests shall be taken at the direction of the ENGINEER and paid by the OWNER. The CONTRACTOR shall be responsible for material replacement of the same design mix in adjacent concrete at no cost to the OWNER where samples are removed.

101.15.9.3 Concrete in the area represented by core tests shall be considered structurally adequate if the average strength of three (3) cores is equal or greater than 85% of the specified design strength (f'c), and no single core has a compressive strength less than 75% of the specified design strength. To check testing accuracy, locations represented by erratic core strength may be retested. If these strength acceptance criteria are not met by the core tests, and if structural adequacy remains in doubt, The OWNER and ENGINEER may order load tests as outlined in Chapter 20, ACI 318 for the questionable portion of the structure. Load tests shall be paid for by The CONTRACTOR.

101.15.9.4 If the structure under consideration does not satisfy the above strength acceptance criteria or the criteria of Section 20.2 or 20.4, ACI 318 The OWNER may order The Contractor to remove and replace any portion of the structure which is not in compliance with the above. If so ordered, The CONTRACTOR shall perform such work at his own expense. The CONTRACTOR shall patch all core sample holes with the same or similar materials adjacent to the core hole. The patching concrete shall be placed and cured in accordance with the requirements of this specification.

101.15.10 TEST REPORTS

101.15.10.1 Test reports shall include but not limited to the information shown in TABLE 101.G – TEST REPORT CONTENT, provided at the end of this section, as directed by the ENGINEER.

101.15.10.2 Test results shall be reported to The ENGINEER, CONTRACTOR, concrete supplier and Materials and Testing Laboratory, Construction Division, Municipal Development Department, in writing, within 7 working days of completion of the test, as directed by the ENGINEER. Non-complying tests shall be reported within one working day of completion of the test.

101.16 MEASUREMENT AND PAYMENT

101.16.1 Measurement for Portland cement concrete supplied under this specification shall be by LOTS as the area, volumes, and as specified in the contract documents, as directed by the ENGINEER.

101.16.2 Payment for Portland cement concrete supplied under this specification shall be for each LOT, at the contract unit price adjusted in accordance with the formula below and TABLE 101.F, as directed by the ENGINEER. A LOT shall be defined as either the volume or area of concrete for each design mix placed on a project in a day as defined in the CONTRACT. The adjusted unit price shall be calculated using the formula below and the pay factor, CF_P, defined in TABLE 101.F. The pay factor shall be defined by the number of samples representing a LOT, and, the % variance of the mean/average (M) portland cement content of the LOT from the minimum cement content specified in TABLE 101.C for the application, as determined by field quality assurance sample test results. Acceptance samples for a LOT shall be sampled and tested in accordance with 101.15. All acceptance samples taken in one day for a type of concrete shall represent a LOT of that type of concrete.

$UP' = PF \times UP$

UP', Adjusted Contract Unit Price

PF, Pay Factor , $PF = 0.50 \times (1.00 + CF_P)$

UP, Contracted Unit Price

TABLE 101.E

MINIMUM COMPRESSIVE STRENGTH, f'_C

$f_c \geq P_{TI} \times f'_c / 100$, psi

°F [2]	73	80	85	90	95	100	105	110	115	120
Cure Day(s)	P_{TI}, % of Specified Strength, f'c [1,3]									
3	100	108	114	120	122	123	125	120	115	110
7	100	101	102	103	100	98	95	91	78	75
28	100	97	95	93	90	88	85	82	78	75

Notes: 1. Reference ACI 306, 6.6.1
2. The Non Submerged assurance cylinder cure recorded maximum initial field cure temperature. If a high- low thermometer was not used, the highest ambient temperature recorded for the initial cure period by the national weather service will be used as the initial cure temperature.
3. f'c specified compressive strength

TABLE 101.F - CEMENT PAY FACTOR CALCULATION, CF_P

n, number of samples	Deficiency, D = (C - M)/C	CF_P
3, OR MORE	$D \leq 0.0$	1.00
	$0.0 < D \leq 1.0$	1.00
	$1.0 < D \leq 2.0$	0.95
	$4.0 < D \leq 6.0$	0.90
	$6.0 < D \leq 8.0$	0.85
	$8.0 < D \leq 10.0$	[1]
	$D > 10.0$	Remove and Replace
D,	Deficient cement content as % of C, minimum	
C,	Minimum cement content specified for the application in TABLE 101.C	
M,	Average or mean (M) cement factor for a LOT. The cement factor shall be calculated as the average of cement factors of all tests taken for a LOT, but not less than three tests, determined in accordance with 101.15.6.	
[1]	If determined by the ENGINEER to be more practical to accept the material, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR at an assigned pay factor CFp= 0.70.	

TABLE 101.G – TEST REPORT CONTENT

A.	Field Data		
1	Date of Sampling		
2	Time of Sampling		
3	City of Albuquerque Project or		
4	City of Albuquerque Project or Permit Number		
5	Contract Title		
6	Portland Cement Concrete Supplier		
7	Delivery Ticket Number		
8	Design Mix Number		
9	Sampling location as defined by the Project Plans and Specifications		
10	Ambient temperature at time of sampling, ^{O}F		
11	Material temperature at time of sampling, ^{O}F		
12	Mixer drum revolution count at start of discharge of concrete		
B.	Field Tests Results, with specifications.	Accuracy	
1	Slump, in (mm)	0.25	1
2	Entrained Air, %	xx.x	
3	Unit Weight, pcf (kg/m^3)	xxx.x	(xxxx)
4	w:(c+fa) ratio	x.xx	x.xx
5	Cement Factor, C.F., lbs/yd^3 (kg/m^3)	xxx	(xxxx)
6	Cement pay factor determined in accordance with 101.16.2		
C.	Comments		
1	Report any addition of water and materials and amounts by either volume or weight, prior to and after sampling.		
2	Report mixer revolutions count at time of discharge.		
3	Record number of mixer revolutions after field tempering with water and/or admixtures, and @ what mixer speed, mixing or agitating speed.		
D.	Laboratory Tests		
1	Calendar reference and day count from date of sampling for each strength test sample		
2	f'c compressive strength test result reported to psi/ MPa	10	1
3	M.R. Modulus of rupture reported to psi/ MPa	5	0.5

E. Analysis & Certification

The testing laboratory shall provide certification the sampling and testing were performed in compliance with the requirements of the specifications. Certification shall be provided by the New Mexico Registered Professional Engineer in direct responsible charge of the laboratory testing program.

SECTION 102

STEEL REINFORCEMENT

102.1 GENERAL

The following specifications set forth the requirements for bar reinforcement, wire reinforcement, and wire mesh reinforcement. The reinforcement shall conform accurately to the dimensions and details indicated on the plans or otherwise prescribed; and before being placed in any concrete work shall be cleaned of all rust, mill scale, mortar, oil, dirt, or coating of any character which would be likely to destroy, reduce, or impair its proper bonding with the concrete. No reinforcing steel will be accepted under this specification until it has been approved by the ENGINEER as conforming with requirements prescribed therefor. When required by the ENGINEER, the CONTRACTOR or vendor shall furnish samples thereof for testing and notify the ENGINEER as to when and where they will be available. Such samples shall be furnished at the expense of the CONTRACTOR or vendor, but the cost of any testing that may be required will be borne by the OWNER. Samples shall only be taken in the presence of the ENGINEER. The CONTRACTOR shall furnish a certificate mill test report for each heat or size of steel when required by the ENGINEER.

102.2 REFERENCES

102.2.1 ASTM

A 82
A 185
A 615
A 616

102.2.2 ACI

318

102.3 BAR REINFORCEMENT

102.3.1 Reinforcing steel bars shall be deformed intermediate grade billet steel conforming with ASTM A 615. Rail steel conforming with ASTM A 616 may be permitted by the ENGINEER. The Grade shall be 40 or 60, unless Grade 60 is specified on the standard detail drawings or on the construction plans.

102.3.2 In testing bar reinforcement, only the theoretical cross-sectional area will be used in all computations.

102.3.3 Bending of steel will conform to requirements of ACI 318. The various grades of steel shall not be used interchangeably in structures. If rail steel is used, shop and field bending shall comply with the following provisions:

102.3.3.1 Continuous and uniform application of force throughout the duration of the bending operation.

102.3.3.2 Unrestricted movement of the bar at points of contact with the apparatus.

102.3.3.3 Close wrapping of the specimen around 1the pin or mandrel during the bending operations.

102.3.4 Bending or straightening of reinforcing steel shall be accomplished in such a manner and by such means as to insure that no damage to the material will result as a consequence thereof. Bars shall not be heated to perform bending of bars. Kinked bars shall not be used.

102.3.5 Cutting reinforcement steel or wire by means of a cutting torch is prohibited.

102.3.6 Welding of reinforcing steel or wire is prohibited.

102.4 WIRE REINFORCEMENT

Wire reinforcement shall, in all respect, fulfill requirements prescribed in ASTM A 82.

102.5 WIRE MESH REINFORCEMENT

Mesh reinforcements shall conform to ASTM A 185. The gauge of the wire and the dimensions of the mesh will be specified in the Supplementary Specifications or shown on the plans. The wire mesh reinforcement shall be so constructed as to retain its original shape and form during the necessary handling. The effective cross- sectional area of the metal shall be equal to that specified or indicated on the plans.

102.6 WIRE TIES

Wire for ties shall be black, annealed, and not lighter than 16 gauge.

102.7 CHAIRS

Chairs used for support or spacer of reinforcement shall be approved by the ENGINEER.

102.8 MEASUREMENT AND PAYMENT

Steel reinforcement will be included in the measurement for reinforced concrete per cubic yard or square yard in place, unless otherwise stipulated in the Bid Proposal. Payment will be made at the unit price per cubic yard or square yard as defined in the bid proposal.

SECTION 103

EPOXY-COATED STEEL REINFORCING BARS

103.1 GENERAL

This section covers deformed steel reinforcing bars with protective epoxy-coating applied by the electrostatic spray method.

103.2 REFERENCES

103.2.1 ASTM

A 615 A 617
A 616 A 775

103.2.2 AASHTO

M 284

103.2.3 AMERICAN WELDING SOCIETY

AWS D 1.4

103.3 MATERIALS

103.3.1 BAR REINFORCEMENT: Reinforcing bars shall be deformed, intermediate grade, billet steel conforming with ASTM A 615 or rail steel conforming with ASTM A 616. The latter steel shall be bend-tested and shall meet the bend-test requirements for axle-steel reinforcing bars, ASTM A 617, Grade 60; and the bar markings rolled into the surface of the bars shall include the letter "R" to designate rail steel meeting these requirements.

103.3.2 EPOXY-COATED REINFORCING BARS: When specified in the construction plans or required by the ENGINEER, epoxy-coated reinforcing bars shall conform with AASHTO M 284, utilizing the reinforcing bars defined in Subsection 103.3.1.

103.3.3 BAR MATS: Bar mats shall conform with ASTM A 184, utilizing the reinforcing bars defined in Subsection 103.3.1. Mats shall be fabricated from reinforcing bars. Metal clips shall be epoxy-coated. Nonmetallic clips may be substituted. Coating damage at the clipped or welded intersections shall be repaired in accordance with Subsection 103.3.4.

103.3.4 REPAIR OF COATING: When required, damaged epoxy-coating shall be repaired with patching material conforming with ASTM A 775. Repair shall be done in accordance with the patching material manufacturer's recommendations.

103.4 FABRICATION

All reinforcement shall be bent cold unless otherwise approved by the ENGINEER.

103.5 FIELD INSTALLATION

103.5.1 Epoxy-coated reinforcing bars supported formwork shall rest on coated wire bar supports, or on bar supports made of dielectric material or other acceptable materials. Wire bar supports shall be coated with dielectric material for a minimum distance of 2 inches from the point of contact with the epoxy-coated reinforcing bars. Reinforcing bars used as support bars shall be epoxy-coated. In walls having epoxy-coated reinforcing bars, spreaders where specified by the plans or ENGINEER shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing bars shall be made of corrosion resistant material.

103.5.2 Epoxy-coated reinforcing bars shall be fastened with nylon-, epoxy-, or plastic-coated tie wire or other acceptable materials.

103.5.3 Splices of reinforcing bars shall be made only as required or permitted in the construction plans or approved by the ENGINEER.

103.5.4 When required or permitted, all welding of reinforcing bars shall conform to AWS D 1.4. Unless otherwise permitted, welding of crossing bars (tack welding) for assembly of reinforcement is prohibited.

103.5.5 Suitable ventilation shall be provided when welding epoxy-coated reinforcing bars.

103.5.6 After completion of welding on epoxy-coated reinforcing bars, coating damage shall be repaired in accordance with Subsection 103.3.4. All welds, and all steel splice members when used to splice bars, shall be coated with the same material used for repair of coating damage.

103.5.7 When required or permitted, mechanical connections shall be installed in accordance with the splice device manufacturer's recommendations.

103.5.8 After installing mechanical connections on epoxy-coated reinforcing bars, coating damage shall be repaired in accordance with Subsection 103.3.4. All parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

103.5.9 Reinforcing bars partially embedded in concrete shall not be field bent, except as indicated on the construction plans or approved by the ENGINEER. When heat is used to field bend epoxy-coated reinforcing bars, suitable ventilation shall be provided. When epoxy-coated reinforcing bars are field bent, coating damage shall be repaired in accordance with Subsection 103.3.4.

103.5.10 Unless permitted by the ENGINEER, reinforcing bars shall not be cut in the field. When epoxy-coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage.

103.5.11 Equipment for handling epoxy-coated bars shall have protected contact areas. Bundles of coated bars shall be lifted at multiple pickup points to minimize bar-to-bar abrasion from sags in the bundles. Coated bars or bundles of coated bars shall not be dropped or dragged. Coated bars shall be stored in protective cribbing. Fading of the color of the coating shall not be cause for rejection of epoxy-coated reinforcing bars. Coating damage due to handling, shipment and placing need not be repaired in cases where the damaged area is 0.1 square inch or smaller. Damaged areas larger than 0.1 square inches shall be repaired in accordance with Subsection 103.3.4. The maximum amount of damage including repaired and unrepaired areas shall not exceed 2 percent of the surface area of each bar.

103.6 MEASUREMENT AND PAYMENT

Epoxy-coated steel reinforcement will be included in the measurement for this special type of reinforced concrete. Payment will be made at the reinforced concrete's unit price per cubic yard or square yard as defined in the Bid Proposal.

SECTION 105

CONCRETE CURING COMPOUND

105.1 GENERAL

This section shall govern the type of concrete curing compound used, in curing fresh concrete. The curing compound shall consist of a liquid which, when applied to fresh concrete by means of a spray gun, will form an impervious membrane over the exposed surfaces of the concrete.

105.2 REFERENCES

105.2.1 ASTM

C-156
C-309
E-97

105.2.2 This Publication

Section 111

105.3 MATERIALS

105.3.1 Curing compound shall be Type 2, White Pigmented as specified in ASTM C-309, unless modified on the plans or the Supplemental Technical Specification, or as approved by the ENGINEER.

105.3.2 When required, the curing compound manufacturer shall supply certification, to the ENGINEER that his product has been tested and complies with ASTM C-309 and for Type 2 compounds, ASTM E-97.

105.3.3 EXCEPTION: Type 2, White Pigmented curing compound shall not be used on colored concrete. The curing compound used on colored concrete shall be as specified in Section 111.

105.4 APPLICATION

The curing compound shall be applied so as to form a uniform, continuous, unbroken film over the concrete surface. The rate of application shall be per the manufacturer's recommendations but in no case greater than 250 square feet per gallon.

105.5 MEASUREMENT AND PAYMENT

No separate measurement or payment will be made for curing compound. The cost of the curing compound and its application shall be included in the cost of the work it is applied too.

SECTION 106

CEMENT MORTAR AND GROUT

106.1 GENERAL

Cement mortar prepared under this specification shall consist of a mixture of cementitious materials, aggregate, and water.

106.2 REFERENCES

106.2.1 ASTM

C 5	C 207
C 91	C 266
C144	C 270

106.2.2 This publication

SECTION 101

106.3 DESIGNATIONS

106.3.1 The designation of cement mortar according to type listed in the following tabulation indicates the proportions of materials to be used in the preparation thereof; the proportions indicated are on a volume basis. The type of mortar to be used shall be as specified in Tables 106.3.1.1, 106.3.1.2, as shown on the plans, or as approved by the ENGINEER.

106.3.2 Grout shall be Type M mortar, unless otherwise approved by the ENGINEER. Neat cement grout shall consist of cement mixed with water as necessary to obtain a fluid and workable mix.

106.4 CEMENT AND LIME

Cement to be used shall conform with the requirements in Section 101. Masonry cement shall conform to ASTM C 91. Quicklime shall conform to ASTM C 5. Hydrated lime shall conform to ASTM C 207.

106.5 AGGREGATES

Aggregates to be used shall conform with ASTM C 144.

106.6 WATER

Water shall be clean and free of deleterious amounts of acids, alkalis, or organic materials.

106.7 ADMIXTURES OR MORTAR COLORS

Admixtures or mortar colors shall not be added to the mortar at the time of mixing unless approved by the ENGINEER and, after the materials are so added, the mortar shall conform to the requirements of this specification.

106.8 ANTIFREEZE COMPOUNDS

No antifreeze liquid, salts, or other substances shall be used in mortar to lower the freezing point.

106.9 MORTAR FOR REPAIRING SPALLED AREAS AND FOR NOSING GROUT.

Mortar shall have a fast setting Portland cement base, no metallic additives, and shall mix, place and finish similar to regular concrete. It shall develop minimum compressive strengths (psi) of 3200 @ 24 hr. and 4500 @ 7 days. The mortar shall meet the resistance to the action of freeze-thaw cycles as ascertained using the rapid method outlined in ASTM C-266 and shall show no excessive spalling after 300 cycles of rapid freezing and thawing in water.

106.10 MEASURING AND MIXING OF MATERIALS

106.10.1 The method of measuring materials for the mortar used in construction shall be such that the specified portions of the mortar materials can be controlled and accurately maintained.

106.10.2 All cementitious materials and aggregate shall be mixed for a least 3 minutes with the maximum amount of water to produce a workable consistency in a mechanical batch mixer.

106.10.3 Mortars that have stiffened because of evaporation of water from the mortar shall be retempered by adding water as frequently as needed to restore the required consistency. Mortars shall be used and placed in final position within 2 1/2 hours after initial mixing.

106.11 TESTS

The mortar shall be designed and the laboratory mix tested in accordance with ASTM C 270.

106.12 MEASUREMENT AND PAYMENT

106.12.1 Measurement and payment for mortar and grout used in repair of spalled areas and for joint nosing material in drainage channels shall be by the square foot and shall include all chipping, sawing, sandblasting, and materials and work required for the completion of the repair.

106.12.2 No separate measurement and payment will be made for mortar and grout in other applications unless designated by the ENGINEER.

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SECTION 106

CEMENT MORTAR AND GROUT

TABLE 106.3.1.1
MORTAR TYPES

Mortar Type	Portland Cement	Masonry Cement	Hydrated Lime or Lime Putty	Aggregate, Measured In A Damp, Loose, Condition
M	1	1 (type II)	0	Not less than 2 1/4 and not more than 3 times the sum of the volumes of the cement and lime used.
M	1	0	1/4	
S	1/2	1 (type II)	0	
S	1	0	Over 1/4 to 1/2	
N	0	1 (type II)	0	
N	1	0	Over 1/2 to 1 1/4	
O	0	1 (type I or II)	0	
O	1	0	Over 1 1/4 to 2 1/2	
K	1	0	Over 2 1/2 to 4	

TABLE 106.3.1.2
MORTAR TYPE VS STRENGTH

Mortar Type	Average Compressive Strength at 28 days, psi
M	2,500
S	1,800
N	750
O	350
K	75

SECTION 107

JOINT FILLER AND SEALANTS

107.1 GENERAL

This section specifies the joint fillers and sealants that are applicable to concrete pavements, concrete channel linings, sidewalks, driveways, and other concrete surfacing applications.

107.2 REFERENCES

107.2.1 ASTM:

C 179	D 994
D 881	D 1751
D 217	D 1752
D 297	D 2007
D 412	D 2240
D 794	

107.2.2 AASHTO:

M 153	T 72
T 59	T 132

107.2.3 Federal Specifications:

LP-590
TT-S-0022 7E

107.3 JOINT FILLERS

107.3.1 PREMOLDED JOINT FILLER:

107.3.1.1 Expansion joint filler material shall consist of premolded strips of a durable resilient compound.

107.3.1.2 Where stiffness is lacking in premolded expansion joint filler, the strips shall be encased in saturated felt, asphalt impregnated cotton webbing, or other satisfactory material. Any material or fabric used for encasement shall be firmly sealed to the body of the joint filler and shall not be detached therefrom after immersion in water for a period of forty-eight hours.

107.3.1.3 Unless otherwise specified, premolded joint filler may be either pre-molded Expansion Joint Filler (nonextruding and Resilient Bituminous types) conforming to the requirements of ASTM C 1751 or Preformed Expansion Joint Filler (Bituminous Type) conforming to the requirements of ASTM D 994.

107.3.1.4 Expansion joint filler material shall be manufactured in a workmanlike manner; and when ten percent or more of any lot or shipment is of nonuniform or improper construction, the entire lot or shipment may be rejected.

107.3.2 ASPHALT-LATEX JOINT FILLER:

107.3.2.1 Asphalt-latex joint filler shall consist of asphalt-latex emulsion and sodium fluosilicate furnished in separate containers and mixed on the site. The emulsion shall consist by volume of 60 parts 200-300 asphalt conforming to the requirements of Section 112, 40 parts of synthetic latex (GRS Type 4 and 5) to 10 parts of sodium fluosilicate, half strength. The emulsion and sodium fluosilicate shall not be mixed until the joint is ready to be filled. The amount of sodium fluosilicate to be mixed with the emulsion shall be approximately 3 percent to 5 percent by weight of the emulsion. The joint to be filled shall be thoroughly cleaned and surface dry.

107.3.2.2 The sealing compound shall consist of paving asphalt, Grade 200-300, conforming to the provisions of Section 112 of these specifications, emulsified with rubber latex in the presence of a suitable emulsifying agent; rubber latex designated as GRS Type 4; or any other approved type containing approximately 40 percent solids.

107.3.2.3 The resulting emulsion shall consist of a minimum of 55 percent of paving asphalt and a minimum of 36 percent of rubber latex and shall conform to the requirements set forth in the Table 107.3.2.3.

107.3.2.4 Test Report and Shipment Certification for Asphalt-Latex Joint Fillers: Each shipment shall be accompanied by a certificate from the vendor that the material will comply with the above specifications and such certificate shall be delivered to the ENGINEER. The certificate shall show the shipment number for the entire lot of material contained in the shipment and shall also show a list which will enable the ENGINEER to identify each individual container by the vendor's batch number, with which each container shall be plainly marked.

107.3.2.5 Application for Asphalt-Latex Joint Filler:

107.3.2.5.1 At no time shall the emulsion be subjected to a temperature below 4 degrees F. Prior to application, the material may be warmed, if necessary, to permit proper pouring of the joints. The method of heating shall be carefully controlled to avoid overheating of any part of the container or mixture and under no circumstances shall the emulsion be heated to a temperature greater than 130 degrees F.

107.3.2.5.2 Joints and cracks shall be thoroughly cleaned by hand or mechanical means immediately in advance of pouring the filler material. When new pavement has been

cured by the Pigmented Sealing Compound Method, the joints and cracks shall be thoroughly scrubbed by means of a wire brush or a cloth mop saturated with gasoline or by other approved means.

107.3.2.5.3 All joints and cracks shall be surface dry before application of the joint sealer. No sealer shall be placed during unsuitable weather or when the atmospheric temperature is below 50 degrees F or when weather conditions indicate that the temperature may fall to 32 degrees F within 24 hours. Immediately before pouring joints and cracks, the emulsion shall be mixed with from 1 percent to 4 percent by weight of powdered sodium fluosilicate.

107.3.2.5.4 The joints and cracks shall be filled in a neat and workmanlike manner by means of cornucopia pot or other approved method.

107.3.3 POLYETHYLENE FOAM JOINT FILLER:

107.3.3.1 Material: Polyethylene foam filler material shall conform to specification ASTM D 1751 and ASTM D 1752 and shall have a density of 2.5 to 3.0 pounds per cubic ft. It shall be constructed of closed cell, cross linked, polyethylene foam.

107.3.3.2 Installation: The closed cell polyethylene filler shall be cut to size and shape of the joint to be filled as shown on the plans and the Standard Details. The filler shall be held in place against previously poured concrete with metal or wood stakes or forms which shall be removed as newly placed concrete holds the filler in place. Nails or other fasteners are not to be driven into concrete mortar or nosing material for the purpose of holding filler material in place.

107.4 JOINT SEALANT

107.4.1 ETHYLENE VINYL ACETATE FOAM SEALANT (EVA FOAM):

107.4.1.1 Material:

107.4.1.1.1 EVA foam to be used to seal joints shall be preformed foam sealant per AASHTO M 153, Type II or III, ultra-violet resistant. It shall be a nonextruding expansion/contraction, waterproof material, closed cell, cross linked, with a density range of 2.5 to 3.5 pounds per cubic foot. EVA foam shall be used to seal joints where the width of joint to be sealed is 1 inch or greater. EVA foam sealants shall be 25 percent wider than the joint width and compressed into the joint per the manufacturer's recommendations.

107.4.1.1.2 The bonding agent to be used to bond EVA foam to concrete or mortar shall be a 100 percent solid 2 part epoxy which meets ASTM C 881, Type II, Grade 2, Class B and C as approved by the ENGINEER. The bonding agent shall be used according to the manufacturer's recommendations. Care shall be taken to assure that the bonding agent does not adhere to the exposed surface of the EVA foam sealant.

107.4.1.2 Preparation and Application:

107.4.1.2.1 Immediately prior to application joints shall be sand-blast-cleaned to remove laitance, curing compound, and other bond inhibitors. At the time of application, concrete must be cured at least 7 days and attain at least 80 percent of design strength. The vertical sides of the joint area to be sealed shall be clean, dry, smooth, sound, and free of any foreign material. The bottom of the area to be sealed, if concrete, shall be covered with a polyethylene bondbreaker, minimum 1/16 inch thick, before applying the bonding agent to this vertical sides. The bonding agents shall be applied to completely cover both the nosing and the sealant surfaces which are to be bonded and to no other surface.

107.4.1.2.2 Sealant shall be extruded to the bottom of the joint groove and tooled to work the sealant into close contact with the joint surfaces to eliminate air bubbles. Any sealant that does not cure properly, fails to establish a satisfactory bond, protrudes more than one half inch above the finished concrete surface adjacent to the joint, does not completely adhere to the sides of the joint, is damaged by the CONTRACTOR'S operations, or is not satisfactory in the opinion of the ENGINEER must be removed and the joint recleaned and resealed.

107.4.1.2.3 After the bonding agent has set, sealant that protrudes 1/8 to 1/2 inches shall be cut with a power sander to the concrete surface. The sealant will then be coated with two coats of ultra-violet proofing, opaque, vinyl coating, which will produce approximately 6 mils thickness, as approved by the ENGINEER.

107.4.2 TWO COMPONENT URETHANE SEALANT:

107.4.2.1 Materials:

107.4.2.1.1 Two Component Urethane Sealant to be used to seal joints shall meet Federal Specifications No. TT-S-0022 7E, Type I Class A (Pour Grade) or No. TT-S-0022 7E, Type II, Class A (Non-Sag). Two Component Urethane Sealant shall be used to seal expansion joints less than 1 inch in width.

107.4.2.1.2 The bonding agent to be used to bond the Two Compound Urethane Sealant to the concrete or mortar nosing shall be a one-component solvent based system, as furnished by the sealant manufacturer.

107.4.2.1.3 Urethane sealants shall not be placed when the temperature of the concrete or air is below 40 degrees F. The non-sag sealant shall be used in joints other than horizontal. Dimensions or urethane sealants shall be as shown on the drawings.

107.4.2.2 Preparation and Application: Two Component Urethane Sealants and Bonding Agents shall be installed in accordance with the manufacturer's recommendations and Subsection 107.4.1.2 of this specification.

107.4.3 ASPHALT RUBBER SEALANT:

107.4.3.1 Materials and Mixing (Method A)

107.4.3.1.1 Bituminous Material. The bituminous material shall be asphalt cement, having a maximum penetration of 120-150, complying with the requirements of Section 112.

107.4.3.1.2 The granulated crumb rubber (100 percent Vulcanized) shall meet the following requirements:

PASSING SIEVE	PERCENT
#8	100
#10	98 - 100
#30	0 - 10
#40	0 - 4

NOTE: The granulated crumb rubber shall be accepted if accompanied by the certificate of compliance from the supplier that the material has been tested during the grinding process and meets the gradation specified.

107.4.3.1.2.1 The specific gravity of the granulated rubber shall be 1.15 ± 0.02. The rubber material shall be free of fabric, wire, or other contaminating materials except that up to 4 percent of calcium carbonate may be included to prevent the particles from sticking together.

107.4.3.1.3 Diluent for diluting the asphalt cement and granulated crumb rubber mixture shall have a boiling point of not less than 350 F, and the temperature of the hot asphalt-rubber shall not exceed 350 F, at the time the diluent is added.

107.4.3.1.4 Mixing. The percentage of the granulated crumb rubber shall be 33 1/3 percent ± 2 percent of the asphalt weight.

107.4.3.1.4.1 The materials shall be combined as rapidly as possible for such a time and at such a temperature that the consistency of the mix approaches that of a semi-fluid material. The temperature of the asphalt cement shall be between 350 and 395 degrees F.

107.4.3.1.4.2 After the full reaction between the asphalt cement and the granulated rubber has occurred and before application, the mix may be cut back with diluent. The maximum amount of diluent used shall not exceed 7 1/2 percent by volume of the hot asphalt cement-granulated crumb rubber composition required for adjusting the viscosity for spraying.

107.4.3.1.4.3 In the event that a delay occurs after the full reaction has taken place, the material may be slowly reheated to an acceptable spraying temperature with no detrimental effect but, because of the polymer reversion that can occur when the granulated crumb rubber is held at high temperature(s) for a prolonged time, the material shall not be reheated to temperatures above 350 degrees F.

107.4.3.2 Materials and Mixing (Method B):

107.4.3.2.1 Bituminous Material. The bituminous material shall be Asphalt cement, having a maximum penetration of 120, complying with the requirements of Section 112 and shall be fully compatible with the ground rubber.

107.4.3.2.2 Rubber Extender Oil. The extender oil shall be a resinous, high flash point aromatic hydrocarbon meeting the following test requirements:

Viscosity, SSU @ 100 degrees F. (ASTM D 88)	2500 Min.
Flash Point, C.O.C., degrees F.	392 Min.
Molecular Analysis (ASTM D-2007)	
Asphaltenes, percent by weight	0.1 Max.
Aromatics, percent by weight	55 Min.

107.4.3.2.3 Rubber Components. The rubber shall be U.S. Rubber Reclaiming Company designation G 274, or approved equal meeting the following physical requirements:

107.4.3.2.3.1 Composition: The rubber shall be a dry, free flowing blend of 40 percent powdered reclaimed (that is, Devulcanized), rubber and 60 percent ground vulcanized rubber scrap with a high natural rubber content and shall be free from fabric, wire or other contaminants except that up

to 4 percent of a dusting agent such as calcium carbonate may be included to prevent cracking of the particles.

107.4.3.2.3.2 Sieve Analysis:

Sieve No.	Percent Passing
8	100
30	60-80
50	15-40
100	0-15

107.4.3.2.3.3 Mill Test: When 40 to 50 grams of rubber retained on the No. 30 sieve are added to a tight set 6-inch rubber mill, the material shall band on the mill roll in one pass. This will indicate the presence of a suitable quantity of reclaimed, devulcanized rubber.

107.4.3.2.3.4 Natural Rubber Content. Minimum 30 percent by weight. (ASTM D-297).

107.4.3.2.4 Mixing. The Asphalt Rubber Blend shall be a combination of the asphalt cement, extender oil, and ground rubber mixed together at an elevated temperature in accordance with the following procedure and proportions:

107.4.3.2.4.1 Preparation of asphalt-extender oil mix. Blend the preheated asphalt cement (250-400 degrees F) and sufficient rubber extender oil, (usually from 2 to 6 percent), to reduce the viscosity of the asphalt cement to within the range of 600 to 1800 Poises at 140 degrees F, when tested in accordance with the requirements of AASHTO M 266. Mix thoroughly by recirculation, stirring, air agitation or other appropriate means.

107.4.3.2.4.2 Addition of Rubber. Increase the temperature of the asphalt cement-extender oil blend with appropriate heat exchanges to within the range of 350-425 degrees F, and then add an amount of specified ground rubber equal to 20 percent, ± 2 percent by weight of the total asphalt-rubber blend. Add the rubber as rapidly as possible and continue recirculating for a period of not less then 30 minutes after the incorporation of all the rubber.

107.4.3.2.4.3 Sufficient recirculation and/or stirring of the total combined material shall be maintained to provide good mixing and dispersion. Temperature of the total blend shall be kept between 350-425 degrees F.

107.4.3.3 Construction Requirements:

107.4.3.3.1 the equipment used for application shall be capable of maintaining a continuous uniform, homogeneous mixture throughout the sealing operation. The method and equipment for heating and preparing the asphalt-rubber mixture for application shall be so designed as to provide a continuous supply of the prepared mixture that will assure sealing operations without delays due to the mixing-heating operation. The equipment shall incorporate a mechanical mixing device within the heating unit such that a continuous mixing of the sealant compound is maintained.

107.4.3.3.2 The ENGINEER shall be satisfied that the material and the mixing process the CONTRACTOR proposes to use has been successfully used in similar circumstances on comparable projects.

107.4.3.3.3 Nozzles shall be of adequate design to provide for uniform application of the asphalt-rubber material without clogging, or other irregularities in distribution.

107.4.3.3.4 Should clogging or irregularities in distribution occur, operations shall cease until corrective action is effected.

107.4.3.3.5 Defective equipment shall be removed from the project.

107.4.3.3.6 Weather Limitations. Asphalt rubber joint sealant shall not be placed during wet or adverse weather, on a wet surface, or unless the atmospheric temperature is at least 40 degrees and rising, or when the wind conditions are such that a satisfactory seal cannot be achieved.

107.4.3.3.7 The ENGINEER will be the sole judge of when the mixed material has reached a consistency for application. Application shall proceed immediately after the proper consistency is attained.

107.4.3.3.8 Immediately prior to placing the sealant, the joints shall be cleaned of all loose particles, dust, and other deleterious substances by means of high velocity compressed air, or any other methods approved by the ENGINEER.

107.4.3.3.9 Only asphalt-rubber sealant shall be used to fill the joints.

107.4.3.3.10 No Vehicular Traffic will be permitted on the asphalt-rubber sealed joints until sufficient time has elapsed for the asphalt-rubber sealant to become non-tacky.

107.4.3.3.11 The ENGINEER shall be the sole judge as to when the joints are properly cleaned and sealed.

107.4.4 SILICONE RUBBER SEALANT: This work shall consist of cleaning the joint, and installation of low modulus silicone sealant in the roadway joints specified on

the plans. The plans will designate the type of joint (transverse or longitudinal) and location of joint.

107.4.4.1 Materials: All materials shall meet the requirements of the following:

107.4.4.1.1 Silicone Sealant: Silicone sealant shall be furnished in a one-part silicone formulation. The compound shall be compatible with the surface to which it is applied. Acid cure sealants are not acceptable for use on concrete. Movement capability shall be +100 percent and -50 percent of the joint width. The physical requirements are:

107.4.4.1.1.1 Accessory Items: The backup material shall be compatible with the sealant or any component of the joint sealant system. No bond or adverse reaction shall occur between the backup material, sealant, or primer if primer is specified.

107.4.4.1.1.2 Test Requirements:

Tensile Stress: 150 45 psi maximum
percent Elongation 7
days cure @ 77 F ±3°F
and 45-55 percent R.H.

Specific Gravity	1.01- 1.515
Durometer Hardness, Shore A:	10-25 (0°F) cured 7 days @ 77°F ±3°F and 45-55 percent R.H.
Shelf Life	6 mo. minimum from date of manufacture
Ozone and U.V.	No chalking, Resistance cracking, or bond loss after 5000 hours
Bond to concrete mortar	50 psi minimum concrete Briquettes air cured 7 days @ 77°F ±3°F
Tack Free Time	6 Hrs. minimum
Movement Capability and Adhesion	No adhesive or cohesive failure after 10 cycles at 0°F

107.4.4.1.1.3 Test Methods:

Tensile Stress	ASTM D-412 (DIE C)
Specific Gravity	ASTM D-794, Method A
Durometer Hardness	ASTM D-2240
Ozone and UV Resistance	ASTM D-793

107.4.4.1.1.4 Bond to Concrete Mortar:

Three briquets molded in accordance with AASHTO T-132 and moisture cured for at least 28 days shall be sawed in half, cleaned, and oven dried to a constant weight in an oven at 100 degrees C ± 5 degrees. After cooling, they shall be bonded with approximately 10 mils of silicone sealant and tested using clips meeting AASHTO T 132. They shall be tested in tension at a loading rate of .3 inch/minute.

107.4.4.1.1.5 Tack Free Time:

Prepare specimen in a mold with an area larger than the brass weight described below and 1/4 inch thick. Place a 30 gram brass weight 1-5/8 inch by one inch by 1/8 inch on a polyethylene strip applied to the specimen after they have cured for the specified time. After removing the weight, peel the polyethylene strip by pulling it at 90 degrees to the compound at a rate of 1 inch in 5 seconds. No material should adhere to the polyethylene when it is tack free.

107.4.4.1.1.6 Movement Capability and Adhesion:

Prepare 1 inch x 1 inch x 3 inch concrete blocks in accordance with ASTM C-719. A sawed face shall be used for bond surface. Seal 2 inch of block leaving 1/2 inch on each end of specimen unsealed. The depth of sealant shall be 3/8 inch and the width 1/2 inch. Cure the specimen 7 days in air at 77 degrees F ±3 degrees F and then 7 days in water at 77 degrees F ±3 degrees F. Subject sealant to movement in accordance with ASTM C 719. The rate of extension or compression shall be 1/8 inch per hour. One cycle is defined as extension to one inch width and return to the initial 1/2 inch width.

107.4.4.1.1.7 Certification: The manufacturer of the joint sealant shall furnish certification test results of each lot of the joint sealant material furnished to the project to meet all of the above requirements except the bond to cement mortar. Certification shall show use of primers where applicable.

107.4.4.1.1.8 Acceptance: Even though a sealant meets all requirements of the specification failure to perform adequately in actual use shall be just cause for rejection.

107.4.4.1.2 Bond-breaking Adhesive Tape shall be polyethylene and Backer-Rod shall be closed cell poly-ethylene. Backer-rod shall be of circular cross section with a diameter 25 percent greater than the joint width.

107.4.4.2 Construction Requirements:

107.4.4.2.1 Cleaning the Joint: The joints shall be thoroughly cleaned of all foreign material (oil, asphalt, curing compound, sealant adhesive, paint, rust, etc.), including existing sealant, if any. The CONTRACTOR may use any one or combination of methods below in his cleaning operation, except Method 2, sawing is to be used only if Method 1 will not properly clean the joint.

107.4.4.2.1.1 Method 1 - High Pressure Water Jet:

The joint shall be thoroughly cleaned with a high-pressure water jet blaster (3000 psi at the tip) and other tools as necessary. After blasting, the joint shall be blown out with compressed air. This process shall be repeated until the joint is thoroughly cleaned of all foreign material, including old sealant, and a new, clean concrete face is exposed on the faces of the joint.

107.4.4.2.1.2 Method 2 - Sawing:

If this method of cleaning is selected (and approved as noted previously), the CONTRACTOR shall exercise utmost care to minimize enlarging the existing width of the joint. Sawing shall be limited to only exposed clean, new concrete faces on the joint with a maximum allowable cut of 1/16 inch on each face of the joint. All dust, sawing residue, and other contamination will be removed from the joint faces. If dry sawing with diamond or abrasive blades is used, the sawing residue shall be thoroughly removed by blowing out the joint and immediate area with compressed air. If wet sawing with diamond or abrasive blades is used, the resulting saw latence or slurry shall be completely removed from the joint and immediate area by flushing clean with a high-pressure jet of clean water. After flushing, the joint shall be blown out with compressed air and allowed to dry 4 hours minimum.

107.4.4.2.2 Installing Backer-Rod in Joint: Prior to placing the backer-rod, the joint must be thoroughly dry and clean. Any necessary cleaning, air blasting, or air-drying will be completed before placing backer-rod (and sealant). On joints less than 1 inch wide after cleaning, a round backer-rod of resilient material, compatible with silicone sealant, and slightly oversized to prevent movement during the sealing operation will be installed in the joint at the depth specified on the appropriate joint detail in the plans or as recommended by the sealant manufacturer. (The thickness of the backer-rod will be greater after squeezing it into the joint and some "rebound" may occur--allowance must be made for this to insure placing at correct depth.) On joints larger than 1 inch after cleaning, use a backup material cut from an approved resilient material which is compatible with silicone sealant.

107.4.4.2.3 Installing Silicone Sealant: The installation of the silicone sealant is to be done as soon after placing the backer-rod as reasonably possible to insure that joint is still clean and dry. In the event the joint does become contaminated, damp, or wet, the backer-rod is to be removed, the joint cleaned and dried, and backer-rod reinstalled prior to placing the sealant material. The sealant material used shall be a low modulus silicone sealant meeting the movement requirements of Section 107.4.4.1.1. The temperature at time of placement must be 35 degrees F or higher. The silicone sealant shall be applied by pumping or manual means. If pumping is used, the pump shall be a sufficient capability to deliver the necessary volume of material to completely fill the joint to the specified width and height of sealant in one pass. The nozzle shall be of sufficient size and shape to closely fit into the joint and introduce the sealant inside the joint with sufficient pressure to prevent voids occurring in the sealant and to force the sealant into contact with the joint faces. The sealant after being placed shall be tooled to provide the specified recess depth and thickness and shape of sealant as shown on the plans. Sufficient force or pressure shall be applied to the sealant in this tooling operation to force the sealant against the joint faces to insure satisfactory wetting and bonding of the sealant to the joint faces. The silicone sealant is not self-leveling and will not position itself correctly in the joint under its own weight. The sealant shall be placed to reasonably close conformity with the dimensions and shape shown on the plans. Any unreasonable deviation will be cause for rejection and necessary corrective action will be made by the CONTRACTOR. See Sketch 107.4.4.2.3 for installation detail.

107.4.4.2.4 Cleaning Pavement: After a joint has been sealed, all surplus sealant or other residue on the pavement or structure surfaces shall be promptly removed.

107.4.4.2.5 Opening to Traffic: Traffic shall not be permitted over sealed joints until the sealant is tack free and until debris from traffic does not imbed into the sealant.

107.4.4.2.6 Special Requirements: The following special requirements apply to this work:

107.4.4.2.6.1 Air compressors used for cleaning joints shall be equipped with suitable traps capable of removing all surplus water and oil in the compressed air. The compressed air will be checked daily by the ENGINEER for contamination. No contaminated air shall be used. The compressor shall be capable of delivering compressed air at a continuous pressure of at least 90 psi.

107.4.4.2.6.2 Unless otherwise specified on the plans, the joints are to be resealed after any required pavement repair.

107.4.4.2.6.3 Any failure of the sealed joint due to (1) adhesion or cohesion failure of joint material (2) unsatisfactory or improper workmanship by CONTRACTOR (3) damage by CONTRACTOR's operations or public traffic will be cause for rejection, and the joint shall be repaired to ENGINEER's satisfaction at no additional cost to the OWNER.

107.5 POLYETHYLENE SHEET BEARING PLATE AND SLEEPER

107.5.1 MATERIAL: Ultra high molecular weight, high density, or low density polyethylene sheet to be used as a bearing plate or sleeper shall conform to Federal Specification LP-590. This material is only used for concrete channel expansion joints.

107.5.2 Installation: The polyethylene sheet shall be cut to size and shape of the horizontal surfaces to be covered. The concrete surface to be covered with polyethylene sheet shall be smooth and flat to within ±1/8 inch when checked with a 10 foot straightedge. The subgrade upon which the polyethylene sheet is to be placed shall not vary more than 1/4 inch from the specified grade when checked with a 10 foot straightedge.

107.6 PRECAUTION

The manufacturer's recommendation for clearance between surface of sealant to top of concrete or joint shall be closely observed. Certain sealants will fail if the joint is over filled and sealant is allowed to spread onto the concrete surface. All joint material that does not comply with the manufacturer's installation recommendations or these specifications shall be removed, joint cleaned and material correctly installed by the CONTRACTOR at no cost to the OWNER.

107.7 MEASUREMENT AND PAYMENT

Filler materials and sealants shall be considered as incidental to concrete joint treatment and no measurement or payment will be made for these materials and installation thereof.

TABLE 107.3.2.3
ASPHALT-LATEX EMULSION JOINT SEALING COMPOUND

Specification Designation	Test Method	Limits	
Furol Viscosity at 77°F	AASHTO T 72	50-250 Seconds	Before adding gelling agent.
Sieve Test	AASHTO T 59	1% Max.	Before adding gelling agent.
Penetration at 77°F	ASTM D 217	50-250	The penetration test is made on a specimen prepared by stirring 5 percent of sodium fluosilicate into the asphalt-latex emulsion in a 6-ounce deep ointment can. The specimen is then allowed to stand in the air at a temperature of 77 degrees F ±2 degrees F for a period of 30 minutes and is then penetrated with a grease cone under a total load of 150 grams in accordance with ASTM D 217.
Elasticity		70% Min.	After addition of 5 percent of sodium fluosilicate and curing for 24 hours at 100 degrees F ±2 degrees F the specimen shall have an elastic recovery of not less than 70 percent.
Dehydration Loss		30 Max.	Twenty-five grams of emulsion, prior to adding the gelling agent, is placed in an 8-ounce flat ointment can and dehydrated in a suitable oven maintained at a temperature of 200 degrees F ±2 degrees F for a period of 24 hours. Weight loss from dehydration shall not exceed 30 percent of sample tested.
Time of "Set"		15 to 60	After mixing the emulsion with 1 percent to 4 percent by weight powdered sodium fluosilicate, the emulsion shall harden or develop a "set" in from 15 to 60 minutes, under field conditions.

SECTION 108

BRICK

108.1 GENERAL

Brick shall be whole, sound, and hard burned and shall give a clear ringing sound when struck together. They shall be uniform in quality and shall be culled or sorted before delivery to the work site.

108.2 REFERENCES

108.2.1 ASTM:

C 32
C 62
C 216
C 902
C 1028

108.3 MANHOLE BRICK

108.3.1 Sewer manhole brick shall conform, except for dimensional tolerances, to the requirements of ASTM C 32.

108.3.2 Manhole brick shall conform to the following standard size dimensions: length = 7-5/8 inches, width = 3-5/8 inches and depth = 2-1/4 inches.

108.4 BUILDING BRICK

Building brick shall conform to the requirements of ASTM C 62, Grade MW. The size and texture shall be specified on the plans or as approved by the ENGINEER.

108.5 FACING BRICK

Facing brick shall conform to the requirements of ASTM C 216, Grade SW, Type FBS. The size, color, and texture shall be as specified on the plans or as approved by the ENGINEER.

108.6 PEDESTRIAN AND TRAFFIC PAVING BRICK

108.6.1 Brick used for sidewalks, drive pads, or street surfacing shall conform to the requirements of ASTM C 902, Class SX, Type I. The size of the brick shall be: length = 8 inches, width = 4 inches and depth = 2 1/4 inches. The surface texture shall be smooth and the color shall be as specified on the plans or as approved by the ENGINEER.

108.6.2 Depending on the size of shipment or order, the ENGINEER may request a random selection of the brick for determining the static coefficient of friction for the dry brick. Tests shall be conducted by an independent testing laboratory and shall be conducted in accordance with ASTM C 1028. All tested brick must have a coefficient of friction greater than 0.65. Test results shall be included in the require certification of the brick, as per Section 348.

108.7 MEASUREMENT AND PAYMENT

No separate measurement or payment shall be made for brick, unless otherwise stipulated in the Bid Proposal.

SECTION 109

RIPRAP STONE

109.1 GENERAL

The riprap stone provided and installed under this specification shall be angular rock, stone or recycled Portland cement concrete complying with the requirements of this specification. The material shall be certified to comply with the specification in accordance with the requirements of Section 13. If a change in material and/or source from that authorized occurs during a project, the CONTRACTOR shall resubmit to include the changed material and/or source for authorization by the ENGINEER. A riprap material shall not be used on a project without written authorization of the ENGINEER.

109.2 REFERENCES

109.2.1 ASTM:

C88
C127
C535

109.2.2 AASHTO:

T103

109.2.3 This Publication

603
610

109.3 MATERIAL

109.3.1 Riprap stone shall be stone, rock or recycled Portland cement concrete complying with this specification. The material shall be free of seams, fractures and coatings and of such characteristics that it will not disintegrate when subject to the action of flowing water.

109.3.2 The minimum specific gravity of the stone shall be 2.65 for sizes and gradation specified in TABLE 209.A, as determined in accordance with ASTM C127, latest edition. If the specific gravity of a stone is less than 2.65. the minimum size of the stone and the depth of the riprap shall be increased in accordance with TABLE 109.8.

109.3.3 The maximum resistance to abrasion shall be fifty (50) percent determined in accordance with the requirements of ASTM C535.

109.3.4 The maximum soundness loss shall be twenty (20) percent determined in accordance with ASTM C88.

109.3.5 The maximum loss to freeze thaw shall be ten (10) percent for 12 cycles determined in accordance with the AASHTO Tl03, Ledge R, Procedure A.

109.4 SHAPE AND GRADATION

109.4.1 Riprap material shall be rectangular in shape rectangular in shape having maximum to minimum dimension ratio not more than 3:1.

109.4.2 Riprap stone shall comply with the gradation requirements of TABLES 109.A and A 109.B.

109.4.3 Waste Portland cement concrete complying with the requirements of this specification may be used as riprap as specified in the plans and specification, as directed by the ENGINEER.

109.5 PLACEMENT

109.5.1 The placement of riprap stone shall be to the line and grade shown on the plans or as authorized by the ENGINEER. The depth of the riprap shown on the plans shall be adjusted based on Table 109.B for the specific gravity of the material provided. The surface tolerances shall be within the maximum variations shown in Table 109.C.

109.6 MEASUREMENT AND PAYMENT

109.6.1 Riprap shall be measured by the cubic yard (cy) placed to the lines and grades in the plans and specifications complete in place.

109.6.2 Payment for riprap will be made at the contract unit price per cubic yard for the type of riprap required, which payment shall include all material, labor and equipment required in placing riprap stone as specified in Section 603 and/or 610.

SECTION 109

RIPRAP STONE

TABLE 109.A
CLASSIFICATION GRADATION

DESIGNATION	MAX. DIMENSIONS inches (m)	% SMALLER	Km [1]
A. GABIONS			
TYPE VL	12 (0.30)	100	
	9 (0.25)	50-70	
	6 (0.15)	35-55	6
	3 (0.08)	10	
TYPE L	18 (0.45)	100	
	12 (0.30)	50-70	
	6 (0.15)	30-55	9
	3 (0.08)	10	
B. RIPRAP			
TYPE M	24 (0.60)	100	
	18 (0.45)	50-70	
	12 (0.30)	30-55	12
	6 (0.15)	10	
TYPE H	36 (0.90)	100	
	24 (0.60)	50-70	
	12 (0.30)	30-55	18
TYPE VH	48 (1.20)	100	
	36 (0.90)	50-70	
	18 (0.45)	30-55	24
	9 (0.23)	10	

[1] Km = mean particle size

TABLE 109.B
SPECIFIC GRAVITY MULTIPLIER

SPECIFIC GRAVITY	MULTIPLIER
2.65	1.00
2.60	1.05
2.50	1.15
2.40	1.25
2.30	1.35
<2.30	REJECT

TABLE 109.C
CONSTRUCTION TOLERANCES

RIPRAP DESIGNATION	MAXIMUM VARIATION FROM SPECIFIED FINISH GRADE inches (meters)		
TYPE VL	+/-	3	(0.08)
TYPE L		6	(0.15)
TYPE M		9	(0.25)
TYPE H		12	(0.30)
TYPE VH	+/-	12	(0.30)

SECTION 111

COLORED PORTLAND CEMENT CONCRETE

111.1 GENERAL

The Colored Portland Cement Concrete shall be a portland cement concrete that meets the requirements of Section 101, to which coloring pigments are added that meet the requirement of this Section.

111.2 REFERENCES

111.2.1 ASTM:

C-979 Specification for Pigments for Integrally Colored Concrete

111.2.2 This publication:

Section 101 Portland Cement Concrete
Section 105 Concrete Curing Compound

111.3 MATERIALS:

111.3.1 The Portland cement concrete shall conform to the requirements of Section 101 or as modified by the Supplemental Specifications and the approved concrete mix design.

111.3.2 Pigments used in the coloring of Portland cement concrete shall be either natural. or synthetic iron and mineral oxides in powder form. Pigments shall conform with the requirements of ASTM C-979.

111.4 DOSAGE

The maximum dosage rate shall not exceed the recommendations of the manufacturer, or 10% by weight of Portland cement in the design mix. When a combination of pigments is required for a specific color, the total dosage rate of all pigments shall not exceed any of the individual maximum dosage rates of the component pigments, or 10% by weight of portland cement in the design mix.

111.5 BATCHING, MIXING. TRANSPORTATION AND PLACEMENT

Colored concrete shall be batched, mixed, transported and placed in/with equipment that is clean of all residual non-colored concrete prior to the introduction of the colored concrete materials.

111.6 PLACEMENT

111.6.1 Colored Portland cement concrete that does not have the color mixed throughout the entire load or has uneven distribution of color in the load shall not be incorporated in the work and shall be rejected.

111.6.2 The finishing of all colored Portland cement concrete shall be conducted in such a manner as to not diminish, streak, or in any way lessen the coloring of the concrete.

111.7 CURING

The liquid membrane-forming curing compound used to cure all colored concrete shall be compatible with the colored concrete, having the same color source pigments as those used in the color concrete and shall conform to the requirements of Section 105.

111.8 SUBMITTALS

111.8.1 The CONTRACTOR shall submit a mix design for the Colored Portland cement Concrete to the ENGINEER for review and approval. The mix design shall show the manufacturer of the pigment material. the dosage per cubic yard of the pigment material, and a certification from the pigment manufacturer that pigment(s) complies with the requirements of this Specification in accordance with Section 13. If during the project a change in the pigment material(s) or a change in the pigment manufacturer from the approved mix design is made. a new mix design shall be submitted to the ENGINEER for review and approval before the new material(s) are used on the project. The submittal shall include a curing program for the Colored Portland Cement Concrete.

111.8.2 As part of the ENGINEER'S review of the mix design, a sample of the colored concrete may be required. The sample shall be not less than the size of the typical element to the cast with the colored concrete or a four foot (4') by four foot (4') section, whichever is smaller. The sample shall be placed. finished and cured according to the project requirements to produce a true sample of the finished product. The sample shall be placed on the project site in a location where the sample may or may not, as approved by the ENGINEER, be incorporated into the completed work. The sample shall be maintained as the acceptance referenced, once approved for the duration of the project.

111.9 MEASUREMENT AND PAYMENT

Colored Portland Cement Concrete shall be measured and paid for at the unit price per specific construction item as specified herein or as defined in the Bid Proposal.

SECTION 112

PAVING ASPHALT BINDER

112.1 GENERAL: Paving asphalt binder for asphalt concrete (AC), bituminous treated base course construction (BTB), and plant mixed seal coat (PMSC), shall conform to the requirements of this specification. The CONTRACTOR shall be solely responsible for the binder supplied under this specification, its proportions and manufacture. The binder shall be supplied from a single source/supplier and be of a single formulation for the duration of either the authorized period of a job mix formula including the binder, or the project, as directed by the ENGINEER. The CONTRACTOR shall submit his qualifications in writing, and at least three references to whom he has supplied the same or similar binder, as directed by the ENGINEER.

112.2 REFERENCES

112.2.1 American Society For Testing and Materials, ASTM

D 5 Standard Test Method for Penetration of Bituminous Materials
D 8 Standard Definitions of Terms Relating to Materials for Roads and Pavements
D 92 Standard Test Method for Flash and Fire Points of Bituminous Materials
D 113 Standard Test Method for Ductility of Bituminous Materials
D 946 Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
D 1754 Standard Test Method for Effect of Heat and Air on Asphaltic Materials (Thin Film Oven Test, TFOT)
D 2042 Standard Test Method for Solubility of Bituminous Materials in Organic Solvents
D 2171 Standard Test Method for Viscosity of Asphalt by Vacuum Capillary Viscometer
D 2170 Standard Test Method for Kinematic Viscosity of Asphalts
D 2872 Standard Test Method for Effect of Heat and Air on Asphaltic Materials (Rolling Thin Film Oven Test, RTFPT)
D 3381 Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
D 4402 Standard Test Method for Viscosity Determinations of Unfilled Asphalt Using the Brookfield Thermosel Apparatus

112.2.2 American Association of State Highway and Transportation Officials, AASHTO

MP1 Standard Specification for Performance Graded Asphalt Binder
MP2 Specification for Superpave™ Volumetric Mix Design
TP1 Test Method for Determining Flexural Creep Stiffness of Asphalt Binder Using Bending Beam Rheometer (BBR)
TP3 Test Method for Determining Fracture Properties of Asphalt Binders in Direct Tension (DT)
TP5 Test Method for Determining Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
T40 Practice for Sampling Bituminous Materials
PP1 Accelerated Aging of Asphalt Binder Using Pressure Aging Vessel (PAV)
PP5 Laboratory Evaluation of Modified Asphalt Systems
PP6 Grading or Verifying the Performance Grade of an Asphalt Binder
PP-28 Superpave™ Volumetric Design for HMA

112.2.4 This Publication:

SECTION 116 ASPHALT CONCRETE CONSTRUCTION
SECTION 307 PLANT MIXED BITUMINOUS TREATED BASE COURSE CONSTRUCTION
SECTION 329 PLANT MIXED SEAL COAT
SECTION 336 ASPHALT CONCRETE PAVEMENT

112.3 MATERIAL

112.3.1 An asphalt binder shall be either an asphalt cement, a blend of asphalt cement(s), or a blend of asphalt cement(s) and admixture(s), to be determined by the CONTRACTOR, complying with the requirements specified in either TABLE 112.A 60-70 PENETRATION GRADE BINDER SPECIFICATION, or TABLE 112.B AC-20 VISCOSITY GRADE BINDER SPECIFICATION, or TABLE 112.C PERFORMANCE GRADE (PG) BINDER SPECIFICATIONS.

112.3.2 The CONTRACTOR shall submit certified test results in writing, with the job mix formula submittal, that a binder complies with the specification. The certification shall include, but not be limited to:

(a) name of the supplier
(b) source(s) of base asphalt cement(s)
(c) type and source(s) of admixture(s)
(d) proportions of materials
(e) laboratory test results of the binder
(f) certification statement that the binder complies with the requirements of this specification.

A certification shall be submitted (1) for a binder used in the design of a job mix formula as a part of the submittal, and, (2) during the life of an authorized job mix formula as scheduled herein.

112.4 SAMPLING AND TESTING

112.4.1.1 Quality assurance sampling and testing of asphalt binders shall be performed by the CONTRACTOR, at no cost to the OWNER, to verify compliance with the specification. A sample shall be taken at random during paving operations from a load(s) of material shipped as directed by the ENGINEER. The sample shall be tested by the CONTRACTOR to verify compliance with the specification requirements specified in either TABLE 112.A 60-70 PENETRATION GRADE BINDER SPECIFICATION, or TABLE 112.B AC-20 VISCOSITY GRADE BINDER SPECIFICATION, or TABLE 112.C PERFORMANCE GRADE (PG) BINDER SPECIFICATIONS. Test results shall be reported in writing to the ENGINEER by the CONTRACTOR. Non-complying sample test results shall be reported in to the ENGINEER within 24 hours of completion of the test(s). Complying sample test results shall be reported in writing to the ENGINEER, no later than ten working days after the date of sampling.

112.4.1.2 The binder sample used in the design of a job mix formula(s) shall be tested, and certified to comply with this specification. Written test results of the design sample binder tabulated with specifications with the certification of compliance shall be reported as specified herein and included in a job mix formula submittal.

112.4.2 A test report shall include, but not be limited to, (1) report date, (2) date of sampling, (3) bill of lading number of load sampled, (4) destination of load, (5) report of test results, (6) standard test identifications, (7) specification requirements, (8) statement of compliance, and certification signature. Failure to comply with quality assurance testing may result in rejection of either the binder, and/or the job mix formula, and/or the associated job mix placed on a project, as directed by the ENGINEER.

112.4.3.1 If non-complying material is identified, the paving program may be suspended for 24 hours, as directed by the ENGINEER, during which time the CONTRACTOR and the ENGINEER will meet to determine the impact of the non-compliance, and specify the necessary remedial action to be taken by the CONTRACTOR. Remedial action shall be either acceptance, or acceptance at a pay adjustment, or removal and replacement at no cost to the OWNER. The paving program may continue upon written authorization by the ENGINEER. The suspension of asphalt concrete construction period due to the identification of non-complying binder shall be at no cost to the OWNER.

112.4.3.2 Production binder identified to be in non-compliance shall not be shipped to a project. Asphalt concrete batched and placed with non-complying binder shall be removed and replaced with complying material by the CONTRACTOR at no cost to the OWNER, as directed by the ENGINEER.

112.4.4.1 GRADE CORRELATION: TABLE 112.D defines binder correlation(s). A binder grade to the right of a respective binder grade in the same row may be substituted.

112.4.4.2 A job mix formula using either penetration or viscosity grade binders shall be designed using the Marshall procedure and specifications.

112.4.4.3 A job mix formula using a performance grade, PG, binder shall be designed using the gyratory (SUPERPAVE) procedure and specification.

112.4.4.4 Binder substitution in an authorized job mix formula shall not be allowed.

112.5 TEMPERATURES

112.5.1 The CONTRACTOR shall specify the temperature ranges for mixing and compaction of a job mix formula for a binder, minimum and maximum, ^{o}F. Temperature ranges for mixing and compaction shall be specified in a job mix formula submittal.

112.5.2 The CONTRACTOR shall specify the "release to traffic" temperature, ^{o}F. Release to traffic temperature shall be the maximum temperature at which the viscosity of a binder is greater than 200,000 cps as determined by ASTM D4402. Release to traffic temperature shall be specified in a job mix formula

submittal.

112.6 MEASUREMENT AND PAYMENT

112.6.1 Asphalt binder is an ingredient of asphalt concrete (AC), bituminous treated base course construction (BTB), and plant mixed seal coat (PMSC). Binder shall be paid either as incidental to the above materials, or as specified in the CONTRACT, as directed by the ENGINEER.

SECTION 112

PAVING ASPHALT BINDER

TABLE 112.A - 60-70 PENETRATION GRADE BINDER SPECIFICATION (ASTM D 946) [1]

	CHARACTERISTIC	min	max	ASTM Procedure
I.	Original Binder			
1	Penetration @ 25 ^{O}C, 100 g, 5 s, mm	60	70	D 5
2	Flash Point (Cleveland open cup), ^{O}C	230		D 92
3	Ductility @ 25 ^{O}C, 5 cm/min, cm	100		D 113
4	Solubility in trichloroethylene , %	99.0		D 2042
II.	Asphalt after Thin Film Oven Test, TFOT			
1	Retained penetration @ 25 ^{O}C, 100 g, 5 s, mm	52		D 5
2	Ductility @ 25 ^{O}C, 5 cm/min, cm	50		D 113

[1] PG64-22 binders shall be used if 60-70 Penetration Grade and AC-20 Viscosity Grade binders are unavailable.

112.B AC-20 VISCOSITY GRADE BINDER (ASTM D 3381, TABLE 2) [1]

CHARACTERISTIC		min	max	Procedure
I.	Original Binder			
1	Viscosity @ 60 ^{o}C, poises	1600	2400	ASTM D2171
2	Viscosity @ 135 ^{o}C, cSt	300	-	ASTM D2170
3	Penetration @ 25 ^{o}C, 100 g, 5 s	60	-	ASTM D5
4	Flash Point, , ^{o}C (Cleveland open cup)	230	-	ASTM D92
5	Solubility in trichloroethylene, %	99.0	-	ASTM D2042
II.	Tests on Residue From Thin-Film Oven Test			ASTM D1754
1	Viscosity after TFOT @ 60 ^{o}C, poises	-	10,000	ASTM D2171
2	Ductility after TFOT @ 25 ^{o}C, 5 cm/min, cm	50	-	ASTM D113

[1] PG64-22 binders shall be used if 60-70 Penetration Grade and AC-20 Viscosity Grade binders are unavailable.

TABLE 112.C PERFORMANCE GRADE (PG) BINDER SPECIFICATIONS

	Performance Grade Binder	PG70-22	PG76-28	Standard
	Characteristic			Procedure
A.	Original Binder			
1	Dynamic Shear, 1.0 kPa min, G*/sin d @10 $^{rad}/_{sec}$	70	76	AASHTO TP 5
2	Flash Point, min	230	230	ASTM D48
3	Viscosity, 3 Pa. s (3000 cP) max, @temp	135	135	ASTM D4402 [1]
B.	Rolling Thin Film Oven Test Residue, RTFOT (T 240), 1 minute			
1	Mass loss, 1% max	yes	yes	
2	Dynamic Shear, 2.20 kPa, min,G*/sin d @ 10 $^{rad}/_{sec}$	70	76	AASHTO TP 5
C.	Pressure Aging Vessel Residue, PAV (PP1), after RTFOT			
1	PAV Temperature	110	110	
2	Dynamic Shear: G*/sin d , max, 5,000 kPa, @10 $^{rad}/_{sec}$	28	28	AASHTO TP 5
3	Physical Hardening (report) [2]			
a.	Creep Stiffness: S, 300 Mpa , max, m-value, 0.300 minimum, @ 60 s	-12	-18	AASHTO TP 1 [3]
b.	Direct Tension: Failure strain, 1.0 % min @ 1.0 mm/min	-12	-18	AASHTO TP 3 [4]

Notes:

[1] This requirement may be waived if the binder supplier warrants that the supplied binder can be adequately pumped and mixed at temperatures that meet all safety standards.

[2] Physical Hardening - TP1 is performed on a set of asphalt beams according to Section 13.1 of TP 1, except the conditioning is extended to 24 hrs $\pm$10 minutes at 10 ^{O}C above the minimum performance temperature. The 24 hour stiffness, S, and the m-value are reported for information purposes only.

[3] The physical hardening index "h" accounts for the physical hardening of the binder. It shall be determined and reported in the submittal for the proposed binder and each sample tested for compliance with TABLE 112.PG76-28.A. "h" is calculated as follows:

$h = (S_{24} / S_{1})^{m1 / m24}$.

"1" and "24" indicate 1 and 24 hours of conditioning of the tank asphalt. Conditioning and testing is conducted at the designated test temperature. Values should be calculated and reported. "S" is the creep stiffness after 60 sec loading time and "m" is the slope of the log creep stiffness versus the log time curve after 60 sec loading time.

[4] If the creep stiffness "S< 300 MPa, the direct tension test is not required. If 300 < S < 600 MPa, the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

TABLE 112.D - ASPHALT BINDER CORRELATION(S)

Pen. Grade [1]	Visc. Grade[1]	Performance Grade [2]	
60-70	-	PG70-22	-
-	AC-20	PG70-22	-
-	-	PG70-22	PG76-28
-	-	-	PG76-28

[1] Marshall analysis/design

[2] Gyratory analysis/design

SECTION 113

EMULSIFIED ASPHALTS

113.1 GENERAL: Emulsified asphalts shall be a homogeneous mixture of paving asphalt base, water, and an emulsifying or stabilizing agent complying with the requirements of this specification. Emulsified asphalt shall be classified as quick-setting, rapid-setting, medium-setting, or slow-setting type in either anionic or cationic emulsions.

113.2 REFERENCES:

113.2.1 American Society for Testing and Materials, ASTM:

D5	Standard Test Method for Penetration of Bituminous Materials
D70	Standard Test Method for Specific Gravity and Density of Semi-Solid Bituminous Materials
D88	Standard Test Method for Saybolt Viscosity
D113	Standard Test Method for Ductility of Bituminous Materials
D244	Standard Test Methods for Emulsified Asphalts
D977	Standard Specification for Emulsified Asphalt
D2042	Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene
D2397	Standard Specification for Cationic Emulsified Asphalt
D3628	Standard Practice for Selection and Use of Emulsified Asphalt
E70	Standard Test Method for pH of Aqueous Solutions with the Glass Electrode

113.2.2 American Association of State Highway and Transportation Officials, AASHTO:

0	Solubility of Asphalt Materials in Trichlorethylene
T49	Standard Test Method for Penetration of Bituminous Materials
T51	Standard Test Method for Ductility of Bituminous Materials
T59	Standard Test Methods for Emulsified Asphalts
T200	Standard Test Method for pH of Aqueous Solutions with the Glass Electrode

113.2.3 This Specification:

SECTION 112 PAVING ASPHALT BINDER
SECTION 116 ASPHALT CONCRETE
SECTION 302 AGGREGATE BASE COURSE CONSTRUCTION
SECTION 305 CEMENT TREATED BASE COURSE CONSTRUCTION
SECTION 336 ASPHALT CONCRETE CONSTRUCTION
SECTION 337 PORTLAND CEMENT CONCRETE CONSTRUCTION

113.3 TESTING REQUIREMENTS: The emulsified asphalt shall conform to the requirements set forth in the Tables 113.3.1, 113.3.2,113.3.3, or TABLE 113.5.3.

113.4 TEST REPORT AND CERTIFICATION: Quality assurance sampling and testing of emulsified asphalt shall be performed by the CONTRACTOR to verify compliance with the specification. A sample will be taken at random during paving operations from a load(s) of material shipped to the project, either at least once a week, or as directed by the ENGINEER. Non-complying sample test results shall be reported to the ENGINEER within 24 hours of completion of the test(s). Complying sample test results shall be reported in writing to the ENGINEER no later than ten working days after the date of sampling. Emulsified asphalt sampling and testing shall be incidental to the cost of the material and placement costs.

113.5 TEMPERATURES:

113.5.1 Emulsified asphalt shall be heated in such a manner that steam or hot oils will not be introduced directly into the emulsified asphalt during heating. The CONTRACTOR shall furnish and keep on the site at all times an accurate thermometer suitable for determining the temperature of the emulsified asphalt.

113.5.2 Unless otherwise specified, the various grades of emulsified asphalt shall be applied at temperatures within the limits specified in Table 113.5.2, the exact temperature to be determined by The ENGINEER. Emulsified asphalt shall be reheated, if necessary, but at no time after loading into a tank car or truck for transportation from the refinery to the purchaser shall the temperature of the emulsion be raised above 185 ^{O}F. During all reheating operations the emulsified asphalt shall be agitated to prevent localized overheating. Emulsified asphalt shall not be permitted to cool to a temperature of less than 40 ^{O}F.

113.6 MEASUREMENT AND PAYMENT: The unit of volumetric measurement shall be the U.S. gallon at a temperature of 60^{O}F. If this material is to be part of a surface treatment the measurement may be in square yards of area covered. All approved quantities shall be paid at the unit price per defined unit of measurement as specified in the Bid Proposal.

SECTION 113

EMULSIFIED ASPHALTS

TABLE 113.3.1 SPECIFICATIONS FOR ANIONIC EMULSIFIED ASPHALT

Type			Rapid Setting				Slow Setting			
Grade			RS-1		RS-2		SS-1		SS-1h	
Test on Emulsions:	AASHTO	ASTM	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity SSF@77ºF (25ºC) , sec		D88	20	100	-	-	20	100	20	100
Viscosity SSF@122ºF (50ºC) , sec		D88	-	-	75	400	-	-	-	-
Settlement, 5 days, %			-	-	-	5	-	5	-	5
Storage Stability 1 day[2]			-	1	-	1	-	1	-	1
Demulsibility in 35 ml of .02N Calcium Chloride[3]			60	-	60	-	-	-	-	-
Cement Mixing Test, %			-	-	-	-	-	2.0	-	2.0
Sieve Test, %			-	0.10	-	0.10	-	0.10	-	0.10
Residue by distillation, %			55	-	63	-	57	-	57	-
Tests on Residue from Distillation										
Test:		D244		(4)		(4)				
Penetration @77ºF(25ºC)	T49	D5	100	200	100	200	100	200	40	90
Ductility, 77ºF(25ºC)5 cm/min, cm	T51	D113	40	-	40	-	40	-	40	-
Solubility in Trichloroethylene, %	T44	D2042	97.5	-	97.5	-	97.5	-	97.5	-

Notes:

1 The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days time; or the purchaser may require the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.

2 The 24 hour (1 day) storage stability test may be used instead of the 5 day settlement test.

3 The demulsibility test shall be made within 30 days from data of shipment.

4 A harder base asphalt meeting current paving asphalt specifications may be specified with the provision that the test requirements on the Residue from Distillation be waived.

TABLE 113.3.2 SPECIFICATIONS FOR CATIONIC EMULSIFIED ASPHALT

Type	Test Method		Rapid Setting				Medium Setting						Slow Setting			
Grade	AASHTO	ASTM	CRS-1		CRS-2		CMS-2S		CMS-2		CMS-2h		CCS-1		CSS- lh	
Tests on Emulsions:			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity SSF @ 77°F. (25°C.) sec.		D88	20	100	100	400	50	450	50	450	50	450	20	100	100	100
Viscosity SSF @ 122°F. (50°C.) sec.		D88	-	5	-	5	-	5	-	5	-	5	-	5	-	5
Settlement 5 days, %			-	1	-	1	-	1	-	1	-	1	-	1	-	1
Storage Stability Test 1 day [2] Demulsibility 35 ml 0.8% sodium dioctyl sulfosuccinate, %[3]			40	-	40	-	-	-	-	-	-	-	-	-	-	-
Coating ability s water resistance:																
Coating, dry aggregate			-	-	-	-	Good	-	Good	-	Good	-	-	-	-	-
Coating, after spraying			-	-	-	-	Fair	-	Fair	-	Fair	-	-	-	-	-
Coating, wet aggregate			-	-	-	-	Fair	-	Fair	-	Fair	-	-	-	-	-
Coating, after spraying			-	-	-	-	Fair	-	Fair	-	Fair	-	-	-	-	-
Particle charge test			Positive		Positive		Positive		Positive		Positive		Positive		Positive	
Sieve test, %			-	0.10	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10	-	0.10
Cement mixing test, %			-	-	-	-	-	-	-	-	-	-	-	2.0	-	2.0
Distillation:																
oil distillate by volume of emulsion %		0	-	3	-	3	-	20	-	12	-	12	-	-	-	-
Residue, %			60	-	65	-	60	-	65	-	65	-	57	-	57	-
Tests on residue from distillation test			-	(4)	-	(4)	-	-	-	-	-	-	-	-	-	-
Penetration, 77°F. (25°C.)	T49	D5	100	250	100	250	100	250	100	250	40	90	100	250	40	90
Ductility, 77°F. (25°C.), 5 cm/min., cm.	T51	D113	40	-	40	-	40	-	40	-	40	-	40	-	40	-
Solubility in Trichloroethylene, %	0	D2042	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-	97.5	-

Notes:

1. The test requirement for settlement may be waived when the emulsified asphalt is used in less than 5 days time; or the purchaser may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than 5 days.
2. The 24 hour (1 day) storage stability test may be used instead of the 5 day settlement test.
3. The Demulsibility test shall be made within 30 days from date of shipment.
4. Must meet a pH requirement of 6.7 maximum (ASTM E-70) if the Particle Charge Test result is inconclusive.

TABLE 113.3.3 EMULSIFIED ASPHALT SLURRY SEAL MIXING GRADES

BITUMULS CLASS			ANIONIC				CATIONIC			
Bitumuls Type			Dense Aggregate Mixing		Quick-Set Slurry Seal		Dense Aggregate Mixing		Quick-Set Slurry Seal	
Bitumuls Grade Designation			DM-h		QS-h		DM-Kh		QS-Kh	
ASTM Grade Designation (Closest)	Test Method		(SS-lh)		(None)		(CSS-lh)		(None)	
Test on Emulsion (a)	AASHTO	ASTM	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt Furol at 77*F (25"c) sec.	T-59	D244	-	100	-	100	-	100	-	100
Storage Stability Test, 1 day, per cent		D244	-	1.0	-	1.0	-	1.0	-	1.0
Cement Mixing Test, per cent	T-59	D244	-	2.0	-	-	-	2.0	-	-
Sieve Test, per cent	T-59	D244	-	0.10	-	0.10	-	0.10	-	0.10
Particle charge Test (b)	T-59	D244	Negative		Negative		Positive		Positive	
pH (b)	T-200	E70	7.3	-	-	-	-	6.7	-	-
Dehydration, ratio			0.5	-	-	-	0.7	-	-	-
Adhesion			Pass	-	-	-	Pass	-	-	-
Slurry Seal Tests (Standard Reference Aggregate ©										
Mixing, seconds			-	-	60	-	-	-	120	-
Setting, minutes			-	-	-	60	-	-	-	60
Water Resistance, after 30 minutes cure			-	-	-	Pass	-	-	-	Pass
Residue by Distillation, per cent	T-59	D244	57	-	57	-	57	-	57	-
Tests on Residue from Distillation Test										
Penetration at 77°F (25"C), 1130 gm, 5 sec.	T-49		40	100	40	100	60	110	40	110
Ductility at 77°F (25"c), cm,	T-51	D113	40	-	40	-	40	-	40	-
Solubility in Trichloroethylene, per cent	T-44	D2042	97	-	97	-	97	-	97	-

Notes:
a) All tests shall be performed within 30 days from the date of emulsified asphalt shipment.
b) Must meet pH Test if inconclusive Particle Charge Test.
c) ASTM C778, Specification for Standard Sand

TABLE 113.5.2 - APPLICATION TEMPERATURE OF EMULSIFIED ASPHALT

Grade	Mixing	Spraying
RS-1	Not Used	70-140 ^{O}F
CRS-1, RS-2, CRS-2	Not Used	125-185 ^{O}F
SS-1, CSS-1	50-160 ^{O}F	70-140 ^{O}F
SS-1h , CSS-lh	50-160 ^{O}F	70-140 ^{O}F
CMS-2S, CMS-2, CMS-2h	50-160 ^{O}F	125-185 ^{O}F
QS-KH, QS-H	50-120 ^{O}F	70-120 ^{O}F

TABLE 113.5.3 - PRIME COAT SPECIFICATION

I.	Material Type		AE-P [1]		PE-P [2]	
II.	Test		Min	Max	Min	Max
	A.	Viscosity, Saybolt Furol, @ 122 degF, sec	15	150	-	75
	B.	Storage Stability @ 24 hr , %	-	1.0	-	-
	C.	Sieve Test No. 20, %	-	-	-	0.10
III.	Distillation Test					
	A.	Residue from Distillation Test To 500 degF, %	65	-	35	-
	B.	Oil by Distillate, % by Volume	-	25	-	4.0
	C.	Solubility in Trichloroethylene, %	97.5	-	-	-

Notes:

[1] AE-P, asphalt emulsified prime

[2] PE-P, penetrating emulsified prime

SECTION 114

ASPHALT PAVEMENT HOT RECYCLING

114.1 GENERAL

Asphalt pavement hot recycling shall consist of removing an existing asphalt pavement, sizing the removed materials, furnishing additional materials if required by the ENGINEER, mixing the materials with a recycling agent in either a dryer-drum or batch plant and placing the recycled asphalt mixture on the roadway or street.

114.2 REFERENCES

114.2.1 ASTM

D 70
D 92
D 244
D 1160
D 2170

114.2.2 AASHTO

T 48	T 202
T 201	T 240

114.2.3 This publication:

SECTION 116
SECTION 336

114.3 REMOVAL AND SIZING OF EXISTING PAVEMENT: The asphalt pavement removed for recycling shall be crushed and rescreened so that all the material removed from the roadway is prepared for recycling and a uniform mixture of all material is maintained. If in the opinion of the ENGINEER the material removed from the roadway and placed in the stockpile is not uniform in nature, the CONTRACTOR shall blend the material in such a manner that it is uniform throughout the stockpile.

114.4 MATERIAL

114.4.1 RECYCLING AGENTS: The recycling agent to be mixed with the removed pavement shall conform with Table 114.4.1.1, 114.4.1.2 and 114.4.1.3

114.4.2 VIRGIN AGGREGATE: If a virgin aggregate is specified for blending with the removed asphalt pavement, it shall meet the requirements of aggregates for an asphalt concrete as described in Section 116. The gradation band to be used shall be as designated by the ENGINEER in the supplemental specifications.

114.5 PROPORTIONING

A job-mix formula for the recycled asphaltic concrete mixture to be supplied under this contract shall be determined by an approved testing laboratory from representative samples of graded aggregate produced and stockpiled and the reclaimed asphalt pavement stockpiled by the CONTRACTOR. Recycled asphaltic concrete material will not be mixed until the ENGINEER has received and approved the job-mix formula. The job-mix formula shall indicate the definite percentage of the reclaimed pavement and the virgin aggregate, the percentage of recycling agent, and the temperature of the completed mixture as it is to be discharged from the mixer.

114.6 MIXING

The recycled asphalt mixture shall consist of the reclaimed asphalt, the virgin aggregate and a recycling agent. No mixing of these materials shall occur until a job-mix formula has been approved by the ENGINEER. The recycled mixture can be mixed in either an asphalt batch-plant or a dryer-drum. The CONTRACTOR is to follow the recommendations of the manufacturer of the plant as to mixing procedure. The reclaimed asphalt and virgin aggregate are to be proportioned in the plant through the cold feed bins or to be blended in the stockpile. The CONTRACTOR is to submit to the ENGINEER, for his approval, an outline of the procedures to be used in mixing the asphalt concrete.

114.7 PLACEMENT

The placement of the mixture will follow the requirements for the placement of asphalt concrete as described in Section 336.

114.8 MEASUREMENT AND PAYMENT

Removal of the existing asphalt pavement will be paid for at the contract unit price per square yard. Payment will include removing and delivering the bituminous pavement materials to the plant, and crushing and stockpiling as required. The recycled bituminous pavement mixture will be paid for at the unit price per ton or square yard, with a separate item for the recycling agent which will be paid for at the unit price per ton.

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TABLE 114.4.1.1

PROPOSED SPECIFICATIONS FOR HIGH FLASH RECYCLING AGENTS

	AASHTO	GRADE					
	TEST	H-1		H-2.5		H-5	
Tests	Method	Min.	Max.	Min.	Max.	Min.	Max.
Original Material: Viscosity, 60 °C (140 °F), Poise	T-202	50	200	200	300	400	600
Viscosity, 135 °C (275 °F), cs	T-201	50	--	80	--	110	--
Flash Point, COC, F	T-48	450	--	450	--	450	--
RTFC Residue:	T-240*						
Weight Loss, %	T-240	--	1.0	--	1.0	--	1.0
Viscosity Ratio**	--	--	3.0	--	3.0	--	3.0

*TFO may be used, but RTFC shall be the preferred method.

**Viscosity Ratio = RTFC Viscosity at 60 °C (140 °F) / Original Viscosity at 60 °C (140 °F)

TABLE 114.4.1.2

SINTERIM SPECIFICATIONS FOR CYCLOGEN

PROPERTY	FUNCTION & PURPOSE	TEST METHOD	L*	M*	H*
Viscosity @140 ^{o}F, CS	Asphalt viscosity adjustment in recycled mix	ASTM D 2170	80-500	1000-4000	5000-10000
Flash Point COC, ^{o}F	Handling precaution	ASTM D 92	350 min.	350 min.	350 min.
Volatility,	Avoidance of air pollution	ASTM D 1160			
1 BP, ^{o}F	and hardening by	10 mm	300 min.	300 min.	300 min
2%, ^{o}F	evaporation		375 min.	375 min.	375 min.
5%, ^{o}F			410 min.	410 min.	410 min.
Compatibility, N/P	Avoidance of syneresis		0.5 min.	0.5 min.	0.5 min.
Chemical Composition $(N+A_1)(P+A_2)$	Durability of asphalt in	ASTM D 2006	0.2-1.2	0.2-1.2	0.2-1.2
Specific Gravity	Calculations	ASTM D 70	Report	Report	Report

Suitable pumping temperatures are the following: L = 115 ^{o}F, M=190 ^{o}F, H=200 ^{o}F

TABLE 114.4.1.3
INTERIM SPECIFICATIONS FOR EMULSIFIED CYCLOGEN
Designated as LE, ME, and HE[1]

PROPERTY	FUNCTION & PURPOSE	TEST METHOD	SPECIFICATIONS
Viscosity @ 77 °F, SFS	Ease of handling	ASTM D 244	15-85
Pumping Stability	Prevention of premature breaking	G.B. Method[2]	Pass
Emulsion Coarseness, %	Optimal distribution	Sieve Test, ASTM D 244 (MOD)[3]	0.1 max.
Sensitivity to Fines, %	Adequate mixing life	Cement Mixing, ASTM D 244	2.0 max.
Particle Charge	Preferential affinity to asphalt	ASTM D 244	Positive
Concentration of Oil Phase, %	Assurance of oil content and for calculations	ASTM D 244 (MOD)[4]	60 min.

[1] Oils used for emulsions must meet specifications listed in Table 1.

[2] Pumping stability is determined by charging 450 ml of emulsion into a one-liter beaker and circulating the emulsion through a gear pump (Roper 29 B22621) having ¼" inlet and outlet. The emulsion passes if there is no significant oil separation after circulation ten minutes.

[3] Test procedure identical with ASTM D 244 except that distilled water shall be used in place of two percent sodium oleate solution.

4 ASTM D 244 Evaporation Test for percent of residue is modified be heating 50 gram sample to 300 °F until foaming ceases, then cooling immediately and calculating results.

SECTION 115

SLURRY SEAL MATERIALS

115.1 GENERAL

Slurry seal coats shall consist of a bituminous material and filler of mineral aggregates in the proportions specified under Section 330.

115.2 REFERENCES

115.2.1 ASTM

C 88
C 131
C 386
D 242
D 2419

115.2.2 This publication:

SECTION 112
SECTION 113
SECTION 330

115.3 MINERAL AGGREGATES

115.3.1 The mineral aggregate shall consist of natural or manufactured sand, slag, crusher fines, or a combination thereof. Smooth textured sand of less than 1.25 percent water absorption shall not exceed 50 percent of the total combined aggregate. The aggregate shall be clean and free from vegetable matter and other deleterious substances. When tested by ASTM D 2419, the aggregate blend shall have a sand equivalent of not less than 45. When tested according to ASTM C 88, the aggregate shall show a loss of not more than 15 percent. When tested according to ASTM C 131, the aggregate shall show a loss of not more than 35 percent.

115.3.2 Mineral fillers such as Portland cement, limestone dust, or fly ash, shall be considered as part of the blended aggregate and shall be used in minimum required amounts. The mineral fillers shall meet the requirements of ASTM D 242. Mineral fillers shall only be used if needed to improve the quality of the mix or gradation of the aggregate.

115.3.3 The combined mineral aggregate shall conform to one of the following gradations on Table 115.3.3 when tested in accordance with ASTM C 386. The type gradation will be as shown on the plans or as specified by the ENGINEER.

115.4 BITUMINOUS MATERIALS

115.4.1 The bituminous material shall be an emulsified asphalt as specified by the ENGINEER or as shown on the plans. The material shall conform to the requirements of Section 113.

115.4.2 Test certificates and reports for bituminous material shall be furnished in accordance with Section 112.

115.4.3 A test report for adhesion of emulsified asphalt as specified in Section 112 is required.

115.5 MEASUREMENT AND PAYMENT

No measurement or payment will be made for separate ingredients of the slurry seal. Payment for asphalt emulsion slurry seal shall be made on the unit price per square yard as per the Bid Proposal.

TABLE 115.3.3
AGGREGATE GRADING FOR SLURRY SEAL

Sieve Size	Type I Percent Passing	Type II Percent Passing	Type III Percent Passing
3/8	100	100	100
No. 4	100	90-100	70-90
No. 8	90-100	65-90	45-70
No. 16	65-90	45-70	28-50
No. 30	40-60	30-50	19-34
No. 50	25-42	18-30	12-25
No. 100	15-30	10-21	7-18
No. 200	10-20	5-15	5-15
Residential Asphalt Content & Dry Aggregate	10-16	7.5-13.5	6.5-12

SECTION 116

ASPHALT CONCRETE

116.1 GENERAL: Asphalt concrete shall consist of a mixture of asphalt binder, aggregates, mineral filler and admixtures, proportioned as required, batched and delivered as specified herein. All materials and job mix formulas used in asphalt concrete, either batched at or delivered to a project, shall be certified in accordance with the requirements of Section 13 of these specifications. The CONTRACTOR shall be solely responsible for asphalt concrete job mix formula supplied under this specification, its proportions and manufacture. Each job mix formula submitted and authorized for use under this Specification shall be identified by a number, unique to that job mix formula. If either a change in material(s) or material supplier(s) from that specified in the job mix formula occurs during a project, authorized use of the job mix formula on the project may be cancelled as directed by the ENGINEER. A job mix formula shall not be used on a project without written approval of The ENGINEER. A job mix formula, upon request by an asphalt concrete supplier, may be approved by the Municipal Development Department for use on City and City related projects for a period of 14 months from the date of sampling of reference aggregates used in the job mix formula.

116.2 REFERENCES:

116.2.1 American Society For Testing and Materials (ASTM):

C88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C117 Method for Material Finer Than 0.75 um (No.200) Sieve In Mineral Aggregates by Washing
C131 Test Method for Resistance to Degradation of Small-size Coarse Aggregate by Abrasion and Impact in a Los Angeles Machine
C136 Method for Sieve Analysis of Fine and Coarse Aggregate
D242 Specifications for Mineral Filler for Bituminous Paving Mixtures
D692 Specification for Coarse Aggregate for Bituminous Paving Mixtures
D979 Methods of Sampling Bituminous Paving Mixtures
D995 Specification for Mixing Plants for Hot-Mixed, Hot Laid Bituminous Paving Mixtures
D1073 Specification for Fine Aggregate for Bituminous Paving Mixtures
D1074 Test Method for Compressive Strength of Bituminous Mixtures
D1559 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
D2041 Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures
D2493 Viscosity-Temperature Chart for Asphalts
D2726 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
D2851 Test for Determining the Percentage of Fractured Particles in Coarse Aggregate
D2950 Density of Bituminous Concrete in Place by Nuclear Methods
D3203 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
D3515 Standard Specification for Hot Mixed, Hot-Laid Bituminous Paving Mixtures
D4791 Test for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

116.2.2 American Association of State Highway and Transportation Officials (AASHTO) (Latest Edition):

MP2 Specification for Superpave™ Volumetric Mix Design
PP-28 Superpave™ Volumetric Design for HMA
TP 4 Preparation of Compacted Specimens of Modified and Unmodified Hot Mix Asphalt by Means of SHRP Gyratory Compactor
PP 2 Short and Long-term Aging of Bituminous Mixes
T53 Quantitative Analysis of Bitumen From Bituminous Paving Mixtures, Ignition Oven Method A
T245 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
T283 Resistance of Bituminous Mixture To Moisture Induced Damage
T304 Uncompacted Void Content of Fine Aggregate

116.2.3 Asphalt Institute

MS-2 Mix Design Methods, Sixth Edition
MS-2 Mix Design Methods, Sixth Edition, Section 5.16, Modified Marshall Method For Large Aggregate

116.2.4 This publication:

SECTION 13 WARRANTY AND GUARANTEE; TESTS AND INSPECTIONS; CORRECTIONS, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK
SECTION 101 PORTLAND CEMENT CONCRETE
SECTION 112 ASPHALT BINDER
SECTION 118 HYDRATED LIME
SECTION 336 ASPHALT CONCRETE PAVEMENT

116.3 MATERIALS

116.3.1 Asphalt binder shall comply with the requirements of SECTION 112-ASPHALT BINDER

116.3.2 Aggregates shall be crushed stone, crushed gravel, crushed asphalt concrete pavement, crushed portland cement concrete, and natural or manufactured sand conforming to the quality and crushed particle requirements of this Specification. Coarse aggregates shall comply with the requirements of ASTM D692, Coarse Aggregate for Bituminous Paving Mixtures. Fine aggregates shall comply with the requirements of ASTM D1073, Fine Aggregate for Bituminous Paving Mixtures. The combined aggregates, proportioned as defined by the target gradation, shall comply with the requirements of Table 116.A. Aggregates shall be certified to comply with the requirements of this Specification and authorized for use by The ENGINEER before the materials may be incorporated in the construction. Prior to delivery of the aggregates or material containing the aggregates, The CONTRACTOR may be required to furnish samples of the aggregates to The ENGINEER for testing. Daily production aggregates gradations shall be submitted to the ENGINEER, upon request.

116.3.3 Mineral filler shall comply with the requirements of ASTM D242, Mineral Filler for Bituminous Paving Mixtures and as specified herein. Mineral filler shall be certified to comply with the requirements of this Specification and approved for use by ENGINEER before the materials may be incorporated in the construction. Prior to either delivery of the mineral filler or material containing the mineral filler, The CONTRACTOR may be required to furnish samples of the mineral filler to The ENGINEER for testing.

116.3.4 Asphalt concrete shall comply with the minimum requirements of TABLE 116.C.1.H. Moisture susceptibility, % retained strength at 7% air voids, AASHTO T283, with freeze cycle. Admixtures to reduce moisture susceptibility in an asphalt concrete mix shall be either hydrated lime, portland cement, liquid admixture, or a modified asphalt binder authorized by the ENGINEER.

116.4 PROPORTIONING:

116.4.1.1 The CONTRACTOR shall be solely responsible for the asphalt concrete job mix formula (jmf) proportions and asphalt concrete either batched at and/or delivered to the site. Asphalt concrete shall be proportioned in accordance with the requirements of this Specification.

116.4.1.2 Asphalt concrete material proportioned with "performance grade binders" shall be proportioned to comply with the requirements of TABLE 116.C.1 of this specification, AASHTO MP2, Specification for Superpave™ Volumetric Mix Design, and PP-28, Superpave™ Volumetric Design for HMA. The job mix formulas shall be designed under the direct supervision of a New Mexico Registered Professional Engineer who has completed a certified "SUPERPAVE Mixture Design & Analysis" Short Course.

116.4.2.1 Asphalt concrete for construction of street classifications of Collector, Minor and Major Arterial, and Controlled Access Roadways may be proportioned with performance grade (PG) binders.

116.4.2.2 Asphalt concrete for construction of classifications of Collector, Minor and Major Arterial, and Controlled Access Roadways may be proportioned with performance grade (PG) binders.

116.4.2.3 Asphalt concrete for construction of street classifications of Residential, Local, Major Local, and streets with design equivalent single axle loads (Esals) less than 3.0 mil, may be proportioned with a PG70-22 performance grade binder.

116.4.3 Asphalt concrete proportioned with either penetration or viscosity grade binders shall be proportioned to comply with the requirements TABLE 116.C.2. A JMF shall be prepared in a laboratory under the direct supervision of a New Mexico Registered Professional Engineer.

116.4.4 Asphalt concrete design and analysis shall be performed in a laboratory accredited in accordance

with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition.

116.4.5.1 An asphalt concrete job mix formula shall be proportioned to comply with the requirements of TABLE 116.B AGGREGATE GRADATION PROPERTIES and either TABLE 116.C.1 ASPHALT CONCRETE DESIGN SPECIFICATIONS PERFORMANCE GRADE BINDERS, or TABLE 116.C.2 ASPHALT CONCRETE DESIGN SPECIFICATIONS PENETRATION AND VISCOSITY GRADED BINDERS.

116.4.5.2.1 Aggregates, mineral filler, and anti-strip admixture if required, shall be proportioned to provide a combined gradation that complies with the requirements specified in Table 116.B, and have the same or similar shape characteristic gradation curve as the specification limits specified therein when graphically plotted on a standard "0.45 POWER" gradation chart. The gradation shall be reported to the nearest whole per cent for material passing sieves above the 0.075 mm (no. 200) sieve, and to the nearest 0.1 per cent for material passing the 0.075 mm (no. 200) sieve. The theoretical maximum density gradation curve shall be the curve represented by a straight line drawn from the intersection of the ordinate and abscissa of the graph to the one hundred percent passing point for the nominal maximum size aggregate.

116.4.5.2.2 The design characteristic shape gradation curve for SP-II asphalt concrete shall be similar to a "S" shape curve, with a convex curve above the maximum density line for aggregate greater than 4.75 mm (No.4) sieve and a concave curve below the maximum density line for aggregate finer than the 4.75 mm (No.4) sieve.

116.4.5.2.3 The design characteristic shape gradation curve for Type SP-III and SP-IV asphalt concretes shall be similar to a "S" shape curve, with a convex curve above the maximum density line for aggregate greater than 2.36 mm (No.8) sieve and a concave curve below the maximum density line for aggregate finer than the 2.36 mm (No.8) sieve.

116.4.5.2.4 The design characteristic shape gradation curves for Types B, C, and D, asphalt concretes shall be similar to two convex curves above the maximum density line, one for aggregate greater than the 2.36 mm (No.8) sieve, and one for aggregate finer than the 2.36 mm (No.8) sieve. The two curves shall intersect each other at the 2.36 mm (No.8) sieve.

116.4.5.2.5 The design characteristic gradation curve shape for Type A asphalt concretes shall be similar to two convex curves above the maximum density line, one for aggregate greater than the 4.75 mm (No.4) sieve, and one for aggregate finer than the 4.75 mm (No.4) sieve. The two curves shall intersect each other at the 4.75 mm (No.4) sieve.

116.4.6 The job mix formula asphalt binder content shall be proportioned to provide a job mix formula that complies with the requirements defined either in TABLE 116.C.1 when proportioned with PG binders, or in TABLE 116.C.2, when proportioned with either penetration or viscosity graded binders. The design asphalt binder content shall be selected, based on laboratory testing, aged binder/mix required. The binder content shall include a minimum of 75% virgin binder when a job mix formula is designed with recycled asphalt concrete pavement, RAP. The design % binder content, ± 0.3%, shall not exceed the binder content at minimum VMA.

116.5.1 A design mix job mix formula submittal shall be include but not be limited to the information specified in TABLE 116.D-SUBMITTAL INFORMATION, as directed by the ENGINEER.

116.5.2 The materials specified in an authorized job mix formula shall be the same source and type for all asphalt concrete batched, delivered, placed and compacted, under the identification code defined for the authorized job mix formula.

116.5.3 A submittal shall be rejected if it does not include the specified information and samples. A job mix formula submittal shall be accepted or rejected within ten (10) working days of receipt by the ENGINEER.

116.6 PRODUCTION:

116.6.1 Asphalt concrete shall be produced in accordance with the requirements of ASTM D3515, the requirements of this Specification, or as authorized by The ENGINEER. Production facilities shall comply with the requirements of ASTM D995, and this Specification. A plant shall be certified annually, by a

New Mexico Registered Professional Engineer, to comply with the requirements of this Specification and Section 13. The production plant shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Certification shall be completed within 12 months prior to production of an authorized job mix formula at the plant. Certificates of calibration and production certifications shall be maintained at the plant for review by The ENGINEER. A copy of the certifications shall be submitted to The ENGINEER upon request.

116.6.2 Asphalt concrete shall be placed at the design proportions specified in the authorized job mix formula within the specified production tolerances for combined aggregate gradation and asphalt binder content. Asphalt concrete placed at a project, sampled and tested in accordance with this specification, shall have a gradation that complies with the authorized design gradation ± the production tolerance(s) specified in the authorized job mix formula. Asphalt concrete placed at a project, sampled and tested in accordance with this specification, shall have an asphalt content that complies with the design asphalt content ± 0.5% (laboratory analysis), T53-Quantitative Analysis of Bitumen From Bituminous Paving Mixtures, Ignition Oven Method, Method A (Modified: reference temperature for constant mass, 149 ± 3° C / 300 ± 7 °F).

116.7 DELIVERY:

116.7.1 Asphalt concrete shall be delivered in trucks free of fluid leaks. Trucks detected to have leaks shall not be allowed on the project. Subgrade, base course, and asphalt concrete surfaces contaminated by uncontrolled equipment fluids shall be removed and replaced with complying material. Contaminated material shall be disposed of as specified. When hauling time from the mixing plant to the job site exceeds two hours or when inclement weather prevails, bituminous mixtures shall be covered with tarpaulins while being hauled. The tarpaulins shall completely cover the load and be firmly tied down. Mixtures shall be delivered to site of the work and placed without segregation of the ingredients and within the temperature range specified in the authorized job mix formula. Diesel fuel or other petroleum based solvents shall not be used in the bed of transport vehicles as a release agent to prevent build-up of the asphalt material. Material contaminated with diesel fuel or other petroleum based solvents shall be removed and replaced with complying material by the CONTRACTOR, as directed by the ENGINEER, at no cost to the OWNER.

116.7.2 The CONTRACTOR shall provide with each load of asphalt concrete batched and/or delivered to the job site, before unloading at the site, a delivery ticket on which is printed, stamped or written, the information defined in Table 116.E One copy of the ticket shall be available for each of the ENGINEER and the quality assurance testing program.

116.8 PLACEMENT:

Asphalt concrete shall be placed in uniform layers/lifts in accordance with the requirements of Section 336. The thickness of a layer/lift shall be not less than two (2) times the maximum size aggregate and/or not greater than 4 inches for SP-II aggregate gradations. The thickness of a layer/lift shall be not less than two (2) times the maximum size aggregate of the job mix formula used but not greater than 3 inches, as directed by the ENGINEER. A pavement lift thickness shall be selected to use the maximum size aggregate, as authorized by the ENGINEER. Lift thickness(s) and asphalt concrete type, designating the maximum size aggregate, shall be either specified in the CONTRACT documents, or as directed by the ENGINEER. S-II asphalt concrete shall not be used for a surface course.

116.9 COMPACTION:

116.9.1 Asphalt concrete compaction shall begin when the asphalt concrete temperature is in the compaction temperature range specified in the authorized job mix formula. Compaction shall be completed before the temperature of the material cools to less than 200 °F. Compaction may be allowed on material with a temperature less than 200°F and greater than 185 °F, as directed by the ENGINEER. The material shall be compacted to a density of at least 93% but not greater than 97% of the theoretical maximum density as determined by ASTM D2041.

116.9.2 The CONTRACTOR shall be responsible for the development and implementation of the compaction program. The program shall be defined by the CONTRACTOR, to include equipment type and description, and procedures, reported in writing to the ENGINEER for each job mix formula/lift thickness used on a project. Changes in the compaction program shall be reported to the ENGINEER as they may occur.

116.9.3 A CONTRACTOR may construct a test strip, a minimum of 10 feet wide and 250 feet long, to establish the rolling pattern for an asphalt mix and lift thickness to be placed on a project, as directed by the ENGINEER. The test strip shall be paid for in accordance with the requirements of the CONTRACT, as authorized by The ENGINEER.

116.9.4.1 Compaction equipment shall be steel wheeled, pneumatic wheeled, and hand plate tampers, free of fluid leaks, selected by the CONTRACTOR, and authorized by the ENGINEER. Compaction equipment detected to have leaks shall not be allowed on the project.

116.9.4.2 Compaction may be either static or dynamic (vibratory). All equipment shall be ballasted and operated as recommended by the manufacturer. Motorized wheeled dynamic (vibratory) compaction equipment shall have the frequency rate and amplitude setting readily available for review by the ENGINEER. Frequency rate and amplitude adjustablility shall be operable on so equipped motorized wheeled dynamic (vibratory) compaction equipment. Motorized compaction equipment with inoperable frequency rate and amplitude adjustment features shall not be used on the project.

116.9.4.3 Motorized compaction equipment shall be equipped with automatic wheel spray systems to apply release agents to prevent tracking of asphalt concrete. Diesel fuel or other petroleum based solvents shall not be used as a release agent to prevent build-up of the asphalt material. Material contaminated with diesel fuel or other petroleum based solvents shall be removed and replaced with complying material by the CONTRACTOR, as directed by the ENGINEER, at no cost to the OWNER.

116.9.4.4 Repair and replacement of damaged adjacent property and structures, resulting from the use of vibratory rolling equipment, shall be the responsibility of the CONTRACTOR, at no cost to the OWNER.

116.10 SAMPLING AND TESTING:

116.10.1.1 Quality assurance asphalt concrete sampling and testing shall be performed in accordance with the requirements of this specification, the Supplemental Technical Specifications, or as directed by The ENGINEER.

116.10.1.2 Quality assurance asphalt concrete analysis shall be (1) performed in a laboratory accredited in accordance with the requirements of the New Mexico State Highway and Transportation Department "Procedure for Approval of Testing Laboratories to Perform Inspection, Testing, and Mix Design Services", April 13, 1998 Edition, and (2) under the direct supervision of a New Mexico Registered Professional Engineer.

116.10.1.3 Testing equipment shall be calibrated annually with calibration standards traceable to the National Bureau of Standards. Calibration records and certifications shall be maintained at the Laboratory for review by The ENGINEER. A copy of the certifications shall be submitted to The ENGINEER upon request.

116.10.1.4 Quality assurance sampling and testing shall be performed by a technician certified under the New Mexico State Highway and Transportation Department/Associated Contractors of New Mexico Technical Training and Certification Program for ASPHALT and SUPERPAVE™.

116.10.1.5 Quality assurance sampling and testing shall be conducted under the direct supervision of a New Mexico Registered Professional Engineer.

116.10.2 FIELD SAMPLING:

A quality assurance asphalt concrete material field sample shall be taken in accordance with the requirements of ASTM D979 for each job mix delivered. The materials shall be sampled at the greater rate of either one sample for each 250 tons, or one sample per day, for each type of material placed on a project, as directed by the ENGINEER. The sample shall be of such size to provide material for all tests specified and a split sample to perform verification/referee tests for gradation and binder content, if required.

116.10.3 MATERIAL TESTING:

116.10.3.1 Asphalt concrete quality assurance sampling and testing shall be performed in accordance with the requirements of this Specification, the Supplemental Technical Specifications, or as directed by The ENGINEER.

116.10.3.2 The asphalt concrete quality assurance sample shall be tested and the properties reported, with authorized job mix formula production limits, as specified in TABLE 116.F - FIELD SAMPLE LABORATORY TESTS.

116.10.3.3 A CONTRACTOR may challenge production material test results, binder content and aggregate gradation, and request that the retained split asphalt concrete sample of record be released to his assigned laboratory and tested for compliance, as authorized by the ENGINEER. Notification of challenge shall be made in writing to the ENGINEER by the CONTRACTOR within 28 calendar days from date of sampling. Challenge test results shall be submitted to the ENGINEER for evaluation no later than 42 calendar days from date of sampling. Challenge test results will be evaluated in accordance with "multi laboratory" precision tolerances specified, T53 for binder content, ASTM C117 and C136 for aggregate gradation. Challenge and record test results that comply with precision tolerances will be averaged with the companion test results of record and the material pay factor, PF_M, recalculated, as directed by the ENGINEER. Challenge and record test results that do not comply with the precision tolerances will direct the disqualification of the challenged sample, as directed by the ENGINEER. Cut/core sample(s) will be taken from the area(s) represented by the disqualified challenge sample(s) and evaluated by the lab of record under the observation of the CONTRACTOR, in accordance with the requirements of this specification and replace the disqualified sample test results. Analysis of the replacement cut/core sample(s) may not be challenged. The CONTRACTOR will submit challenge test results in writing to the ENGINEER for each split sample released to his assigned laboratory of record. Challenges filed after the time limitations will not be considered. The OWNER shall pay for all complying tests.

16.10.4 FIELD TESTING:

116.10.4.1 Asphalt concrete quality assurance sampling and testing shall be performed in accordance with the requirements of this Specification, the Supplemental Technical Specifications, or as directed by The ENGINEER.

116.10.4.2 Quality assurance in place field compaction tests shall be conducted in accordance with the requirements of this specification, as directed by the ENGINEER. A test shall determine the density of a constructed asphalt concrete roadway lift. Compaction shall be calculated as the measured in-place density, divided by the average maximum theoretical density (G_{mm}) of the samples taken for that day's placement, reported to one tenth of a percent, xxx.x.%. Maximum theoretical density (G_{mm}) shall be determined in accordance with ASTM D2041.

116.10.4.2.1 Field density for SP-II and Type A materials shall be measured from field core samples. A minimum of one core sample shall be taken for each lift of 250 tons of a material type, or fraction thereof, placed each day, but not less than 3 cores per day, as directed by the ENGINEER. The bulk density (G_{mb}) of each core shall be measured in accordance with the requirements of D2726 and reported to the nearest one-tenth pound per cubic foot , (one kilogram per cubic meter). The compaction for the shall be calculated as the average measured density of the cores for a lift of a type of material placed in a day, divided by the average of the maximum theoretical density (G_{MM}) of the samples of the same or similar materials taken for that day's placement, reported to the nearest one tenth of a percent, xxx.x.%. The maximum theoretical density (G_{MM}) shall be determined in accordance with ASTM D2041, and reported to the nearest one-tenth pound per cubic foot , (one kilogram per cubic meter). The core barrel shall be 6 inches (150mm) o.d. or greater, taken full depth. A lift sample shall be trimmed from the core at the lamination lines between lifts. The CONTRACTOR shall be responsible for material replacement at no cost to the OWNER where samples are removed.

116.10.4.2.2.1 The field density for Types B, C, D, SP-III, SP-IV, and SP-V materials shall be measured in accordance with the requirements of ASTM D2950, at the minimum rate of three tests per lift, per 500 sy of each type of asphalt material placed in a day, as directed by The ENGINEER.

116.10.4.2.2.2 A reference density test of the support material, for the asphalt concrete roadway lift to be construction, shall be taken prior to the placement of the fresh asphalt concrete lift, or defined from previous test results. The density of the support material shall be used as reference in performing the density test of a fresh asphalt concrete lift in accordance with the requirements ASTM D2950, placed over the support material. a density test of the support material shall be taken at the rate of one (1) test for each 500 sy of

surface or less to be paved over in a day, as directed by the Engineer. The density of the support material shall be reported as "reference support material density" in the compaction test report of the constructed asphalt concrete pavement over the area represented by the support material compaction test.

116.10.4.2.3.1 Compaction tests shall be taken at random locations on the asphalt being placed, as directed by The ENGINEER. The three (3) general areas in which tests are to be taken are the free edge of the mat, mat interior, and the joints. The number of tests taken in each area will vary but the total number of tests taken on any project shall be per TABLE 116.G-FIELD IN PLACE DENSITY PROPORTIONS.

116.10.4.2.3.2 Samples of the compacted Types SP-III, SP-IV, B, C, and D asphalt concretes may be taken and tested to determine compaction conformance of the finished pavement with the specified requirements either as requested by the CONTRACTOR, or as directed by the ENGINEER. Cores shall be sampled and tested in accordance with 116.10.4 - Field Testing.

116.10.5.1 Test reports shall include but not be limited to the information specified in TABLE 116.H - TEST REPORT.

116.10.5.2 Test results shall be reported to The ENGINEER, CONTRACTOR, and Supplier in writing, within 7 working days of completion of the sampling of the asphalt and/or the field testing. Non-complying tests shall be reported to The ENGINEER, CONTRACTOR and supplier within 1 working day of completion of the test.

116.10.5.3 The New Mexico Registered Professional Engineer in direct charge of the laboratory shall certify on a quality assurance test report that the test procedures used to generate the report complied with the specifications.

116.11 MEASUREMENT AND PAYMENT

116.11.1 The measurement of the asphalt concrete material shall be by the ton delivered and unloaded at the project, and, by the square yard lift placement and compaction, for each mix type used on a project, each day.

116.11.2 Each LOT of asphalt concrete material shall be paid at the adjusted CONTRACT unit price for asphalt concrete, calculated in accordance with the equation below, adjusted by a material factor, PF_M, specified in TABLE 116.J, as authorized by the ENGINEER. A LOT shall be defined as the total tonnage placed in a day, for each type of material placed. Acceptance samples shall be sampled and tested in accordance with the requirements of 116.10, and tested for compliance with the specifications. a material pay factor, PF_M, shall be determined in accordance with TABLE 116.J, as defined for test results for combined aggregate gradation and asphalt content, as compared to the authorized job mix formula's production specifications. All complying acceptance samples taken in a day for a material type shall represent a LOT in the computation specified in TABLE 116.J. Non complying acceptance samples shall be evaluated in accordance with this specifications as directed by the Engineer. The material factor, PF_M, for a LOT shall be determined based on the deviation of the average value, arithmetic mean, M, of the acceptance samples' test results from the job mix formula targets, T, adjusted for the range of the test results, maximum value minus the minimum value. If the absolute value of the deviation of the daily mean from the target is greater than the maximum allowable deviation, the LOT will be removed and replaced with materials complying with the specifications at no cost to the OWNER, as directed by the ENGINEER. If it is determined by the ENGINEER to be more practical to accept the material under a specific project condition, the LOT may be accepted under written agreement between the OWNER and the CONTRACTOR at an assigned pay factor PF_M= 0.70, for a LOT having a compaction pay factor, PF_C, equal or greater than 0.85, as authorized by the ENGINEER.

$UP' = PF_M \times UP$

UP', adjusted contract unit price/ton

UP, Contract unit price/ton

PF_M, material adjustment factor

116.11.3 The placement and compaction factor, PF_C, for a LOT shall be determined based on the average value of the compaction tests for the LOT, with any single test neither less than 90.0% nor greater than 98%, and TABLE 116.K. If a test for a LOT is either less than 90.0% or greater than 98%, the LOT will be evaluated as directed by the ENGINEER.

$UP' = PF_C \times UP$

UP', adjusted contract unit price

PFC, See table 116.K

UP, contract unit price

TABLE 116.A - COMBINED AGGREGATE DESIGN PROPERTIES

CHARACTERISTIC	AGGREGATE TYPE Coarse		Fine	PROCEDURE
1. Coarse aggregate angularity, material > 4.75 mm	[1]	[2]	-	ASTM D 5821
ESALs < 3.0 mil	85	80		
3.0 < ESALs < 30.0 mil	95	90		
30.0 mil ≤ ESALs	100	100		
2. Fine aggregate angularity as air voids, %, min	-		45	AASHTO TP 33
3. Flat and elongated particles, 3:1 or greater dimension, material > 4.75 mm, %	20 max			ASTM D 4791
4. Clay content, min %	-		45	ASTM D 2419
5. Deleterious material, max %	1		1	ASTM C 142
6. LA Abrasion, material > 2.36 mm, max loss, %	40		40	ASTM C 131
7. Soundness, max loss after 5 cycles, %	15		15	ASTM C 88

[1] coarse aggregate has one or more fractured faces
[2] coarse aggregate has two or more fractured faces

TABLE 116.B AGGREGATE GRADATION [3]

	% PASSING TYPE, Nominal Maximum Size Aggregate [1]												
	SP-II/A, 1		SP-III, 3/4		SP-IV, ½		SP-V/D, 3/8		B, 3/4		C, ½		PRODUCTION
SIEVE SIZE,	min	max	min	max	min	max	min	max	min	max	min	max	TOLERANCE (+/-
1-1/2	100	100	-	-	-	-	-	-	-	-	-	-	
1.00	86	96	100	100	-	-	-	-	100	100-	-	-	8
3/4	-	90-	89	96	100	100	-	-	88	96	100	100	8
½	62	83	-	90	88	96	100	-	-	90	88	96	8
3/8	-	-	64	85	-	90	91	97	70	85	73	90	8
no.4	31	40	37	47	52	70	-	90	51	69	57	75	7 [2]
8	19	27	23	32	28	39	47	67	35	49	39	58	6
16	10	18	12	22	14	26	38	55	28	40	32	48	6
30	6	14	8	17	8	19	28	43	21	31	24	38	5
50	4	11	5	14	5	16	19	30	14	23	16	27	5
200	3.0	7.0	3.0	8.0	2.0	10.0	3.0	10.0	2.0	8.0	3.0	10.0	3.0

NOTES: [1] SP-II and Type A gradation materials may not be used for the surface course
[2] If recycled asphalt concrete aggregate (RAP) is used, ±8%
[3] A JMF aggregate gradation may pass through the restricted zone if all JMF volumetric design criteria is in compliance. The restricted zone is defined by the material passing the no.8 to no.30 sieves for SP-II and Type A asphalt concretes. The restricted zone is defined by material passing the no.4 to no.30 sieves for all other asphalt concrete.

TABLE 116.C.1 - ASPHALT CONCRETE SUPERPAVE DESIGN SPECIFICATIONS

DESCRIPTION	Local, Major Local, Residential, Intersections [1]		Collector, Minor and Major Arterial, Controlled Access Roadway, and Intersections [1]			
A. Binder	PG70-22		PG76-28		PG76-28	
B. Equiv.. Single Axle Load, ESALs (million)	< 3		3 ≤ ESALs <30		30 ≤ ESALs [2]	
C. Voids, %	3.5 - 4.5		3.5 - 4.5		3.5 - 4.5	
D. Voids in Mineral Aggregate, VMA, %	min	max	min	max	min	max
Type SP-II [3], (1 in.)	12	14	12	14	12	14
Type SP-III, (3/4 in.)	-	-	13	15	13	15
Type SP-IV, (½ in.)	-	-	14	16	14	16
Type SP-V, (3/8 in.)	-	-	16	18	16	18
Type A, (1 in.) [3]	12	14	-	-	-	-
Type B, (3/4 in.)	13	15	-	-	-	-
Type C, (½ in.)	14	16	-	-	-	-
Type D, (3/8 in.)	16	18	-	-	-	
E. Voids filled with binder, %						
Type SP-II [3], (1 in.)	-	-	65	75	65	75
Type SP-III, (3/4 in.)	-	-	65	75	65	75
Type SP-IV, (½ in.)	-	-	65	75	65	75
Type SP-V, (3/8 in.)	-	-	65	75	65	75
Type A, (1 in.) [3]	68	78	-	-	-	-
Type B, (3/4 in.)	68	78	-	-	-	-
Type C, (½ in.)	68	78	-	-	-	-
Type D, (3/8 in.)	68	78	-	-	-	-
F. Dust Ratio, -no.200 (0.075mm) : $\%P_{be}$	0.6	1.6	0.6	1.6	0.6	1.6
G. Gyratory compaction [4] at binder compaction temp, ± 5^{O}F				%		%
Gyrations	N	% CMPTN	N	CMPTN	N	CMPTN
N_i (initial)	7	91.0	8	89.0	9	89.0
N_d (design)	75	96.0	100	96.0	125	96.0
N_m (max)	115	98.0	160	98.0	205	98.0
H. Moisture susceptibility, % retained strength @7% air voids, AASHTO T283, with freeze cycle.	80 min		80 min		80 min	

NOTES:

[1] The intersection area shall be the core area common to all intersecting streets, and, include the distance to the curb return of the approach and departure of the intersecting streets.

[2] Level II Design Complying with NMSHTD Procedures at Date of Bid, as directed by the ENGINEER.

[3] SP-II and Type A gradations asphalt concrete shall not be used for surface course

[4] % of maximum theoretical specific gravity / density, Gmm

TABLE 116.C.2 - ASPHALT CONCRETE DESIGN SPECIFICATIONS
PENETRATION & VISCOSITY GRADE BINDERS

DESCRIPTION	Residential, Local, Major Local, and Intersections
A. Binder Grade	60-70 Pen, AC-20 Viscosity
B. Equiv. Single Axle Load, ESALs (million)	ESALs < 3.0
C. Voids, %	3.5 - 4.5
D. Voids in Mineral Aggregate, VMA, %	
Type A, (1 in.)	12 - 14
Type B, (3/4 in.)	13 - 15
Type C, (½ in.)	14 - 16
Type D, (3/8 in.)	15 - 17
E. Voids filled with binder, %	68 - 78
F. Dust Ratio, -no.200(0.075 mm) : $\%P_{be}$	0.6 - 1.6
G. Marshall Stability Design, Blow counts/ each face	50
Stability, lbs, min	1500
Flow, 0.01 in	10-18
H. Stability to Flow Ratio, minimum @target binder $\pm$ 0.5%	200
I. Moisture susceptibility, % retained strength, @ 7% air voids, AASHTO T283, with freeze cycle.	80 min

NOTES:
[1] The intersection area shall be the core area common to all intersecting streets and include the distance to the curb return of the approach and departure of the intersecting streets.

TABLE 116.D - SUBMITTAL INFORMATION

I. Identification
- A. Asphalt concrete supplier
- B. Laboratory that performed design/development tests
- C. Date of Submittal
- D. Unique mix code identification number
- E. Aggregate sample date

II. Job Mix Formula (jmf)
- A. City type/application of asphalt concrete
- B. Component material target proportions to include combined aggregate gradation and asphalt content, specifications, and production tolerances
- C. 0.45 power gradation plot of combined aggregate gradation with specification and production limits
- D. Temperature viscosity relationship of binder
- E. Recommended mixing, compaction, and release to traffic maximum temperatures.
- F. Tabulation of job mix formula performance characteristics defined in either TABLE 116.C.1 or TABLE 116.C.2, as applicable, at the proposed design proportions, with reference specification limits and production limits (if specified), maximum theoretical specific gravity/density (as pcf), and bulk specific gravity/density (pcf).
- G. Reference daily production gradation, see 116.3.2

III. Certifications of Compliance
- A. Compliance of job mix formula by NM Registered Professional Engineer in direct charge of design/development;
- B. Design Laboratory Certification, projects bid after June 30, 2000.
- C. Component materials testing and certification by supplier/manufacturer with supporting test data for materials used in design development

D. Certification and laboratory test results of asphalt binder used in job mix formula design development, see 112.4.1.2.

IV. Design Development (Tables and graphs, with specifications limits of the following:)

A. Marshall Design & Modified Marshall Designs (design development with a minimum of 4 asphalt binder contents required, and the recommended design characteristic bracketed by a minimum of two test points for the design binder content ± 0.5%)

1. Design hammer blow counts, mold diameter, hammer mass and drop
2. Stability (lbs.) vs. % asphalt content
3. Flow (0.01 in.) vs.% asphalt content
4. Briquette bulk Specific Gravity and Bulk Density (as pcf) vs. % asphalt content
5. % Voids In Mineral Aggregate (% VMA) vs. % asphalt content
6. % Voids (Pa) in asphalt concrete vs. % asphalt content
7. % voids filled in Asphalt Concrete vs. % asphalt content
8. dust ratio vs.% asphalt content

B. SUPERPAVE Design (Tables and graphs, with specifications limits of the following)

1. Trial Designs: Aggregate gradations, 3 minimum required, and trial asphalt binder content (%)

a) Table of Aggregate Gradations and 0.45 power plot, with specification limits
b) Trial design % asphalt content
c) Trial designs volumetric analysis for each gradation, VMA, Va, VFA, graph not required
d) Trial designs compaction analysis @ Ni, Nd, and Nm, for each gradation
e) Dust ratio for each trial design, graph not required

2. Job Mix Formula Design, (design development with a minimum of 4 asphalt binder contents required, and the recommended design characteristic bracketed by a minimum of two test points for the design binder content ± 0.5%)

a) Table of design aggregate gradation and 0.45 power plot, with specification limits and production targets
b) Compaction analysis G_{mb} as % $G_{m,}$ at Ni, Nd, and Nm, vs asphalt content (separate graphs for Ni, Nd, and Nm)
c) Volumetric analysis of VMA, Va, VFA, and dust ratio at design gyration, @Nd, vs % asphalt content
d) Gyratory compaction tables as height of sample versus gyration, for each asphalt content, Gmb @ NM, and bulk specific gravity/density correction factor(s) (graphs not required)
e) Maximum theoretical specific gravity/density (as pcf), G_{mm}, vs %asphalt content @Nd
f) Corrected bulk specific gravity/density (as pcf), G_{mb}, vs % asphalt content
e) dust ratio vs.% asphalt content
f) Recommended gyratory sample mass(g) for 115 mm sample height at Nm

C. Ignition Correction Factor: Correction for material losses during asphalt content ignition oven analysis

The correction factor shall be determined as the average value for three samples, design % asphalt content, design - 1.0%, and design +1.0%, developed in an ignition oven complying with the requirements of AASHTO T53, Method A.

TABLE 116.E - DELIVERY TICKET INFORMATION

Name of Asphalt Concrete Supplier
Date of Delivery
Delivery Ticket Number Contractor
Project Name (optional)
Job Mix Formula Number
Weight of Load (tons)
Time loaded

TABLE 116.F - FIELD SAMPLE LABORATORY TESTS

I. Marshall Design Analysis
- A. Energy Reference:
  - 1 briquette mass / mold size;
  - 2 hammer size and drop; and
  - 3 number of blow counts per face;
- B. Volume characteristics of compacted briquettes, with production specifications, average of three:
  - 1 VMA, voids in mineral aggregate;
  - 2 Va, voids in asphalt concrete;
  - 3 VFA, voids filled with asphalt binder; and,
  - 4 Gmb, bulk specific gravity and density, with authorized jmf target, average of three;
- C. Gmm, maximum theoretical specific gravity/density with authorized jmf target, one test;
- D. Strength Characteristics:
  - 1 stability;
  - 2 flow; and,
  - 3 stability : flow ratio.

III. SUPERPAVE Analysis (sample aging is not required)

Analysis at authorized jmf gyrations, N_i (initial), N_d (design), and N_m (max). (1) Two briquettes required. (2) Report average of test results of two briquette tests.
- A. Compaction analysis with authorized design, and specifications (if applicable)
  - 1 Bulk specific gravity/density, G_{mb}, @ Ni, Nd, and Nm
  - 2 Maximum theoretical specific gravity/density, Gmm
  - 3 Compaction: Gmb as % Gmm at Ni, Nd, and Nm
  - 4 Sample height, mm, at Nd
- B. Volume characteristics of compacted briquettes @ N_d, with design value and specifications
  - 1 VMA, voids in mineral aggregate
  - 2 Va, voids in asphalt concrete
  - 3 VFA, voids filled with asphalt binder

IV. Asphalt binder content, with design value and authorized production range, T53-Quantitative Analysis of Bitumen From Bituminous Paving Mixtures, Ignition Oven Method A (Modified: reference temperature for constant mass, 149 ± 3° C/ 300 ± 7°F)

V. Dust ratio, $\%P_{be}$

VI. Extracted Combined Aggregate, with design value(s) and authorized production range
- A. Gradation
- B. Coarse aggregate angularity, material > 4.75 mm, coarse aggregate has two or more fractured faces
- C. Flat and elongated particles, 3:1 or greater dimension, material > 4.75 mm, %

TABLE 116.G
FIELD IN PLACE DENSITY PROPORTIONS

Location	% of total tests
Free Edge of Mat[1]	20 to 33
Mat Interior	33 to 60
Joints[2]	20 to 33

NOTES:
1 The free Edge of Mat test shall be taken in the area between one (1) foot and two (2) feet in from a free edge of a lift.
2 Joints shall include the longitudinal and transverse butt joints between adjacent lifts of asphalt having the same finish elevation. Tests may be taken on material placed against a cold joint edge of formed surface.

TABLE 116.H - TEST REPORT

A.		Field Data and Test Results:
	1	Date of Sampling/Test
	2	City of Albuquerque Project Number or Permit Number
	3	Project Title
	4	Asphalt Concrete Supplier
	5	Delivery Ticket Number (asphalt concrete sample-only)
	6	Job Mix Formula Number
	7	Location of sample/test as defined by Contract Documents
	8	Time of Sampling/testing
	9	Material temperature at time of sampling, □F
	10	Ambient temperature at time of sampling, □F
	11	Field test results with reference specification limits (compaction test)
B.		Laboratory Test Results
	1	Laboratory results as defined in TABLE 116.F
	2	Field Test Data, 116.10.4
C.		Recommended Pay Adjustment Factor for a LOT
	1	C_{LM}, material factor, see TABLE 116.J
	2	C_{LC}, placement/compaction factor, see TABLE 116.K

TABLE 116.J - MATERIAL FACTOR, PF_M, FOR GRADATION & BINDER CONTENT

NUMBER OF DAILY SAMPLES	For |T-M| equal or greater than D', [1, 2] D', MAXIMUM ALLOWABLE DEVIATION [3]		
1	1.40D	1.20D	D
2	D + R	D + 0.37R	D - 0.10R
3	D + 0.30R	D + 0.07R	D - 0.14R
4	D + 0.16R	D - 0.01R	D - 0.17R
5	D + 0.11R	D - 0.03R	D - 0.20R
6	D + 0.09R	D - 0.05R	D - 0.22R
7	D + 0.07R	D - 0.07R	D - 0.24R
8	D + 0.06R	D - 0.08R	D - 0.25R
9	D + 0.05R	D - 0.09R	D - 0.26R
10 OR MORE	D + 0.04R	D - 0.10R	D - 0.27R
MATERIAL FACTOR, PFm [3]	0.85	0.95	1.00

[1] D, production tolerance +/- %, see TABLE 116.B and paragraph 116.4.2.2 , and authorized job mix formula, R, range of test values, maximum - minimum values, M, average test value of a LOT's samples test results, T, target value specified in the authorized job mix formula.

[2] If the deviation of the daily mean from the target exceeds the maximum allowable deviation for a LOT, |T-M|>D', the LOT will be removed and replaced with material complying with this specification, at no cost to the OWNER, as directed by the ENGINEER. If determined by the ENGINEER to be more practical to accept the material, the

LOT may be accepted under written agreement between the OWNER and the CONTRACTOR AT an assigned pay factor PF_M= 0.70, for compaction LOT(s) having a compaction factor, PFc, equal or greater than 0.85, as directed by the ENGINEER.

[3] The material factor, PFm, shall be the lowest of the factors calculated for either the combined aggregate gradation of material passing the nominal maximum size aggregate screen, 3/8 inch, and smaller screens, or, the binder content.

TABLE 116.K - PAY FACTOR (PF_C) FOR COMPACTION

Average of Acceptance Test Results	Pay Factor, PF_C
98.0% and greater	[1]
97.1 to 97.9	0.85
93.0 to 97.0	1.00
92.0 to 92.9	0.95
91.0 to 91.9	0.90 [2]
90.0 to 90.9	0.85 [2]
less than 90%	[1], [2]

[1] The material defined for the Lot shall be removed and replaced with asphalt concrete material complying with this Specification at no cost to The OWNER, as directed by The ENGINEER. Upon written agreement, the CONTRACTOR and ENGINEER may determine that for practical purposes the Lot shall not be removed. If determined by the ENGINEER to be more practical to accept a LOT, a LOT may be accepted under written agreement between the OWNER and the CONTRACTOR at an assigned compaction pay factor PF_C= 0.50 [2], for a LOT having a material factor pay factor equal or greater than 0.85, as directed by the ENGINEER.

[2] When the lift is the surface course, and is accepted at this pay factor, the CONTRACTOR shall apply a sanded fog seal to the LOT complying with the requirements of SECTION 333, as directed by the ENGINEER, at no cost to The OWNER.

SECTION 117

ASPHALT REJUVENATING AGENTS

117.1 GENERAL

117.1 Type I asphalt rejuvenating agent, a cationic oil and resin emulsion, shall be composed of a petroleum resin oil base uniformly emulsified with water and conforming to the requirements contained herein.

117.2 Asphalt rejuvenating agents shall not be used except under the provisions in the approved supplemental technical specifications.

117.2 REFERENCES

117.2.1 ASTM

D 244
D 445

117.3 TESTING REQUIREMENTS

Table 117.3 indicates testing requirements for asphalt rejuvenating agents.

117.4 CERTIFICATION

The CONTRACTOR shall furnish the ENGINEER with the brand name and name of the manufacturer of the asphalt rejuvenating agent he proposes to use and the material shall be approved by the ENGINEER before it is used. The CONTRACTOR shall also furnish the ENGINEER with a manufacturer's certificate of compliance indicating quantity and specification control.

117.5 MEASUREMENT AND PAYMENT

117.5.1 If this material is to be paid for as a separate item, then the measurement and payment shall be by the treated square yard.

117.5.2 If this material is to be combined with other items as a complete unit, then the measurement and payment will be made in accordance with the applicable section and per the Bid Proposal.

TABLE 117.3

ASPHALT REJUVENATING AGENT TEST REQUIREMENT

Specification Designation	Test Method	Requirements
Viscosity, S.F., at 77° F Sec.	ASTM D 244	15-40
Residue, % (1)	ASTM D 244 (Mod.)	58-62
Cement Mixing Test, %	ASTM D 244	Zero
Sieve Test, % Max. (2)	ASTM D 244 (Mod.)	0.10
Particle Charge Test	ASTM D 244	Positive
Test on Residue from ASTM D 244		
Viscosity, cs., 140° F	ASTM D 445	100-200

ASTM D 244 Modified Evaporation Test for percent residue is made by heating 50 gram sample to 300 degrees F until foaming ceases, then cool immediately and calculate results.

Test procedure identical with ASTM D 244 except that distilled water shall be used in place of 2 percent sodium oleate solution.

SECTION 118

HYDRATED LIME MINERAL FILLER

118.1 GENERAL

Hydrated lime mineral filler will be required as an additive to the entire aggregate portion of the asphaltic concrete surface course, asphaltic concrete overlays, and plant mix seal.

118.2 REFERENCES

118.2.1 ASTM

D 242

118.2.2 AASHTO

M 17

118.3 MATERIAL

Hydrated lime mineral filler shall conform to the requirements specified in ASTM D 242 and AASHTO M 17.

118.4 MIXING AND PROPORTIONS

118.4.1 The hydrated lime shall be added to the aggregate such that loss of hydrated lime is minimal or non-existent. Placement of the lime on an open conveyor belt will not be permitted. Placement of the lime on an enclosed belt that does not permit blowing or loss of lime is acceptable.

118.4.2 The CONTRACTOR shall provide appropriate weighing devices, approved by the ENGINEER, to assure that the proportionate amounts of hydrated lime are being added to the coarse aggregate, fine aggregate and filler (if required).

118.4.3 Hydrated lime will be added at a proportion of 1 percent to 2 percent by weight of total aggregate as approved by the ENGINEER.

118.4.4 Hydrated lime shall be added to the combined aggregate materials in a pug-mill immediately after leaving the cold feed and just prior to introduction into the dryer drum or dryer.

118.4.5 Minimum moisture content of the combined aggregates shall be 3 percent by weight, at the time the aggregate and lime are mixed, to affect a complete coating of the aggregate with the hydrated lime.

118.4.6 The ENGINEER may increase the moisture content of the coarse and fine aggregates or the combination of coarse and fine aggregates to obtain proper coating of the aggregates with hydrated lime and to eliminate dust pollution.

118.5 MEASUREMENT AND PAYMENT:

No separate measurement or payment will be made for the additive of hydrated lime mineral filler to specified asphaltic surfacing materials.

SECTION 119

PAVING FABRICS

119.1 GENERAL

This section specifies the materials for paving fabrics which may be part of a pavement rehabilitation project.

119.2 REFERENCES

119.2.1 ASTM

D 1117
D 1777
D 3776

119.3 MATERIALS

119.3.1 FABRIC PROPERTIES: The fabric shall consist of woven or nonwoven polypropylene and/or polyester material meeting the requirements of Table 119.3.1 when tested in conformance with the respective test method.

119.3.2 PACKAGING: The fabric shall be packaged in rolls with each roll wound onto a suitable cylindrical form or core to aid in handling and placing. Each roll and the form or core upon which it is rolled shall be packaged in a suitable wrapper which is defined to include a sheath or container to protect the fabric from damage due to ultraviolet light and moisture during storage and handling.

119.3.3 IDENTIFICATION: Each roll shall be labeled or tagged in such a manner that the information for sample identification and other quality control purposes can be read from the label without opening the wrapper. Each roll shall be numbered by the manufacturer and further identified as to lot number or control number, date of manufacture, tare weight of core plus wrapper, width and length of fabric, and gross weight of the entire roll which includes fabric, core, wrapper, tags, etc.

119.3.4 SAMPLING:

119.3.4.1 Test samples will be cut at the project from rolls selected at random and shall be no less than three feet in length by the full width of the roll. Nothing in this section shall negate the ENGINEER's right to take additional samples.

119.3.4.2 The samples will be taken according to the following frequency:

SQUARE YARDS	NO. OF SAMPLES
0-50,000	8
50,000-150,000	16
100,000-300,000	24
Over 300,000	32

119.3.5 TESTING: Specimens will not be conditioned for testing. One-half of the above samples will be tested initially: if the average test results indicate the material meets specification requirements no additional testing will be done. If the test results indicate the material does not meet specification requirements, the CONTRACTOR will be notified and the remaining samples will be tested. These additional test results will be combined with the first set.

119.3.6 WEIGHT (FULL ROLL): Weight determinations will be made using procedures described in ASTM D 3367 Option A. The CONTRACTOR shall provide scales and move the roll to said scales for this purpose. Net weight of the fabric is total weight minus the weights of the core, wrapper, tags, etc.

119.3.7 WEIGHT (SPECIMENS): Specimen weight determinations will be made using procedures described in ASTM D 3776 Option C. Each specimen taken for the strength/elongation test and the asphalt retention test will be weighted to the nearest 0.1 gram.

119.3.8 STRENGTH AND ELONGATION:

119.3.8.1 The "breaking load" will be determined in accordance with ASTM D 1117, using constant rate of traverse of 12 $\pm$ 0.5 inches per minute and 1-inch (wide) x 2-inch (long) smooth-faced jaws. Test specimens will be rectangular and measure four by eight inches. When placed in the jaws, the fabric will project one-half inch at each end and 1.5 inches on each side.

119.3.8.2 Twenty individual test specimens will be taken at random for tensile and elongation testing, ten with the long dimension in the machine direction and ten with the long dimension in the cross-machine direction. No test specimens will be taken from either edge of the roll which is defined as within the outer one-tenth of the width. Ten specimens (five in each direction) will be tested for breaking load and elongation.

119.3.8.3 The average test values for the machine-wise and the cross-machine specimens will be reported separately as the final test values.

119.3.9 THICKNESS: Using ASTM D 1777, thickness will be determined using a 0.5-inch-diameter foot exerting 45 grams per square centimeter pressure onto a 1.1-inch-diameter anvil. Five thickness measurements will be made on each specimen used in the strength/ elongation tests and asphalt retention test: one measurement in the vicinity of each corner and one in the center.

119.3.10 ASPHALT RETENTION: Two machine- wise test specimens and two cross-machine specimens each three by fifteen inches will be selected from the full-width sample in the same manner as described in Subsection 119.3.8. Each test specimen will be weighed to the nearest 0.1 gram, saturated in asphalt cement maintained at 150 $\pm$ 4°F, placed between sheets of newspaper and pressed with a hot iron to remove excess asphalt. (Presence of excess asphalt is evidenced by a glossy appearance.) The saturated specimen will be weighted to the nearest 0.1 g, then placed in naphtha heated to 110° $\pm$5°F for 30 minutes. Fresh naphtha at the specified temperature will be alternated as necessary during the 30-minute period to effect removal of the asphalt cement from the specimen. The specimen will be blotted with paper towels and allowed to air dry to effect naphtha removal, then measured. Asphalt retention will be calculated as follows:

asphalt retention (oz./sq. yd.) =

$$\frac{\text{(wt w/ asphalt - weight init.)gms x } 0.0352739 \text{ oz./gm.}}{\text{(area of specimen after test, sq. in.)/ 1296 sq. in./sq. yd.}}$$

119.3.11 BASIS FOR REJECTION: If a roll fails to meet the weight requirements when it is weighed in accordance with Option A, that roll will be rejected. If the average of the test results shows that the material does not meet specification requirements for any property, the material shall be rejected.

119.3.12 TESTING TIME REQUIREMENT: Testing may require up to 20 working days. Paving fabric from a shipment shall not be placed until testing from the shipment is complete.

119.3.13 TACK COAT: The tack coat shall be composed of paving grade bituminous material of the type and grade specified by the manufacturer of the fabric and shall meet the requirements of 85-100 or 120-150 penetration asphalt, CSS-1 or SS-1 emulsified asphalt, or AC-5 or AC-10 asphalt. The tack coat application rate shall consist of the total of the mean optimum asphalt content required by the fabric as determined by the ENGINEER plus an amount to satisfy the "surface hunger" of the existing pavement as determined by the ENGINEER.

119.4 MEASUREMENT AND PAYMENT

Measurement and payment shall be as specified in Section 335.

SECTION 119

PAVING FABRICS

TABLE 119.3.1

PROPERTY	ASTM DESIGNATION TEST*	VALUE	UNITS
Weight (Full Roll)***	D 3776, Option A	3.5 to 8.0***	oz./sq.yd.
Weight (Specimens)***	D 3776, Option C	3.5 to 8.0**	oz./sq.yd.
Grab Tensile Strength	D 1117	80.0 min.	pounds
Elongation at Break	D 1117	50.0 min.	percent
Fabric Thickness***	D 1777	0.030 min.**	inches
Asphalt Retention	None	0.10 min.	gal./sq.yd.

*Information about unique procedures for each of the tests is included in Subsections 119.3.5 through 119.3.9.

**Maximum allowable coefficient of variation is 12.5% where coefficient of variation = (standard deviation/mean) x 100%.

***For spun-bonded fabric these minimum values are to be: Thickness, 0.015 inches and asphalt retention, 0.07 gal./sq.yd.

SECTION 121

PLASTIC PIPE

121.1 GENERAL: Plastic pipe for pressure and non-pressure uses shall be manufactured from polyvinyl chloride (PVC) or double and triple wall Polypropylene (PP).

121.2 REFERENCES.

121.2.1 American Society for Testing and Materials (Latest Editions) (ASTM):

D1598 Test Method for Time-to-Failure of Plastic Pipe under Constant Internal Pressure

D1599 Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings

D1601 Test Method for Dilute Solution Viscosity of Ethylene Polymers

D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics

D1784 Specifications for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

D2239 Specifications for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

D2657 Heat-Joining Polyolefin Pipe and Fittings

D3034 Specification for type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

D3212 Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals

F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F679 Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

F794 Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

F2764 6 to 60 inch Polypropylene (PP) Corrugated Double and Triple Wall pipe and Fittings for Non-Pressure Sanitary Sewer Applications

F2881 12 to 60 inch Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications

121.2.2 American Water Works Association (Latest Edition) (AWWA):

C900 AWWA Standards for Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in. for Water Distribution

C905 AWWA Standard for Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameter 14 in. through 48 in.

121.2.3 THIS PUBLICATION:

SECTION 800 WATER TRANSMISSION, COLLECTOR DISTRIBUTION AND SERVICE LINES

SECTION 900 SANITARY AND STORM SEWER FACILITIES

SECTION 1502 SUBMITTALS

121.3 CERTIFICATION

121.3.1 The CONTRACTOR shall submit certification from the manufacturer of the pipe as specified in Section 1502 as to the pipe material and that the pipe meets or exceeds the required testing. Only pipe manufactured in the United States of America will be acceptable.

121.4 GENERAL PLASTIC PIPE REQUIREMENTS

121.4.1 POSITIVE IDENTIFICATION: All PVC pipe shall be coded in accordance with the applicable material standard to eliminate future confusion and

prevention accidental damage and service interruption of the facilities. PVC pipe used for potable water mains shall be blue in color. PVC pipe used for non-potable water mains shall be purple in color. PVC pipe used for sanitary sewer collection lines shall be green in color.

121.4.2 LINE LOCATOR: Metallic tape shall be used as a locator for all plastic pipe which is installed less than 10 feet deep. The tape should be installed 2 ft. to 6 ft. below top of ground and centered over the pipe. When feasible, the tape shall be fastened to metallic appurtenances associated with the installation (i.e. valves, fittings, manhole rings, etc.) in an effort to enhance its detectability.

121.4.3 PIPE STORAGE: All types of plastic pipe shall be stored in a manner that the pipe will not be deformed as recommended by the manufacturer. PVC pipe is subject to potential degradation when exposed to prolonged periods of sunlight. Material degradation is generally indicated by a discoloration of the pipe. PVC pipe shall be stored inside a building, under a cover or covered up totally. All discolored pipe shall not be installed and shall be immediately removed from the project.

121.4.4 JOINING SYSTEMS

121.4.4.1 All plastic pipe which is connected to a manhole, junction box, inlet or similar structure shall be installed with an approved manhole connection adapter or water-stop such that each connection is leak-free and that there is no detrimental affect resulting from the material property characteristic differences between the plastic pipe and the structure.

121.4.4.2 BELL AND SPIGOT JOINTS: Pipe with gasket joints shall be manufactured with a socket configuration, which will prevent improper installation of the gasket and will ensure that the gasket remains in place during joining operations. The gasket shall be manufactured from a synthetic elastomer material and shall conform to the requirements of ASTM F 477. The spigot end of each joint of pipe shall be marked circumferentially to indicate the proper home mark. Pipe, which is field-cut, shall be chamfered and the home mark identified in accordance with the applicable criteria.

121.5 MATERIALS AND UTILIZATION

121.5.1 Polyvinyl Chloride (PVC) Pressure Pipe:

121.5.1.1 The material in PVC pipe shall be in accordance with ASTM D 1784.

121.5.1.2 Pipe for potable water shall be suitable for use in the conveyance of water for human consumption. The pipe shall be marked with two seals of the testing agency that certified the pipe material is suitable for potable water use.

121.5.1.3 PVC pipe shall be approved by the Underwriters Laboratories (UL) and be furnished in cast iron pipe-equivalent outside diameters. Joints shall be push-on flexible elastomeric gasketed.

121.5.1.4 PVC Pressure pipe shall have a minimum working pressure of 150 psi (DR 18) or as specified on the plans or in the Supplemental Technical Specifications.

121.5.1.5 Pipe lengths shall contain one bell-end or couple with an elastomeric gasket. Gasket shall meet the requirements of ASTM F 477. The bell shall be an integral part of the pipe length and have the same strength and DR as the pipe. The spigot pipe end shall be beveled.

121.5.1.6 PVC pressure pipe in sizes 4-inch through 12-inch shall meet the requirements of AWWA C 900.

121.5.1.7 PVC pressure pipe in sizes 14-inch through 24-inch shall meet the requirements of AWWA C 905.

121.5.1.8 PVC pressure pipe shall not be used for public water mains larger than 24-inches.

121.5.2 Polyvinyl Chloride (PVC) Gravity Flow Pipe:

121.5.2.1 The material in PVC pipe shall be in accordance with ASTM D 1784.

121.5.2.2 PVC gravity flow pipe may be used for storm and sanitary sewer applications for sizes 8-inch and greater, except for installation resulting in a depth of cover (to subgrade elevation) less than 3.1 feet or when the Contract documents specifically prohibit its use.

121.5.2.3 Lateral line connections shall be made at manholes or at factory manufactured saddles or tees only, unless specifically authorized by the ENGINEER.

121.5.2.4 PVC gravity flow pipe in sizes 8-inches through 15-inches shall meet the requirements of ASTM D 3034. Only solid wall pipe shall be used. Minimum wall classification shall be SDR 35.

121.5.2.5 PVC gravity flow pipe in sizes 18-inch and larger shall meet the requirements of ASTM F 679 or ASTM F 794. Minimum pipe stiffness shall be 46 psi.

121.5.2.6 Sanitary sewer service line connections to 15-inch and larger pipe diameter will not be permitted, unless authorized by the Water Authority.

121.5.3 Polypropylene (PP) pipe:

121.5.3.1 The material in PP pipe shall be in accordance with ASTM F2764 and ASTM F2881.

121.5.3.2 Pipe shall meet the minimum joint performance requirements per ASTM D3212, a 10.8 psi, gage, laboratory pressure test for 10 minutes with no visible leaks at the joint. Watertight joints shall be bell and spigot and gaskets shall meet the requirements of ASTM F477.

121.5.3.2 Pipe diameters 12” up to and including 60” will be allowed and have an exterior bell wrap installed by the manufacturer.

121.6 MEASUREMENT AND PAYMENT: Plastic pipe used for both pressure and gravity flow shall be measured and paid for at the contract unit price as specified in Section 800 and 900 and/or as defined in the Bid Proposal.

SECTION 122

PLASTIC LINER PLATE

122.1 GENERAL

These specifications include material requirements and installation of the plastic liner plate.

122.2 REFERENCES

122.2.1 ASTM
D 1243

122.3 MATERIALS

122.3.1 PROPERTIES OF MATERIALS:

122.3.1.1 The materials used in all sheets of plastic liner plate and in all joint, corner, and welding strips shall be a polyvinyl chloride resin and other necessary ingredients compounded to make permanently flexible sheets and strips which are impermeable to sewage. Copolymer resins will not be permitted. Polyvinyl chloride shall constitute not less than 99 percent by weight, of the resin used in sheets and joint strips. The resin shall have a specific viscosity of 0.40 when measured in accordance with Standard Method of Test ASTM D 1243 and a 10 gram sample of the resin when heated in a 30 cu. cm. crucible at 100 degrees C for one hour shall have a loss not exceeding 0.7 percent. The resin used in welding and corner strips and other accessory pieces shall be of the highest molecular weight that is compatible with field welding.

122.3.1.2 The material used in joint strips and in plain sheets of plastic liner plate shall be identical to that used in sheets having locking extensions.

122.3.1.3 The CONTRACTOR shall submit to the ENGINEER manufacturer's certifications of compliance of each type of plastic liner sheet and strip proposed for use, together with a list of all ingredients from which the sheets and strips are to be compounded. The list shall show the percentage of use of each ingredient.

122.3.1.4 The samples will be subjected to the tests set forth hereinafter; and when the samples and their ingredients have been approved, no changes will be permitted without prior approval by the ENGINEER.

122.3.1.5 The samples shall show no significant changes when exposed to soaps; detergents; animal, vegetable, or mineral oils, fats, greases, or waxes; enzymes of sewer bacteria and fungi; or water solutions of any of the following chemicals at 85 degrees F:

Chemical	Concentration (percent)
Sodium Hypochlorite	1
Ferric Chloride	1
Sulphuric Acid	20
Nitric Acid	1
Sodium Hydroxide	5
Ammonia	5

122.3.1.6 All plastic liner plate sheets; joint, corner, and welding strips; and accessories shall have the following physical properties when tested at 70 degrees F:

Tensile strength, minimum --- 2000 psi
Elongation at break, Minimum --- 200 percent

Shore Durometer (Type D) Readings:

Instantaneous
50 minimum
60 maximum

10 Seconds
35 minimum
50 maximum

122.3.1.7 Liner plate locking extensions embedded in concrete shall withstand a test pull of at least 100 pounds per linear inch, applied perpendicular to the concrete surface for a period of one minute, without rupture of the locking extensions or withdrawal from embedment. This test shall be made at a temperature between 70 degrees F to 80 degrees F inclusive.

122.3.1.8 All plastic liner plate sheets, including locking extensions, and joint, corner, and welding strips shall be free of cracks, cleavages, or other defects adversely affecting corrosion resistance or required strength. The ENGINEER may authorize the repair of defects by approved methods.

122.3.1.9 Specimens taken at any time prior to final acceptance of the work from sheets and strips, when tested in accordance with tests specified herein-before, shall show no greater reduction in quality or change in dimensions than

the reduction in quality and change in dimensions shown by the original approved samples when tested.

122.4 DETAILS AND DIMENSIONS

122.4.1 APPROVAL OF DETAILS: The CONTRACTOR shall submit for approval by the ENGINEER 30 days prior to any manufacturing of material, drawings showing details of liner plate, joint, corner, and other accessory plastic strips and devices. Such details shall conform to the requirements of these specifications and applicable provisions of the standard plans showing liner plate installation methods.

122.4.2 THICKNESS OF MATERIAL: Liner plate which is to be locked in concrete by means of integral extensions embedded in the concrete shall have a minimum thickness of 0.065 inch. Liner plate which is to be bonded to concrete or steel surfaces by means of adhesive shall have a minimum thickness of 0.075 inch. Welding strips shall have a minimum thickness of 0.125 inch plus or minus 0.031 inch.

122.4.3 SHEET AND STRIP SIZE: Sheets of liner plate used for pipe and cast-inplace sewers shall not exceed 16 feet 4 inches in length measured along the conduit. Sheets of liner plate for all other construction shall not exceed 16 feet by 16 feet. Said permitted maximum size shall be reduced where necessary to produce satisfactory results. Large sheets shall be formed by lapping basic size sheets a minimum of 1 inch in fusing the sheets together in such a manner as to produce a continuous welded joint. Specimens taken from welded joints shall show no cracks or separation and shall be tested in tension after flexing. Each specimen shall withstand a minimum load of 132 pounds per linear inch of weld or the product of 1800 and the minimum thickness in inches of the material adjoining the weld, whichever is greater. The thickness shall be taken within a 1 inch gauge length. The composition, corrosion resistance, and impermeability of specimens taken from the welded joints shall comply with the requirements of Subsection 122.3 above. Evidence of tears, cracks, or separation in the laps will be cause for rejection. Joint strips shall be four inches plus or minus 1/4 inch in width. Welding strips shall be one inch plus or minus 1/8 inch in width. Joint strips shall have each edge beveled prior to application. All welding and outside corner strips shall have edges beveled at time of manufacture. Sloping of the longitudinal terminal edges of liner plate at designated variations in circumferential coverage shall be as specified under Subsection 122.8 herein.

122.4.4 LOCKING EXTENSIONS: All liner plate applied to concrete shall have integral locking extensions embedded in the concrete, except that liner plate may be bonded to concrete surfaces with an adhesive if such is specifically shown on the plans, set forth in the Supplementary Specifications, or permitted by the ENGINEER. Locking extensions shall be of the same material as that of the liner plate, shall be integrally molded to or extruded with the sheets of liner plate, shall have an approved cross section with a minimum height of 3/8 inch and a minimum web thickness of 0.090 inch, shall be approximately 2 1/2 inches apart, and shall be such that when the extensions are embedded in concrete the liner plate will be held permanently in place. Locking extensions shall be parallel and shall be continuous except where omitted for joints and transverse weep channels. Weep channels which involve the omission of one inch of locking extensions as described in Subsection 122.8 herein may be made during the manufacture of liner plate. A locking extension shall be provided along all lower, terminal oblique, or longitudinal edges of liner plate.

122.4.5 PROVISIONS FOR STRAP CHANNELS: Unless alternate methods are approved by the ENGINEER, liner required to be secured to the inner form with straps shall have strap channels at not more than 20 inches on center perpendicular to the locking extensions. The channels, one-inch wide maximum, shall be formed by removing the locking extensions at strap locations so that a maximum of 3/16 inch of the base remains in the strap channel. Strap channels shall not be provided in the final two locking extensions adjacent to the terminal edge of the liner coverage.

122.5 TESTS

All liner plate shall be shop tested for holes, using an approved spark detector with a minimum of 20,000 volts. Sheets having holes shall be satisfactorily repaired in the shop and retested prior to shipping the sheets to the job site or the pipe manufacturing plant. Shop welds shall be subjected to testing for composition of the material after the weld has been made and for corrosion resistance, impermeability, and strength. Samples of liner plate shall be taken at the point of manufacture each week during production of sheet and strip material. These samples will be submitted to the ENGINEER for testing as provided in these specifications.

122.6 ADHESIVE

Adhesives used on liner plate shall be limited to those products made by the liner plate manufacturer specifically for use with the liner plate. Adhesives, solvents, and activators proposed for use shall be submitted to the ENGINEER for testing prior to use.

122.7 INSTALLATION OF PLASTIC LINER PLATE--GENERAL

112.7.1 INSPECTION: Wherever possible, liner plate shall be applied and secured to the forms and inspected and approved prior to the placement of reinforcing steel.

122.7.2 QUALIFICATIONS OF INSTALLERS:

122.7.2.1 APPLICATORS: The application of plastic liner plate to forms and other surfaces shall be considered as highly specialized work, and personnel performing this type of work shall be trained in methods of installation and demonstrate their ability to the ENGINEER.

122.7.2.2 WELDERS: Each welder shall successfully pass a welding test before making any field weld and may be retested at any time deemed necessary by the ENGINEER. All test welds shall be made in the presence of the ENGINEER and shall consist of the following: Two pieces of liner plate, at least 15 inches long and 9 inches wide, shall be lapped 1 1/2 inches and held in a vertical position. A welding strip shall be positioned over the edge of the lap and welded to both pieces of liner plate. Each end of the welding strip shall extend at least two inches beyond the liner plate to provide tabs. The weld specimen shall be submitted to the ENGINEER and tested as follows: Each welding strip tab, tested separately, shall be subjected to a 10 pound pull normal to the face of the liner plate with the liner plate being held firmly in place. There shall be no separation between the welding strip and the liner plate when the welding tabs are submitted to the test pulls. Three test specimens shall be cut from the welded sample tested in tension across the welds. If none of these specimens fail in the weld or within 1/2 inch adjacent to either edge of the weld when the specimens are individually subjected to a pull of 132 pounds per linear inch of weld or the product of 1800 and the minimum thickness in inches of the material adjoining the weld, whichever is greater, the weld will be considered as satisfactory in tension. The thickness used will be the minimum measured within a 1 inch gauge length. If one of the specimens fails to pass the tension test, a retest will be permitted. The retest shall consist of testing three additional specimens cut from the original welded sample. If all three of the retest specimens pass the test, the weld will be considered satisfactory. A disqualified welder may submit a new welding sample when, in the opinion of the inspector, he has had sufficient off-the-job training or experience to warrant re-examination.

122.8 PLACING LINER PLATE

122.8.1 COVERAGE: Liner plate shall cover, as a minimum, the areas shown on the plans to be lined. The variation in circumferential coverage at each longitudinal terminal edge of adjoining sheets of liner plate shall not exceed one inch or one percent of the inside diameter of pipe, whichever is greater. In the case of cast-in-place

conduits, the inside height of the conduit shall be used in lieu of pipe diameter in determining allowable variation in circumferential coverage. At a station where there is a difference in coverage, as shown on the plans, and the longitudinal terminal edges of liner plate downstream from said station are lower than those upstream, the terminal edges of the liner plate installed in the section of pipe or structure immediately upstream from the station shall be sloped uniformly for the entire length of the section of pipe or structure from the limits of the smaller coverage to those of the greater coverage. Wherever the longitudinal terminal edges of liner plate downstream from the station are higher than those upstream, the slope shall be accomplished uniformly throughout the length of the section of pipe or structure immediately downstream from the station. An approved locking extension shall be provided along all tapered lower terminal edges of liner plate.

122.8.2 POSITIONING LINER PLATE: All liner plate installed in pipe shall be positioned so that the locking extensions are parallel with the axis of the pipe. Liner plate shall be centered with respect to the "T" of the pipe when the inner form is positioned. Liner plate shall be set flush with the inner edge of the bell end of the pipe section and shall extend to the spigot end or to approximately four inches beyond the spigot end, depending upon the type of liner plate joint to be made with adjoining pipe. All liner plate installed in a cast-in-place sewer shall be positioned so that the locking extensions are parallel to the axis of the sewer, and all liner plate installed in other sewer structures shall be positioned with locking extensions horizontal unless otherwise indicated on the plans or in the Supplementary Specifications. Liner plate sheets shall be closely fitted to inner forms. Sheets shall be cut to fit curbed and warped surfaces using a minimum number of separate pieces. The CONTRACTOR shall furnish field sketches to the ENGINEER showing the proposed layout of liner plate sheets for cast-in-place sewerage structures. The sketches shall show the location and type of all field welds. The ENGINEER may require the use of patterns or the markings of sheet layout directly on the forms where complicated or warped surfaces are involved. At transverse joints between regular size sheets of liner plate, the space between ends of locking extensions, measured longitudinally, shall not exceed four inches. Where sheets are cut and joined for the purpose of fitting irregular surfaces, this space shall not exceed two inches.

122.8.3 SECURING LINER PLATE IN PLACE: Liner plate shall be held snugly in place against inner forms by means of light gauge steel wire, light steel banding straps, or other approved means. Banding straps or wire shall be located in strap channels to prevent crushing or tilting the extensions. Means approved by the ENGINEER shall be provided, if necessary, to prevent crushing or tilting locking extensions on extruded sheets. Where the form ties or form stabilizing rods pass through liner plate, provisions shall be made to maintain the liner plate in close contact with the forms during concrete placement.

122.8.4 WEEP CHANNELS: At 8-foot intervals longitudinally along liner plate installed in sewers, a gap not less than one inch nor more than four inches wide shall be left in all locking extensions to provide an unobstructed transverse weep channel. Any area behind liner plate which is not properly served by regular weep channels shall have additional weep channels one inch wide provided by cutting away locking extensions. Provisions shall be made to permit water behind the liner of concrete manhole shafts to drain into the weep channels of the lined sewer. A transverse weep channel shall be provided approximately twelve inches away from each liner plate return where surfaces lined with plastic liner plate join surfaces which are not so lined. As a part of the work of installing liner plate, all outlets of transverse weep channels shall be cleared of obstructions which would interfere with their proper function.

122.8.5 LINER PLATE RETURNS: A liner plate return shall be installed wherever required as shown on the plans and wherever surfaces lined with plastic liner plate join surfaces which are not so lined, such as brick, clay pipe, cast-iron pipe, manhole frames, and metal, or clay tile gate guides. Unless otherwise indicated by the plans, the Supplementary Specifications, or the plans showing liner plate installation methods, returns shall be made as follows: Each liner plate return shall be a separate strip of liner plate at least four inches wide joined to the main liner plate by means of approved corner strips. Corner strips shall be continuously welded to the return and to the main liner plate and applied wherever possible from the back of the lining. Locking extensions shall be provided on returns to lock the returns to

the concrete or plastic lined, cast-in-place structures. Locking extensions will not be required on liner plate returns installed on lined precast concrete pipe. Each liner plate return shall be sealed to adjacent construction with which it is in contact by means of a chemically resistant elastomeric material recommended by the manufacturer of the liner plate. If the joint space is too wide or the joint surfaces too rough to allow satisfactory sealing with this material, the joint space shall be filled with two inches of densely caulked cement mortar, lead wool, or other caulking material approved by the ENGINEER and finished with a minimum of one inch of an approved corrosion resistant material.

122.8.6 CORNERS: Liner plate corners shall be installed as detailed on the plans. If not so detailed and if the corner is a straight line, liner plate may be bent around the corner provided that the liner plate can be bent and secured in the forms in such a manner as to produce a satisfactory corner in the opinion of the ENGINEER. The radius of such a bend in liner plate shall not exceed one inch. Bending of liner plate to form a liner plate return will not be permitted. A separate liner plate return shall be installed at said locations in accordance with requirements specified in Subsection 122.8.5.

122.9 CONCRETE OPERATIONS

122.9.1 CONCRETE PLACEMENT: Concrete placed against liner plate shall be carefully vibrated so as to avoid damage to the liner plate and to produce a dense, homogeneous concrete securely anchoring the locking extensions into the concrete. External vibrators shall be used if deemed necessary by the ENGINEER. If steel stiffener rods are used along locking extensions of liner plate installed in forms for pipe, they shall be completely withdrawn during the placement of concrete in the forms. The concrete shall be revibrated to consolidate the concrete in the void spaces caused by the withdrawal of the stiffener rods.

122.9.2 REMOVING FORMS: In removing forms, care shall be taken to protect liner plate from damage. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the liner plate shall be pulled without tearing the liner plate and the resulting holes clearly marked. Form tie holes shall be marked before ties are broken off and all areas of serious abrasion of the liner plate shall be marked.

122.10 JOINING LINER PLATE

122.10.1 GENERAL: No field joint shall be made in liner plate until the lined sewer or structure has been backfilled and flooding required therefor has been completed. Liner plate at joints shall be free of all mortar and other foreign material and shall be clean and dry before joints are made. Hot joint compounds shall not be brought in contact with liner plate. No coating of any kind shall be applied over any joint, corner, or welding strip, except where nonskid coating is applied to liner plate surfaces.

122.10.2 FIELD JOINT IN PIPE INSTALLATION: Field joints in liner plate at pipe joints shall be one of the following types: Type P-1--A Type P-1 joint shall consist of a four-inch joint strip, centered over the mortared pipe joint and secured along each edge to adjacent liner by means of a welding strip. Type P-2--A Type P-2 joint shall be made with an integral part of the liner plate extending four inches beyond the spigot end of the pipe, overlapping the liner plate downstream from the pipe joint and secured to the downstream liner by means of a welding strip. The four-inch strip of liner plate extending beyond the spigot end of the pipe shall be devoid of locking extensions and shall be protected from damage during pipe handling and jointing operations. Excessive tension and distortion in the strip caused by bending it back sharply at the end of the pipe will not be permitted. Any four-inch integral joint strip which has been bent and held back during pipe laying and jointing operations shall be released well in advance of making the liner plate joint to allow the strip to return to its original shape and flatness. On beveled pipe, the liner plate extension at the spigot end of the pipe shall be trimmed to extend four inches beyond and parallel to the beveled end. Joints between lined pipe and lined cast-in-place structures shall be either Type C-1 or Type C-2 specified hereinafter.

122.10.3 FIELD JOINTS IN CAST-IN-PLACE STRUCTURES: Field joints in liner plate on cast-in-place structures shall be one of the following types: Type C-1--A Type C-1 joint shall be made in the same manner as a Type P-1 joint. The width of the space between adjacent sheets of liner plate in a Type C-1 joint shall not

exceed 1/2 inch. This type of joint is the only type permitted as transverse contraction joints in concrete. Its only other use is for joints between pipe and cast-in-place structures. Type C-2--A Type C-2 joint shall be made by over- lapping sheets not less than 1 1/2 inches and securing the overlap to the adjacent liner plate by means of a welding strip. The upstream sheet shall overlap the downstream sheet. The length of that part of the overlapping sheet not having locking extensions shall not exceed four inches. A welding strip shall be applied to the back of the joint if necessary to prevent leakage of concrete. This type of joint may be used at any transverse liner plate joint other than those at transverse contraction joints in concrete and shall be used for liner plate joints made at longitudinal joints in concrete. Type C-3--A Type C-3 joint shall be made by butting sheets of liner plate together and applying a welding strip over the back of the joint before concrete is poured and applying a welding strip over the front of the joint after concrete is poured. A Type C-3 joint will not be permitted at a transverse joint which extends to a lower terminal edge of liner plate or any joint where the gap between adjoining sheets of liner plate exceeds 1/8 inch.

122.10.4 INSTALLATION OF WELDING STRIPS: Welding strips shall be fusion welded to joint strips and liner plate by qualified welders using only approved methods and techniques. The welding operation of any joint shall be continuous until that joint has been completed.

122.11 APPLICATION OF LINER PLATE TO CONCRETE SURFACES BY MEANS OF ADHESIVE

122.11.1 Application and bonding of liner plate to concrete surfaces by means of adhesive shall be accomplished by the following steps: The concrete surface shall be etched in lieu of being sandblasted. After the sand blasting, the concrete surface shall be thoroughly cleaned of dust. Surfaces etched with acid shall be thoroughly washed with clear water after the etching and thoroughly dried before applying primer. Grouting Procedure--All concrete imperfections such as water and air pockets in poured concrete surfaces must be filled with cement grout. The concrete surface shall then receive two brush coats of an approved primer. Coverage shall not exceed 250 square feet per gallon for each coat. The first coat of primer shall be thinned with an equal amount of approved thinner. The first primer coat shall be permitted to dry for at least two hours before the application of the second primer coat. The second coat of primer shall be applied unthinned and permitted to dry for at least four hours. Brush apply one coat of manufacturer's recommended 19Y primer (at approximately 250 square feet/ gallon). The concrete surface and the back surface of the liner plate shall each be given one coat of an approved adhesive. Coverage shall not exceed 250 square feet per gallon for each coat.

122.11.2 One coat of an approved activator shall be applied to both the underside of liner plate and the adhesive coated concrete. Application of activator shall be limited to the extent that the application of coated liner plate can be completed within a 20-minute period. The activator shall be applied evenly by brushing. Coverage of activator shall not exceed 500 square feet per gallon. When the surface of the adhesive is barely tacky to the touch, the liner plate shall be positioned with one edge firmly pressed down. The liner plate shall then be rolled into place, care being taken to avoid the formation of air pockets. All joints shall be tight-fitting butt joints. The surface of the liner plate shall be rubbed vigorously to secure the liner plate firmly in place. Corner and welding strips shall be positioned over all joints and welded in place. No adhesive shall be applied to liner plate or to any of the liner plate strips which will deleteriously affect the plate or strips in any way. Adhesive shall not be applied to the surfaces of concrete at liner plate joints or to the surfaces of liner plate or joint strips opposite said mortar and concrete surfaces.

122.12 NONSKID SURFACES

All surfaces of liner plate shown on the plans to be nonskid shall be treated as follows: After all corner and welding strips have been installed, the surface of the liner plate shall be cleaned, dried, and sprayed with an adhesive coating recommended by the manufacturer of the liner plate. The surface shall then be liberally sprinkled with clean, dry, well-graded sand, all of which will pass a No. 40 sieve but be retained on a No. 70 sieve. After the sanded surface has thoroughly dried, all excess sand shall be brushed away and a seal coat of the coating shall be sprayed over the sand in sufficient quantity to coat and bond the sand to the liner plate. The coat sand surface shall

be allowed to dry thoroughly before any walking is permitted thereon.

122.13 APPLICATION OF LINER PLATE TO STEEL

Fabrication and welding of steel to be lined with plastic liner plate shall be completed before the liner is installed. Steel surfaces to which plastic liner is to be applied shall be sandblasted, leaving surfaces free of all mill scale, rust, grease, moisture, and other deleterious substances. All interior welds shall be ground smooth and all weld spatter removed. The application of primer unthinned, adhesive, and liner plate to steel surfaces shall conform to the requirements set forth herein for bonding of liner plate to concrete surfaces with adhesive. Field joints shall be tight-fitting butt joints. After the liner plate has been applied to steel surfaces, corner strips, or welding strips shall be applied over all joints and welded in place.

122.14 PROTECTION AND REPAIR OF LINER PLATE

All necessary measures and precautions shall be taken to prevent damage to liner plate from equipment and materials used in or taken through the work. Any damage to installed liner plate shall be repaired by the CONTRACTOR in accordance with the requirements set forth herein for the repair of liner plate. All nail and tie holes and all cut, torn, and seriously abraded areas in the linerplate shall be patched. Patches made entirely with welding strip shall be fused to the liner plate over the entire patch. The use of this method is limited to patches which can be made with a single welding strip. The use of parallel, overlapping, or adjoining welding strips will not be permitted. Larger patches may consist of smooth liner plate over the damaged area with edges covered with welding strips fused to the patch and to the liner plate adjoining the damaged area. The size of a single patch of the latter type shall be limited only as to its width, which shall not exceed four inches. Wherever liner plate is not properly anchored to concrete or wherever patches larger than those permitted above are necessary, the repair of liner plate and the restoration of anchorage shall be as directed by the ENGINEER.

122.15 FIELD TEST

All liner plate, when installed, will be tested by the CONTRACTOR in the presence of the ENGINEER, using a spark type detector set at a minimum of 20,000 volts. All areas of liner plate failing to meet the field test shall be properly repaired and retested.

122.16 MEASUREMENT AND PAYMENT

Measurement for furnishing and installing plastic liner plate shall be included in the payment for the pipe or structure required to be lined, unless a different measurement is stipulated in the Bid Proposal.

SECTION 123

REINFORCED CONCRETE PIPE

123.1 GENERAL

123.1.1 These specifications cover reinforced concrete pipe intended to be used for the construction of storm drains, sewers, and related structures.

123.1.2 The size and class of the concrete pipe to be furnished shall be as shown on the plans or as specified under the item of work for the project of which the pipe is a part. Minimum class of concrete pipe shall be class 3.

123.1.3 Unless otherwise specified, pipe shall be either cast, spun, or manufactured by an approved equal method.

123.1.4 The interior surface shall be smooth and well finished. Joints shall be of such type and design and so constructed as to be adequate for the purpose intended so that, when laid, the pipe will form a continuous conduit with smooth and uniform interior surface.

123.1.5 Bell and spigot shall be free from any deleterious substance or condition which might prevent a satisfactory seal at the joints.

123.1.6 Pipe stronger than that specified may be furnished at the manufacturer's option and at his own expense, provided such pipe conforms in all other respects to the applicable provisions of these specifications.

123.1.7 Reinforced concrete pipe utilized for sanitary sewers shall be fully lined with no longitudinal seams in accordance with Section 122.

123.2 REFERENCES

123.2.1 ASTM:

C-33	C-76
C-150	C-260
C-361	C-441
C-443	C-494
C-618	

123.2.2 American Concrete Pipe Association (ACPA)

Concrete Pipe Design Manual

123.2.3 This Publication

Section 102
Section 122

123.3 PIPE LINE LAYOUTS

123.3.1 When specials and radius pipe and/or fittings are required, the required number of sets of the pipe line layout be furnished to the ENGINEER prior to the manufacture of the concrete pipe. Storm inlet or inlet connector pipe need not be included in the pipe line layout; however, pipe stubs shall be included. In lieu of including storm inlet connector pipe line layout, a list of storm inlet connector pipes shall accompany the layout. The connector pipe list shall contain the following information:

123.3.1.1 Size, class. and wall type.

123.3.1.2 Station at which pipe joins main line.

123.3.1.3 Number of sections of pipe, length or section, type of sections (straight. horizontal bevel, vertical bevel, etc.).

123.4 MATERIALS

123.4.1 Reinforced Concrete Pipe shall consist of a mixture of Portland cement, aggregates, water and admixtures, proportioned and manufactured accordance with the requirements of ASTM C76, latest edition, and this specification. The pipe shall be certified in accordance with the requirements of Section 13 of these specifications. Certification of compliance shall be submitted by the CONTRACTOR and approved by the ENGINEER prior to manufacture of the Reinforced Concrete Pipe, Reinforced Concrete Pipe shall not be used on a project without written approval of the ENGINEER.

123.4.2 Portland cement shall comply either with the requirements of ASTM C 150. Types I, II, III, and V, Low Alkali (LA) cements, or as specified herein. in the Supplementary Technical Specifications, plans, or as approved by the ENGINEER. The CONTRACTOR shall submit

certification of compliance signed by the cement manufacturer, identifying the cement type and source (plant location), stating the portland cement used in the Reinforced Concrete Pipe delivered to the project complies with this specification. Portland cement concrete used in the manufacture of Reinforced Concrete Pipe shall have a minimum cementitious content of 470 lbs./cu.yd., except as either specified herein, as specified in the Supplemental Technical Specifications, or as approved by the ENGINEER. Portland cement shall be of the same source and type for all Reinforced Concrete Pipe delivered to a project.

123.4.2.1 Portland cement concrete for Reinforced Concrete Pipe shall be proportioned to provide a minimum cementitious content of 470 lbs./cu.yd. and a maximum water (W) to cementitious material ratio by weight, W:(C+TA)=0.40. Cementitious material shall consist of portland cement and class F fly ash complying with this specification. The fly ash shall be proportioned to provide a fly ash (FA) to portland cement (C) ratio by weight,

FA:C+l :r.

123.4.3 Mineral admixtures shall be "Class F fly ash" and comply with the requirements of ASTM C 618 including Table 4 "Supplementary Optional Physical Requirements."

A. Uniformity requirements, air entraining agent dosage for 18.0% vol of mortar, shall not vary by more than 20%.

B. Reactivity with cement alkalies: Reduction of mortar bar expansion at 14 days, minimum (ASTM C441) 65%.

Reactivity with cement alkalis shall be determined in accordance with the requirements of ASTM C44l, using DOW CORNING glass rod base for aggregates. The CONTRACTOR shall submit certification of compliance identifying the type fly ash and source (plant location), stating the fly ash used in the Reinforced Concrete Pipe delivered to the project complies with this specification. Fly ash shall be of the same source and type for all Reinforced Concrete Pipe delivered to the project.

123.4.4 Admixtures of any type, shall not be used without written approval of the ENGINEER. The CONTRACTOR shall submit certification of compliance signed by the admixture manufacturer, identifying the admixture and its source (plant location), stating the admixture(s) used complies with this specification. Admixtures shall be of the same source for all reinforced concrete pipe delivered to a project.

123.4.4.1 Air entraining admixtures shall be used in all Reinforced Concrete Pipe provided under this specification. It shall conform to the requirements of ASTM C 260. Entrained air content shall comply with the following requirements:

Nominal Max Size Aggregate (inches)	Air Cont. Range (%)
3/8, ½ & ¾	4 - 8
1	4 - 7
1-1/2	3 - 6

or as required by the Supplementary Technical Specifications, on the plans and/or as approved by the ENGINEER.

123.4.4.2 Chemical admixtures shall conform to either the requirements of ASTM C 494, and/or as specified in the Supplementary Technical Specifications, on the plans, and/or as approved by the ENGINEER.

123.4.4.3 Neither calcium chloride nor non-calcium chloride accelerating admixtures shall be used in Reinforced Concrete Pipe provided to a project under this specification.

123.4.4 Aggregates shall be assumed to be alkali-reactive. Variance for a specific aggregate may be approved by the Engineer upon written request by the CONTRACTOR and submittal of test data, as required by the ENGINEER. Aggregates shall comply with the requirements of ASTM C 33 and ASTM C 76 and as specified herein. Aggregates shall be of the same source and type for all Reinforced Concrete Pipe manufactured and delivered to the project.

123.4.5 Reinforcement shall comply with the requirements of this specification and Section 102. The CONTRACTOR shall submit certification of compliance signed by the reinforcement manufacturer, identifying the material and its source (plant location), stating the reinforcement complies with this specification. Reinforcement shall be of the same

source for all Reinforced Concrete Pipe delivered to the project.

123.5 CAUSES FOR REJECTION

Such inspection of pipe as may be deemed necessary by the ENGINEER will be made at the place of manufacture and pipe may be rejected for any of the reasons described in ASTM C 76, unless it can be repaired in accordance with the requirements noted therein and the approval of the ENGINEER.

123.6 ACCEPTANCE

Basis of acceptance shall be in compliance with ASTM C 76.

123.6.1 D-LOAD BEARING STRENGTH METHOD

123.6.1.1 The ENGINEER will select at random at the point of manufacture test specimens of the pipe to be furnished for the project.

123.6.1.2 The required number of test specimens and the test pipe shall conform in all respects to the applicable requirements of ASTM C 76. The pipe shall be tested by one of the two standard methods of testing; namely, (A) the three-edge bearing, (B) the sand bearing, as prescribed in ASTM C 76, and the required strength of the pipe specimens undergoing the bearing tests shall conform with the D-Load requirements designated therein.

123.6.2 STRUCTURAL DESIGN METHOD:

Where structural details of the pipe are shown on the plans, the manufacture of pipe shall be checked by making the appropriate tests on the concrete placed in the pipe forms, by inspection of the steel reinforcing cages that are to be used in the pipe, and by inspection of the fabrication of the pipe.

123.6.3 "DOWNGRADING" OF PIPE:

123.6.3.1 For the purpose of these specifications, "downgraded" pipe shall be defined as pipe which is to be used under loads less than that for which they have been designed.

123.6.3.2 Pipe manufactured in accordance with these specifications which have not met their designed test loads may be "downgraded" by the ENGINEER and used provided that:

123.6.3.2.1 Enough load tests are made to establish the load under which they may be used. The number of tests to be made shall be as determined by the ENGINEER; this may require the testing of each section for acceptance.

123.6.3.2.2 They comply with the test and inspection requirements of these specifications.

123.6.3.3 Individual specimens of pipe embodying major repairs or having numerous hairline cracks extending the full length of the section on the inside of the pipe at the minor axis or on the outside of the pipe at the major axis may be tested for acceptance at the discretion of the ENGINEER.

123.6.4 STOCKPILED PIPE:

123.6.4.1 Stockpiled pipe may be used only when approved by the ENGINEER provided the pipe meets all other specified requirements.

123.6.4.2 For the purpose of these specifications, "stockpiled" pipe shall be defined as pipe manufactured in quantity which will meet requirements of this section but which was not manufactured for use in specific projects; however, pipe which has been rejected by another agency will not be considered as "stockpiled" pipe, nor will such pipe be accepted.

123.7 JOINTS

123.7.1 Rubber gasket joints shall be required. Such joints shall conform to the requirements of ASTM C 443 and the requirements set forth in this document. The joint shall be designed for not less than 15%, or more than 50% deformation of the rubber gasket when the pipe is joined off-center with all manufacturing tolerances considered. Minimum manufacturing tolerances shall be assumed to result in a centered annular space of 1.75 times the nominal design annular space. Joint mating surfaces shall be parallel and not be greater than 3.5° slopes. In addition to the hydrostatic joint test requirements per ASTM C 443, the pipe shall be loaded to cause maximum joint annular space to occur at the top. The pipe shall then be subjected to an internal hydrostatic pressure of 13 psi for 10 minutes. The test set up shall include a minimum of (2} pipe sections per lot. Bulkheaded end joints are acceptable, only mating pipe joints are allowed. Moisture or beads of water appearing on the surface of the joint will not be considered as leakage. If leakage of joints should initially

occur, the manufacturer shall have the option to allow the pipe to soak under pressure for up to 24 hours and then retest. Any leakage during such retest will constitute failure of the test.

Pipe with beveled ends or pipe joints specifically designed to allow unsymmetrical joint closure may be provided for use around curves, the radii of which are shown on the drawings. Unless otherwise shown on the plans or specified in the Supplementary Specifications, either one or both ends may be beveled up to a maximum of 5 degrees, as required to provide well fitted joints. Beveled ends may conform to the Typical Method of Designing Curved Concrete Pipe sewers, as shown in the ACPA Concrete Handbook. Deflections per joint shall be limited to the manufacturer's standards for each particular diameter and type of pipe used.

123.7.2 Cement mortar joint fillers will not be accepted for round, elliptical, or arch reinforced concrete pipe.

123.7.3 If required by the ENGINEER to meet specified laying tolerances, the pipe shall be "match marked" at the place of manufacture, and laying diagrams furnished to the CONTRACTOR by the manufacturer shall be subject to approval by the ENGINEER.

123.8 DIMENSIONS

123.8.1 LENGTH

123.8.1.1 The nominal length shall be as supplied by the manufacturer unless otherwise specified in the Supplementary Technical Specifications on the plans or required for bends or special joints.

123.8.1.2 Except for special shapes, the plane of the ends of the pipe shall be perpendicular to the longitudinal axis of the pipe, with the exception that variations in laying lengths of two opposite sides of pipe shall be not more than 1/8 inch per foot of diameter with a maximum of 5/8 inch in any length of pipe.

123.8.2 WALL THICKNESS

The wall thickness of pipe shall conform to the requirements indicated for Wall B or Wall C, reinforced concrete pipe specified in ASTM C 76 unless otherwise specified.

123.9 REINFORCEMENT

Fabrication and placement of reinforcement for the various sizes and strengths of pipe shall conform to the applicable requirements of ASTM C 76.

123.10 CURING REQUIREMENTS

The pipe shall be cured in conformance with the applicable requirements of ASTM C 76.

123.11 MARKINGS:

123.11.1 Each section of pipe shall be marked in conformance with the requirements of ASTM C 76. The ENGINEER may at the place of manufacture, indicate his acceptance of the pipe for delivery to the job by marking the pipe with the Contracting Agency's mark. Such acceptance, however, shall not be considered a final acceptance.

123.11.2. If the pipe is subsequently rejected, the mark placed thereon by the ENGINEER shall be defaced. No pipe will be marked, "Reject." Only pipe accepted shall be marked, "Accepted ."

123.12 LOW-HEAD PRESSURE PIPE

Reinforced concrete low-head pressure pipe shall conform to the requirements of ASTM C 361.

123.13 SELECTION FOR CLASS OF PIPE

123.13.1 The classes of reinforced concrete pipe and the D-Load to produce a 0.0l-in. crack for each class of pipe are specified in ASTM C 76.

123.13.2 The appropriate formulas, tables and figures contained in the "Concrete Pipe Design Manual," prepared by the American Concrete Pipe Association, will be used, to determine the class of pipe to be installed between manholes or for a culvert. It is essential that maximum trench width, class of bedding and soil weight be considered in the pipe class selection with the exception that the minimum pipe class shall class 3.

123.13.3 The construction plans will indicate the following information for each length of pipe between manholes or for a culvert: the nominal diameter of the pipe, the class of pipe, the class of bedding and the maximum trench width at top of pipe.

123.14 MEASUREMENT AND PAYMENT

123.14.1 The measurement and payment for the materials specified in this section will be made as specified in the applicable section of these specifications or as specified in the supplemental technical specifications or as called for in the plans and as shown in the Bid Proposal.

SECTION 124

REINFORCED CONCRETE PRESSURE PIPE

124.1 GENERAL

These specifications cover three types of reinforced concrete pressure pipe, two of which are not prestressed and one prestressed, with internal diameters of 12 inches and larger and for pressures specified on the plans, to be used in the transmission and distribution systems that carry water under pressure.

124.2 REFERENCES:

124.2.1 ASTM

C 361

124.2.2 AWWA

C 300
C 301
C 302

124.3 MANUFACTURE AND TESTS

Reinforced concrete pressure pipe and fittings shall be manufactured and tested to conform to one of the following specification requirements:

124.3.1 AWWA C 300 for the steel bar reinforcement and cylinder type in pipe diameters of 24 inches and larger, for design pressures no greater than 40 psi, and for external loading conditions as may be designated on the plans or in the Supplementary Specifications.

124.3.2 AWWA C 301 for the prestressed steel wire reinforcement and cylinder type, in pipe diameters of 30 inches and larger, for design pressures to a maximum of 350 psi, and for external loading conditions as may be designated on the plans or in the Supplementary Specifications.

124.3.3 AWWA C 302 for the steel bar reinforcement (without cylinder) type, in pipe diameters 12 inches and larger, for design pressures of not more than 45 psi, and for external loading conditions as may be designated on the plans or in the Supplementary Specifications.

124.4 MEASUREMENT AND PAYMENT

124.4.1 When required as a separate material item, the measurement shall be by the linear foot and payment will be made at the unit price per linear foot per diameter of pipe, as specified in the Bid Proposal.

124.4.2 Reinforced concrete pressure pipe, when used in conjunction with a project, the measurement and payment will be as defined in Section 901 or 910.

SECTION 127

STEEL WATER PIPE

127.1 GENERAL

This specification covers steel pipe and the interior and exterior protective coating for use only in connections to or repair of water supply and distribution systems carrying water under pressure.

127.2 REFERENCES

127.2.1 ASTM

A 53

127.2.2 AWWA

C 200
C 201
C 203
C 204
C 207
C 208
M 11

127.2.3 ANSI

B 16.5

127.2.4 Asphalt Institute

Construction Series No. 96, Specifications M-2

127.3 PIPE

127.3.1 Pipe 6 inches and larger in diameter of either the fabricated or mill type shall be manufactured in accordance with AWWA C 200. Specific pipe type (fabricated or mill) shall be as specified in the Supplementary Specifications.

127.3.2 Wall thickness for steel pipe 6 inches and larger shall be based on the computation techniques contained in AWWA M-11, Steel Pipe Design Manual, computations shall take into consideration internal pressure, external pressure and any special physical loading.

127.3.3 Pipe in sizes less than 6 inches in diameter shall be in accordance with ASTM A 53, standard weight (Schedule 40).

127.3.4 Working pressure of 150 psi shall be used for pipe design.

127.4 FITTINGS

Fittings for pipe 4 inches and larger in diameter shall be fabricated of the same kind of steel and same wall thickness as the pipe to which they are to be connected. Dimensions shall be as shown in AWWA C 208.

127.5 FLANGES

Flanges shall be slip-on type conforming to AWWA C 207 drilled as specified in ANSI B 16.5.

127.6 JOINTS

127.6.1 Steel pipe shall be prepared for one of the following types of joints as noted on the plans or specified in the Supplementary Specifications:

127.6.1.1 Bell-and-spigot ends prepared for O-ring rubber gaskets.

127.6.1.2 Lap joints for field welding.

127.6.1.3 Beveled ends for field butt welding.

127.6.1.4 Plain ends fitted with butt straps for field welding.

127.6.1.5 Ends prepared for mechanical coupled field joints.

127.6.1.6 Plain ends fitted with flanges.

127.6.2 Unless otherwise shown on the plans or specified in the Supplementary Specifications, the pipe joints shall comply with AWWA Standards. Joints tolerances shall not exceed those specified in AWWA C 201.

127.7 COATINGS

Exterior of steel pipe and fittings shall be coated with coal-tar enamel. Coating shall be in accordance with AWWA C 203.

127.8 MEASUREMENT AND PAYMENT

Measurement shall be by the linear foot along center line of pipe through all fittings. Payment shall be made on the unit price per linear foot.

SECTION 128

CONCRETE CYLINDER PIPE

128.1 GENERAL

These specifications cover concrete cylinder pipe intended for use in water supply lines and distribution systems that carry water under pressure. Concrete cylinder pipe may be furnished in pipe diameters of 24 inches and larger for design pressure to a maximum of 400 psi. Unless otherwise shown on the drawings or specified in the Supplementary Specifications, concrete cylinder pipe shall be designed and manufactured for an internal working pressure of 150 psi with allowance for transient pressure in the amount of 50 percent of the indicated working pressure.

128.2 REFERENCES

128.2.1 American Water Works Association (Latest Edition) (AWWA)

C 207 Steel Pipe Flanges for Waterworks Service Sizes 4 in. through 144 in.

C 208 Dimensions for Fabricated Steel Water Pipe Fittings

C 303 Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, Pretensioned, for Water and Other Liquids

128.3 DESIGN

128.3.1 The calculation of the cross-sectional area of steel shall be based upon the design procedure stated in AWWA C 303, Appendix A. The design data used in the design of the pipe shall be as stated in the Supplemental Technical Specification or as shown on the plans. The design data shall include but not limited to normal operating pressure, surge pressure, external loading, bedding required, backfilling requirements, estimated weight of the soil to be used for backfilling, modulus of soil reaction, etc. Design calculations shall be submitted for approval prior to fabrication of pipe and fittings.

128.3.2 Use of welded wire fabric in the exterior coating shall conform to the manufacturer's standards; however, use of fabric shall not be included in the total steel area calculations.

128.4 MANUFACTURED PIPE AND FITTINGS

128.4.1 Pipe and fittings shall be manufactured in conformance with AWWA C 303 and shall be manufactured with minimum steel thickness as required in approved design calculations.

128.4.2 JOINTS:

128.4.2.1 Joints shall be flanged where shown on the drawings or as specified herein with steel flanges as specified herein. Unspecified joints shall be of the rubber gasket type using a bell and spigot design, and shall be in conformance with AWWA C 303.

128.4.2.2 Bells and spigots shall conform to the requirements of AWWA C 303 with the following additions: The spigot ring shall be similar and equal to Carnegie Shape M 3516. Bell and spigot rings shall be designed using their respective internal diameters, with resulting thickness extending a minimum of one inch beyond the limits in the area of the connection between the bell or spigot and the regular cylinder.

128.4.3 Flange connections shall be used at junctures to valves or as may be required on the construction plans. Flanges shall conform to AWWA C 207, Class D.

128.4.4 Specials and Fittings. The ends of pipe or fittings for side street stub-outs or at juncture of valves will be flanged, with flanges conforming to the requirements of AWWA Specifications C 207 designed for a minimum operating pressure of connections to 150 psi.

128.5 DESIGN OF FITTINGS:

The design of tees, wyes, elbows, and bends using crotch plates shall be manufactured in accordance with design criteria established by Ameron Pipe Company and the paper on " Design of Wye Branches for Steel Pipe" by Swanson, Chapton, Wilkenson, King, and Welson and published in June, 1955 issue of " Journal of the American Water Works Association."

128.6 MEASUREMENT AND PAYMENT

SECTION 128

CONCRETE CYLINDER PIPE

The measurement and payment will be as specified in Section 801.

SECTION 129

DUCTILE IRON PIPE

129.1 GENERAL

Ductile iron pipe is acceptable for use in the installation of water lines for sizes 4-inches to 64-inches. Ductile iron pipe shall only be used for sanitary sewers where specifically required by the plans or authorized by the ENGINEER. The size and thickness class for ductile iron pipe shall be as specified herein or on the plans.

129.2 REFERENCES

129.2.1 American Society for Testing and Materials (Latest Editions) (ASTM)

A 674 Practice for Polyethylene Encasement for Ductile Iron Pipe for Water and Other Liquids

A 746 Specifications for Ductile Iron Gravity Sewer Pipe

129.2.2 American Water Works Association (Latest Editions) (AWWA)

C 104 American National Standard for Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water

C 105 American National Standard for Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids

C 111 American National Standard for Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings

C 115 American National Standard for Flanged Ductile Iron Pipe with treaded Flanges

C 150 American National Standard for the Thickness Design for Ductile Iron Pipe

C 151 American National Standard for Ductile Iron Pipe, Centrifugally Cast, for Water or Other Liquids

C 600 Installation of Ductile Iron Water Mains and Their Appurtenances

129.2.3 This Publication

Section 130 Gray Iron and Ductile Iron Fittings

Section 801 Installation of Water Transmission, Collector and Distribution Lines

Section 900 Sanitary and Storm Sewer Facilities

129.3.1 The ENGINEER shall determine the required class of ductile iron pipe based on the laying conditions, depth of cover and loading factors in accordance with AWWA C 150 but in no case shall the ductile iron pipe be less than pressure class 150. If a pressure class higher than 150 is required, it will be specified on the plans or in the Supplemental Technical Specifications.

129.3.2 Ductile iron pipe shall be manufactured in accordance with AWWA C 151 and shall be cement mortar lined with a bituminous seal coat in accordance with AWWA C 104.

129.3.3 Ductile iron pipe joints for underground installations shall be rubber-gasketed push-on, or mechanical type in accordance with AWWA C 111.

129.3.4 Where specified on the construction drawings, the ductile iron flanged joint pipe shall meet the requirements in AWWA C 115. Flanged joints shall only be utilized in above ground installations or within structures, such as: valve pits or vaults.

129.3.5 Ductile iron pipe connections to fittings shall be as specified in Section 130.

129.3.6 Ductile iron pipe shall be installed in accordance with AWWA C 600 and Section 801 and shall be polyethylene encased as per AWWA C 105.

129.3.7 BELL AND SPIGOT JOINTS: Pipe with gasket joints shall be manufactured with a socket configuration, which will prevent improper installation of the gasket and will ensure that the gasket remains in place during joining operations. The gasket shall be manufactured from a synthetic elastomeric material and shall conform to the requirements of ASTM F 477. The spigot end of each joint of pipe shall be marked circumferentially

to indicate the proper home mark. Pipe, which is field-cut, shall be chamfered and the home mark identified in accordance with the applicable criteria.

129.4 DUCTILE IRON SANITARY SEWER PIPE

129.4.1 Ductile iron pipe, utilized for sanitary sewer installation, shall be asphaltic lined in accordance with ASTM A 746, unless otherwise specified on the plans or in the Supplemental Technical Specifications.

129.4.2 All pipes shall be a minimum of pressure class 150.

129.4.3 Polyethylene encasement shall be installed in accordance with ASTM A 674.

129.5 MEASUREMENT AND PAYMENT

129.5.1 Ductile iron pipe with polyethylene encasement for both pressure and gravity flow shall be measured and paid for at the contract unit price as specified in Section 801 and 900 and/or as defined in the Bid Proposal.

SECTION 130

GRAY IRON, DUCTILE IRON, AND STEEL FITTINGS

130.1 GENERAL

130.1.1 Fittings required in the installation of ductile iron, polyvinyl chloride and asbestos cement pipes shall be either gray iron or ductile iron, as specified herein.

130.2 REFERENCES

130.2.1 AWWA

C 104 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

C110 American National Standard for Ductile-Iron and Gray-Iron Fittings for Water

C111 American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

C153 American National Standard for Ductile-Iron Compact Fittings for Water Service

C208 American National Standard for Dimensions for Fabricated Steel Water Pipe Fittings

C226 American National Standard for Stainless-Steel Fittings for Waterworks Service Sizes 1/2 In. through 72 In.

130.3 COATINGS

130.3.1 All fittings shall be coated in accordance with AWWA C 110, C 111, and cement-mortar lined, per AWWA C 104.

130.4 MECHANICAL JOINT FITTINGS

130.4.1 Mechanical joint fittings shall be used in all buried installations. The type of fitting shall be as required to install the line in conformance with the grade and alignment shown on the construction drawings or as directed by the ENGINEER.

130.4.2 Mechanical joint fittings shall conform to the requirements of AWWA C 110, C 111, and C 153.

130.4.3 Fittings shall be installed in accordance with the manufacturer's published recommendations. Malleable iron or gray iron bolts, as per AWWA C 110 and C 111, shall be used to complete the connection. Bolts shall be of sufficient length to provide a minimum of three (3) threads beyond the tightened nut. The bolts shall be tightened evenly such that the distance between the gland and the face of the flange is approximately equal around the circumference of the pipe. All bolts shall be tightened with a torque-measuring wrench and the torque values shall be as follows:

FITTING SIZE	TORQUE RANGE
4" – 24"	79 – 90
30" – 36"	100 – 120
Larger than 36"	120 – 150

130.5 FLANGED JOINT FITTINGS

130.5.1 Flanged end fittings shall only be used where specifically required on the construction drawings or as directed by the ENGINEER.

130.5.2 The bolting material for pipe connection and installation shall be the same as Subsection 130.4.3.

130.6 RESTRAINTS

130.6.1 Thrust restraint blocking shall only be used when adequate mechanical restrain length is not available. When approved by the Water Authority, recommended by the ENGINEER, or shown on the plans, a polyethylene liner, with a minimum thickness of 8 mils, shall be installed between the fitting and any concrete.

130.6.2 All restrained joints shall be by mechanical means unless directed or approved otherwise by the ENGINEER. Prior to the installation, the CONTRACTOR shall submit manufacturer's literature with sufficient data to the ENGINEER for review and approval in writing.

130.7 STEEL FITTINGS

130.7.1 Steel fittings shall only be used when authorized by the ENGINEER and when needed to connect to an existing steel water line. Measurement and payment for steel fittings, when authorized, shall be made at the contract unit price per pound based on weights of an all mechanical joint ends fitting of the type fitting and size used, as specified in AWWA C110. This payment shall include all fabrication and welding required on the fitting.

130.8 PRESSURE RATING

130.8.1 All fittings shall have a minimum pressure rating of 250 psi.

130.9 MEASUREMENT AND PAYMENT

130.9.1 All cast iron and ductile iron fittings shall be measured and paid for at the contract unit price per pound based on weights of an all mechanical joint ends fitting for the type and size of fitting used as specified in AWWA C110, regardless of the type of ends on the fitting installed. The contract unit price per pound of fittings shall include all gaskets, glands, bolts, and nuts required. No separate payment will be made for these items.

130.9.2 When the CONTRACTOR installs a Water Authority furnished fitting and replaces that fitting in the Water Authority's inventory, the CONTRACTOR shall be paid the full contract unit price of that fitting as outlined above. If the CONTRACTOR does not replace the fitting in the Water Authority's inventory, the payment to the CONTRACTOR will be at the contract unit price of the fitting less the cost of the fitting itself.

130.9.3 Fitting Insertion: The insertion of a fitting into an existing pipe line shall be measured and paid for at the contract unit price per pound based on weights of an all mechanical joint end fitting and if required an all mechanical joint connecting piece (coupling) of the type fitting and size used, as specified in AWWA C110, regardless of the type of ends on the fitting and coupling installed. This payment shall include all compensation for the excavation, cutting and removal of the existing pipe, installation of the fitting and coupling, if required, the re-cutting of the existing pipe or new pipe installed between the fitting and coupling, and backfill and compaction complete in place. In addition to the payment for the fitting insertion, the CONTRACTOR shall be paid for each non-pressurized connection and if pavement, curb and gutter, sidewalk, drive pad, etc., are removed, these items will be paid for as part of the appropriate item.

130.9.4 Restrained joint fittings shall be measured and paid for in the same manner as Subsection 130.9.1.

SECTION 131

CENTRIFUGALLY CAST FIBERGLASS REINFORCED POLYMER MORTAR PIPE

131.1 GENERAL

131.1.1 The design, materials, manufacture, testing, and construction requirements of the centrifugally cast fiberglass reinforced polymer mortar pipe in sizes of 18-inch through 96-inch with gasketed bell and spigot joints shall conform to this specification.

131.1.2 The piping for sliplining and/or direct-bury applications supplied in compliance with this section shall be listed on the Water Authority Approved Products List.

131.1.3 The piping shall be in accordance with the latest edition of ASTM D 3262, Standard Specification for Glass-Fiber-Reinforced-Thermosetting-Resin Sewer Pipe; and all applicable sections of AWWA C950: Fiberglass Pressure Pipe.

131.1.4 The pipe shall consist of interior surface, interior layer and an exterior surface. The resins, reinforcing materials, and fillers materials, when combined as a composite structure, shall produce a pipe which meet or exceed the service and design conditions specified.

131.1.5 The interior surface of the pipe shall be a resin rich finish, 40 mils thick minimum, of epoxy, polyester or vinylester resin with no fillers and shall be free of cracks and crazing when placed under the design loading.

131.1.6 The interior and exterior layers of the pipe shall be composed of resin impregnated glass fibers and silica sand fillers in layers.

131.2 REFERENCES

131.2.1 American Society for Testing and Materials (Latest Editions) (ASTM):

C33 Specification for Concrete Aggregates

D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

D3262 Specification for Fiberglass Sewer Pipe

D3681 Test Method for Chemical Resistance of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe in Deflected Condition

D4161 Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals

F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

131.2.2 American Water Works Association (Latest Edition) (AWWA)

C950 Fiberglass Pressure Pipe

131.2.3 THIS PUBLICATION

SECTION 900 SANITARY AND STORM SEWER FACILITIES

SECTION 1502 SUBMITTALS

131.3 MATERIALS:
The centrifugally cast fiberglass liner shall conform to ASTM D 3262, Type 1, Liner 2, Grade 3. The pipe shall also meet the strain corrosion resistance requirements of ASTM D 3681 and joint requirements of ASTM D 4161. Certified test data proving conformance with specifications shall be required from the pipe manufacturer and submitted to the ENGINEER.

131.3.1 Resin Systems:
The manufacturer shall use a thermosetting polyester resin system with a minimum tensile elongation of 2 percent.

131.3.2 Glass Reinforcements:
The reinforcing glass fibers used to manufacture the components shall be commercial grade of E-type glass filaments with binder and sizing compatible with impregnating resins.

131.3.3 Fillers:
Sand shall be in accordance with ASTM C 33 and shall be a minimum 98% silica, kiln-dried and graded, with a maximum moisture content of 0.2%.

131.3.4 Fittings:

Flanges, elbows, reducers, tees, wyes, laterals, and other fittings shall be capable of withstanding all operating conditions when installed. Fittings may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber reinforced overlays.

131.4 JOINING SYSTEM

The CCFRPM pipe shall be field connected with low profile or flush gasketed fiberglass bell and spigot joints meeting the performance requirements of ASTM D 4161. An O-ring type elastomeric gasket meeting the requirements of ASTM F 477 shall be used to provide a positive leak proof sealing system at each pipe joint. Maximum allowable joint angular deflection shall be 1.0 degrees.

131.5 PIPE LENGTHS

Pipe shall be supplied in nominal lengths of 20 feet. Where radius curves in the existing pipe or limitations in the entry pipe dimensions restrict the pipe to shorter lengths, nominal sections of 10 feet or other even divisions of 20 feet shall be used.

131.6 PIPE STIFFNESS

The CCFRPM pipe produced shall have a minimum pipe stiffness of 46 psi at 5% deflection as set forth in ASTM D 2412.

131.7 CERTIFICATIONS

131.7.1 The CONTRACTOR shall submit certification from the manufacturer of the pipe as specified in Section 1502 as to the pipe material and that the pipe meets or exceeds the required testing. Only pipe manufactured in the United States of America will be acceptable.

131.7.2 Certifications of the materials shall include the cell classification, grades, type of resins, glass fibers, and all other materials used in the manufacturing of the pipe.

131.7.3 Pipe certification shall include calculations with parameter listing, formulas, and all other data which are necessary for the pipe design. Calculations submitted shall use a design temperature of 80°F and shall include, but not be limited to; soil loads, live loads, hydrostatic loads, pipe stiffness, Standard Dimension Ratio, pipe wall crushing strength, initial and long term (50 years) values of pipe deflection including grout load deflection, pipe bonding strain, hydrostatic collapse resistance, constrained buckling strength, and allowable jacking force and length.

131.7.3.1 The CONTRACTOR shall submit the liner pipe manufacturer's details of the pushing or pulling heads to be used.

131.7.4 Certifications shall include drawings showing the cross sectional profile of the pipe wall and pipe joint details.

131.7.5 The manufacturer of pipe and fittings must demonstrate a ten-year minimum history of successful installations in the United States for direct-bury and slip line rehabilitation of sanitary sewers.

131.8 PIPE QUALIFICATION AND PRE INSTALLATION INSPECTION: Pipes shall be inspected by the OWNER or ENGINEER for damage prior to installation.

131.8.1 If pipe is found to be superficially damaged by cracks, holes, delaminations, foreign inclusions, blisters, or other defects that would, due to their nature, degree, or extent, have a deleterious effect on the pipe performance as determined by the ENGINEER; the ENGINEER may reject the pipe or may allow the pipe to be repaired. Rejected pipe shall be replaced with a new section of pipe at no additional cost to the OWNER.

131.10 INSTALLATION

131.10.1 Liner Pipe Installation Plan and Procedures: The CONTRACTOR shall prepare and submit, for review and approval a minimum of 30 working days prior to commencing work, the plan with procedures, and the locations of insertion/access pits. The pits shall be located such that their total number shall be minimized, and the footage of liner pipe installed in a single push shall be maximized. As directed by the OWNER, insertion pits shall be located where obstructions or damaged pipe are planned to be removed.

131.10.2 LINER PIPE INSERTION

131.10.2.1 The existing sewer shall remain in operation during the relining process.

131.10.2.2 Obstructions such as roots, hanging gaskets, special duct and grout invert, large joint offsets, rocks or other debris, that would prevent passage or damage to the liner sections shall be removed or repaired prior to installing the liner.

131.10.2.3 After completing the insertion pit excavation, the top of the existing sanitary sewer interceptor shall be removed, where required, down to the spring line. Bumpers shall be provided in the insertion pit in order to prevent the edges of the existing pipe from damaging the outside of the liner as it is inserted into the existing sewer.

131.10.2.4 The liner shall be inserted into the existing sewer spigot end first with the bell end trailing.

131.10.2.4 The pushing force shall be applied to the pipe wall end inside of the bell in accordance with the manufacturer's printed instructions. No jacking load shall be applied to the end of the bell. The installation heads or mechanism shall incorporate a gauging system which shall provide a continuous monitor of the force being applied during liner insertion operations.

131.10.2.4.1 If the gauging system does not provide a direct reading of the force being applied to the pipe in pounds, the system shall be calibrated and such calibrated data shall be tabulated in written form to allow the ENGINEER to readily determine the force in pounds being applied to the pipe during the insertion operation.

131.10.2.4.2 The insertion force used by the CONTRACTOR shall not exceed the liner pipe manufacturer's recommended maximum allowable pulling or pushing force that can be exerted on the pipe without damaging integrity of the liner pipe or pipe joints.

131.10.2.4.3 Maximum allowable joint angular deflection shall be 1.0 degree.

131.10.2.5 For manholes where no point of intersection occurs in the manhole, the interceptor liner shall be inserted through the manholes with no pipe joints in the manhole. For manholes where points of intersection occur in the manhole, the interceptor liner shall be terminated and sealed.

131.10.3 DIRECT-BURY PIPE:
Direct-bury pipe installation and testing shall be in accordance with Section 901.

131.11 MEASUREMENT AND PAYMENT

131.11.1 Payment for pipe liner or direct-bury pipe shall be measured and paid for at the contract unit price as specified in Section 900 or as defined in the Bid Proposal.

131.11.2 The payment shall include all labor, materials, tools, equipment, and performance all of the work involved in furnishing, installing, testing, and incidentals required to complete the installation, as specified in the construction drawings.

131.11.2.1 Modification of the pipe thickness or other properties to meet varying site conditions shall be incidental to the bid amount.

131.11.3 Measurement and payment for obstruction removal by remote device or by excavation, reconnecting sewer services, abandonment of sewer service, insertion and access pits, backfill, paving replacement, clamps and encasement, sealing the liner at the manhole, and grouting of the annular space shall be defined in the Bid Proposal.

131.11.4 Measurement and payment for sewer line cleaning shall be as specified in the Bid Proposal unless otherwise stated in the bid documents.

131.11.5 Measurement and payment for sewer line inspection by CCTV shall be considered incidental unless otherwise stated in the bid documents.

SECTION 135

CORRUGATED METAL PIPE AND ARCHES (STEEL)

135.1 GENERAL

135.1.1 Corrugated metal pipe, pipe arches, and connectors shall be manufactured and inspected in conformance with the requirements of AASHTO M 36 and as hereinafter specified. The size, type, and gauge of the pipe to be furnished shall be as shown on the plans or as specified in the Supplementary Specifications.

135.1.2 Nominal diameter of dimensions as referred to in M 36 shall be defined as meaning the minimum inside dimension of the pipe.

135.1.3 Corrugated metal pipe and arches may be used for pond outfall structures/risers and for stormwater infiltration .

135.2 REFERENCES

135.2.1 ASTM

A 36
A 123

135.2.2 AASHTO

M 36
M 190
M 196
M 219

135.3 MATERIALS

135.3.1 Materials for corrugated metal pipe, pipe arches, and connectors including base metal, rivets, and spelter coating shall be as specified in AASHTO M 36.

135.3.2 Headwalls or flared end sections may be used if called for on the plans or in the Supplementary Specifications.

135.4 FABRICATION

At the option of the CONTRACTOR, corrugated metal pipe may be fabricated by riveting, replacing rivets with resistance spot welds, or using a helically corrugated metal pipe with a continuous helical lock seam paralleling the corrugation or by a method of welding approved by the ENGINEER.

135.4.1 FABRICATION BY RIVETING: Pipe fabricated by riveting shall conform to AASHTO M 36.

135.4.2 FABRICATION BY WELDING: Pipe fabricated by replacing the rivets with resistance spot welds shall conform to AASHTO M 36.

135.5 FABRICATION BY CONTINUOUS LOCK SEAM

Pipes fabricated with a continuous helical lock seam parallel to the corrugations shall conform to the requirements of AASHTO M 36, M 196, and M 219.

135.6 BITUMINOUS COATING

When required by the Supplementary Specifications, pipes and connecting bands shall be protected, both inside and outside, with a bituminous coating. The bituminous coating shall conform to the requirements of AASHTO M 190, Type A, Type B, or Type C.

135.7 REPAIR OF DAMAGED SPELTER COATING

Spelter coating which has been burned by welding or otherwise damaged in fabrication shall be repaired and recoated in accordance with AASHTO M 36.

135.8 MEASUREMENT AND PAYMENT

135.8.1 When only required as a separate material item, the following will apply:

135.8.1.1 The measurement and payment of corrugated metal pipe or corrugated metal arches will be by the linear foot measured along the centerline of the pipe or arch to the nearest foot.

135.8.1.2 Pipe culvert with beveled or skewed ends will be measured along the invert to the nearest foot.

135.8.1.3 End sections will be measured by the number of units each.

135.8.2 If this material is to be used in conjunction with a complete installation, then the measurement and payment will be defined in Section 910.

SECTION 139

STRUCTURAL AND RIVET STEEL, RIVETS, BOLTS, PINS, AND ANCHOR BOLTS

139.1 GENERAL

All steel, the class of which is not definitely designated herein, in the Supplementary Specifications, or on the plans, shall be structural steel and shall conform to the requirements of ASTM A 36.

139.2 REFERENCES

139.2.1 ASTM

A 6
A 36
A 242
A 307
A 325
A 490
A 502
A572
A 668
E 10

139.3 REPORT OF TESTS

Before fabrication, the CONTRACTOR shall furnish to the ENGINEER a report in duplicate certified by the mill of the tests for each melt of steel or iron from which the material is to be fabricated. These tests shall include the chemical and physical tests required by the ASTM specifications for the materials.

139.4 ADDITIONAL TESTS

139.4.1 The ENGINEER reserves the right to require additional mill and laboratory tests to assure compliance with ASTM requirements.

139.4.2 By "identifiable stock" is meant material for which authentic records of the chemical and physical properties are available.

139.4.3 Test specimens shall be furnished, cut, and machined in accordance with ASTM specifications for the material to be tested, as referred to herein. Test specimens shall be furnished and machined at the CONTRACTOR's expense.

139.5 MILL TOLERANCES

Rolling and cutting tolerances, permissible variations in weight and dimensions, defects and imperfections shall not exceed the limits for structural steel contained in ASTM A 6.

139.6 STOCK MATERIAL

When the CONTRACTOR proposes to use material already in stock, he shall notify the ENGINEER of such intention at least ten days in advance of beginning fabrication to permit sampling and testing.

139.7 STRUCTURAL STEEL:

139.7.1 STOCK MATERIALS: The CONTRACTOR shall select the material he wishes to use from stock and place it in a location apart from other stock material and accessible for inspecting and sampling. The CONTRACTOR shall select the material from as few heat numbers as possible and shall furnish certified mill test reports on each of the heat numbers. Two samples shall be taken by a representative of the ENGINEER from each heat number, one for the tension test and one for the cold bend test. If the heat numbers cannot be identified, the representative of the ENGINEER may, at his discretion, select random test specimens from the unidentifiable heats. The number of such test specimens shall be entirely within the discretion of the representative of the ENGINEER.

139.7.2 HIGH-STRENGTH LOW-ALLOY STRUCTURAL STEEL: The material shall conform to the requirements of ASTM M 242, A 572 (Grades 42, 50, 60, or 65).

139.7.3 COPPER BEARING STRUCTURAL STEEL: Copper bearing structural steel shall conform to the requirements of ASTM A 36 or as specified.

139.8 RIVETS

139.8.1 STOCK MATERIAL:

139.8.1.1 Rivets taken from identifiable stock shall be accepted by the ENGINEER in accordance with Subsection 139.4.2.

139.8.1.2 Rivets from unidentifiable stock (for which authentic records of the chemical and physical properties are not available) shall not be used except where shown on the shop drawing. See Subsection 139.6.

139.8.2 HIGH-STRENGTH STRUCTURAL RIVET STEEL:

The material shall conform to the requirements of ASTM A 502.

139.8.3 STRUCTURAL RIVET STEEL: The material shall conform to the requirements of ASTM A 502, except that the test specimen shall be bent upon itself when performing the bend test.

139.9 BOLTS

139.9.1 UNFINISHED BOLTS

139.9.1.1 The bolts shall have square heads and square nuts unless otherwise specified. The bolts shall be long enough to extend entirely through the nut but not more than 1/4 inch beyond. Washers shall not be furnished unless specified.

139.9.1.2 Steel bolts shall conform to the requirements of ASTM A 307, except that steel manufactured by the acid-Bessemer process shall not be used.

139.9.2 HIGH-STRENGTH BOLTS: High Strength bolts shall conform to the provisions of the specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings of the American Institute of Steel Construction (ASTM A 325 or A 490).

139.10 ANCHOR BOLTS

Anchor bolts shall be manufactured from steel conforming to ASTM A 36 or A 307.

139.11 MILD-STEEL FORGINGS FOR STRUCTURAL PURPOSES

Steel forgings shall be made from steel of forging quality and shall conform to the requirements of ASTM A 668. They shall be Class C forgings with a maximum carbon content of 0.35 percent and shall be given a thorough annealing. The metal shall have a minimum Brinell hardness number of 130 and a maximum of 190 when tested in accordance with ASTM Test E-10.

139.12 MEASUREMENT AND PAYMENT

Structural and rivet steel, rivets, bolts, pins, and anchor bolts will be considered subsidiary items to major items of construction as listed in the specifications or required on the plans. No separate measurement or payment will be made.

SECTION 143

GALVANIZING

143.1 GENERAL

These specifications cover the hot-dip galvanizing of various metals where required by the detailed plans or specifications.

143.2 REFERENCES

143.2.1 ASTM

A 116	A 153
A 120	A 392
A 121	A 444
A 123	A 525

143.3 SPECIFICATIONS

Materials shall be hot-dip galvanized and the weight and uniformity of coating determined in accordance with the standard specifications given in the Table 143.3.

143.4 WORKMANSHIP

The galvanizing shall be applied in such a manner that the spelter will not peel off. The finished product shall be free from blisters and excess spelter; and the coating shall be even, smooth, and uniform throughout. Machine work, dye work, cutting, punching, bending, welding, drilling, thread cutting, and other fabricating shall be done as far as is practicable before the galvanizing. No member shall be galvanized which is out of alignment. All members, nuts, bolts, washers, etc. shall be galvanized before a structural unit is assembled. All uncoated spots or damaged coatings due to poor workmanship, rough handling, or any other reason shall be cause for rejection.

143.5 TEST COUPONS

Test coupons for determining the quality of the galvanizing shall be wired to the materials to be galvanized before immersion in such a manner as to represent the amount of coating deposited on the materials.

143.6 REPAIR OF GALVANIZED SURFACES

Unless otherwise specified, where galvanized surfaces are field or shop cut, broken, burned, or abraded, thus breaking the galvanizing, the locations thus damaged shall be coated with "Galvalloy" or "Galvicon" or an approved equal.

143.7 MEASUREMENT AND PAYMENT

Galvanizing will be considered a subsidiary item to the product so treated. No separate measurement or payment will be made.

TABLE 143.3

GALVANIZING SPECIFICATIONS

Material or Test	Std. Spec. ASTM	Class
Corrugated Metal Pipe	A 444	
Flat Steel or Iron Sheets	A 525	
Iron or Steel Wire	A 116	2
Chain-Link fabric (Galv. after Fabrication	A 392	1
Barbed Wire	A 121	2
Steel Pipe Rails	A 120	
Structural Shapes, Tie Rods, Ornamental Iron Railings, Handrails, Manhole and Catch Basin Steps, and Curb Armor	A 123	
Bolts, Nuts, Washers, Anchor Bolts, Packing Spools, Gray Iron and Malleable Iron Castings, and Steel Castings	A 153	
Guard Rails	A 525	

SECTION 145

LUMBER

145.1 GENERAL

This section specifies the types and grading of lumber that will be acceptable for certain uses.

145.2 REFERENCES

145.2.1 United States Product Standard PS 1-66 for Softwood Plywood

145.2.2 Standard Specifications for Grades of California Redwood of the Redwood Inspection Service

145.2.3 Western Wood Products Association

145.3 LUMBER, PLYWOOD, AND REDWOOD

145.3.1 LUMBER AND PLYWOOD:

145.3.1.1 Unless otherwise specified or shown on the drawings, all lumber shall be Douglas fir or pine and shall be selected as to grade and shall conform in all particulars to the Standard Grading and Dressing Rules of the Western Wood Products Association or other grading agency approved by the ENGINEER.

145.3.1.2 Plywood shall conform to the performance standards for its type in United States Product Standard PS 1-66 for Softwood Plywood, Construction and Industrial.

145.3.1.3 Lumber or plywood for the uses listed in Table 145.3.1.3 shall not be lower than the grades shown.

145.3.2 REDWOOD:

145.3.2.1 Redwood lumber shall be selected as to grade and shall conform in all particulars to the Standard Specifications for Grades of California Redwood of the Redwood Inspection Service.

145.3.2.2 Redwood lumber for the uses listed in Table 145.3.2.2 shall not be lower than the grades shown.

145.4 GRADE MARKING

145.4.1 Each piece of lumber shall bear an official grade mark which, unless authorized otherwise, shall be the grade mark adopted by one of the following:

145.4.1.1 For Douglas fir and pine, marking shall be the Western Wood Products Association or other grading agency approved by the ENGINEER.

145.4.1.2 For redwood, marking shall be the Redwood Inspection Service.

145.4.1.3 For plywood, each sheet of plywood shall bear the official stamp of a quality control agency stating the grade of the sheet.

145.5 MEASUREMENT AND PAYMENT

145.5.1 Lumber, plywood, or redwood where required may be considered a subsidiary item. In which case no measurement or payment will be made.

145.5.2 If any one of these materials are considered as a pay item, then the unit of measurement and payment will be specified in the Bid Proposal.

SECTION 145

LUMBER

TABLE 145.3.1.3
LUMBER AND PLYWOOD--USES AND GRADES

	USES	GRADES
A.	Permanent construction, such as bridges and culverts.	Select structural for beams and stringers; construction grade for balance of structure.
B.	Minor permanent construction, such as fences, guard rails and posts, pavement headers, bulkheads, retaining structures, etc.	Construction grade.
C.	Falsework and studs, and wales for formwork.	Construction grade framing, beams, or timbers.
D.	Form sheeting for non-showing surfaces of ornamental concrete.	Standard grade boards; shiplap; or any grade of plywood.
E.	Form sheeting for showing surface of ornamental concrete.	Vertical grain "C" industrial clear; concrete form grade of plywood; or overlay plywood.
F.	Form sheeting for curved soffits of bridge and tunnel arches, plastered, or unplastered.	Select merchantable boards concrete grade of plywood; or overlay plywood.
G.	Soffits of beams and girders and slabs between beams and girders; for beam and girder sides, except ornamental concrete; and for head-walls or end-walls of culverts or covered conduits.	Concrete form grade of plywood or overlay plywood.
H.	Form sheeting for showing surfaces of channel walls or interior surfaces except floors, of covered conduit, and all other showing surfaces not specified above.	Tongue and groove flooring equal to Grade "C" and better flat grain; concrete form grade of plywood; or overlay plywood.
I.	All other lumber.	Construction grade.

TABLE 145.3.2.2
REDWOOD USES AND GRADES

	USES	GRADES
A.	Bridges, culverts, and guardrail posts.	Select all heart structural timber.
B.	All other redwood lumber.	Foundation.

SECTION 146

WOOD PRESERVATIVES

146.1 GENERAL

146.1.1 This work shall consist of treating lumber, timber, and piling. Lumber, timber, and piling to be treated shall conform to the requirements of the various sections of these specifications specifying these materials.

146.1.2 Where practical, lumber to be treated shall be cut to size and framed prior to treatment, unless indicated otherwise on the drawings. Proper allowance for shrinkage in the sizes of lumber shall be made by the CONTRACTOR where it is necessary to meet definite dimensions shown on the drawings.

146.2 REFERENCES

146.2.1 ASTM

D 390
D 391
D 1032
D 1272
D 1325
D 1624
D 1625
D 1760
D 1858
D 1859
D 2604
D 2605

146.2.2 AASHTO

M 133

146.3 OIL-TYPE PRESERVATIVE TREATMENT:

Preservatives under this specification shall be creosote, creosote-coal tar solutions, creosote petroleum solutions, or pentachlorophenol in petroleum oils, conforming to ASTM D 390, D 391, D 1858, D 1272, and/or AASHTO M 133, respectively, with petroleum oils per ASTM D 1859, D 2604, and D 2605 or any combination of above preservatives as approved by the ENGINEER.

146.4 WATER-BORNE SALT PRESERVATIVES TREATMENT

146.4.1 Preservatives under this section shall conform to the requirements of ASTM D 1032, D 1325, D 1624, and D 1625.

146.4.2 Unless indicated otherwise on the plans, the amount of preservative to be retained shall conform to the requirements of ASTM D 1760.

146.5 TREATMENT

146.5.1 The treating operations shall conform to the applicable requirements of ASTM D 1760 and/or AASHTO M 133.

146.5.2 Unless indicated otherwise on the plans or in the Supplementary Specifications, the amount of preservative to be retained and the treating process to be used for the various types of service shall conform to the requirements established in the standards referenced in this section.

146.6 PENETRATION

Penetration shall conform to the applicable specification or ASTM D 1760, unless otherwise indicated on the plans or Supplementary Specifications.

146.7 INCISING

Timber of those species required to be incised by ASTM Specifications shall be incised before treatment only when it is 3 inches or more in nominal thickness and 4 inches or more in nominal width, as a means of securing penetration of the preservative. If such thickness is less than 4 inches, the material may be incised on the wide faces only, otherwise all four faces shall be incised.

146.8 PENTRATION

Penetration shall conform to the applicable ASTM Specification listed in Subsection 146.6.

146.9 FIELD TREATMENT OF CUT SURFACES

146.9.1 When sawing or drilling is necessary after plant treatment of creosoted materials, the cut surfaces shall be thoroughly brushed with 2 coats of hot coal tar creosote of the same kind used at the plant. If such hot application is not practicable, then a cold application shall be made.

146.9.2 In treating surfaces exposed when pile heads are cut off, the brush treatment shall be given with great care and thoroughness. A coat of pitch, asphalt, or similar material should then be applied over the creosote, followed by some protective sheet material such as metal, roofing felt, or saturated fabric fitted

over the pile head and brought down the sides far enough to protect against damage to the top treatment.

146.9.3 Lumber sawed or cut after salt treatment shall have the cut surfaces well-brushed with the same preservative that was used at the plant.

146.10 INSPECTION

146.10.1 All material treated under this specification will be subject to inspection for compliance with the prescribed requirements.

146.10.2 Acceptance of material at any step from vendor through treatment, storage, and incorporation into the work, will not bar subsequent rejection for damage of any nature. All material so rejected shall be replaced at the expense of the CONTRACTOR.

146.10.3 All facilities and supplies that may be required for testing and for ascertaining compliance with the provisions of this specification relative to the treatment of the material shall be furnished by the treatment plant for use by the ENGINEER. Duly authorized representatives of the ENGINEER shall be given free access to all parts of the plant in which any work is being done and to all records pertaining to the performance of such work.

146.11 HANDLING AND PROTECTION OF TREATED MATERIAL

Material that is stored on the site of work prior to its use shall be neatly piled on skids to raise it from the ground and shall be protected from the sun and weather. When so required, the material shall be accessible for inspection.

146.12 MEASUREMENT AND PAYMENT

Wood preservatives where called for shall be considered a subsidiary item. No measurement and payment will be made.

SECTION 150

TIMBER PILES

150.1 GENERAL

This work shall consist of furnishing timber piles of type and size shown on the plans or specified.

150.2 REFERENCES

150.2.1 ASTM

D 25

150.2.2 AASHTO

M 133

150.2.3 This publication

SECTION 502

150.3 MATERIALS

150.3.1 Timber piling shall be dense southern yellow pine, Coast Region Douglas fir, or western larch cut from sound trees. Piling shall meet the requirements of ASTM D 25 and shall comply with the minimum circumference values given in the Table 150.3.1.

150.3.2 Unless otherwise provided, piles shall be furnished in lengths shown on the plans. Variations of one foot from the designated length will be permitted, except that the average length of all piles of a specified length shall be equal to or greater than the required length. The supplier shall legibly mark the size and length on the butt end of each pile. Tips and butts shall be cut at right angles to the axis of the pile. Tips shall be pointed to a 4 inch square point when approved by the ENGINEER.

150.3.3 Piles shall be cut from the main body of the tree and shall be cut above the ground swell with a gradual taper from the point of butt measurement to the tip.

150.3.4 All piling shall be subject to inspection by the ENGINEER before and after treatment. In the rejection of materials not found suitable, the judgment of the ENGINEER shall be accepted. The butt and tip of each pile accepted will be branded with a marking hammer showing the identity of the ENGINEER who performed the work.

150.3.5 Treated timber piling not inspected prior to treatment will not be accepted unless approved in writing by the ENGINEER.

150.3.6 The method of handling and storing piles shall be such as to prevent injury during handling or damage during storage. Piles shall be handled with slings or other approved methods. Cant hooks, pike poles, or similar tools shall not be used where such tools will penetrate the wood.

150.3.7 Timber piling shall be treated with creosote oil conforming with the requirements of AASHTO M 133. The amount of preservative retained shall be 12 pounds per cubic foot of wood. The empty-cell process shall be used.

150.4 MEASUREMENT AND PAYMENT

Measurement and payment shall be as specified in Section 502.

TABLE 150.3.1

MINIMUM CIRCUMFERENCE VALUES

Pile Length (Feet)	Minimum Circumference 3 Feet from Butt (inches)
40 and under	38
41 to 50 inclusive	41
51 to 60 inclusive	44
61 to 70 inclusive	50
Over 70	as shown on plans

SECTION 151

STEEL PILES

151.1 GENERAL

Steel piles furnished under this specification shall consist of structural steel shapes and other steel shapes that fulfill the requirements prescribed below for such material and shall conform to the details and dimensions indicated by the drawings and specifications relating directly thereto. The kind and type of steel piling to be used in the Work shall be as indicated on the plans or Supplementary Specifications.

151.2 REFERENCES

151.2.1 ASTM

A 36
A 252
A 328

151.2.2 AASHTO

M 150
M 183

151.2.3 American Welding Standard Specifications for Welding Highway and Railroad Bridges

151.2.4 This publication

SECTION 157
SECTION 502

151.3 MATERIALS

151.3.1 The CONTRACTOR shall furnish the ENGINEER with manufacturer's certificate indicating that structural steel piles and pile columns and steel pipe piles and pipe pile columns conform with all the requirements herein provided.

151.3.2 Unless otherwise provided, after installation, the exposed areas of steel piles or steel pile columns, together with all steel bracing, shall be given 3 coats of paint in conformity with Section 157. The areas to be painted shall extend from the bottom of the concrete cap to 2 feet below ground surface or to the surface of the water, when the water surface is normal or below normal.

151.3.3 When approved by the ENGINEER, the CONTRACTOR, for his convenience, may furnish steel piles over 30 feet in length or in lengths less than the full length of piles shown on the plans. Such piles shall be spliced not more than two splices per pile to obtain not less than required length, with minimum piece length of 5 feet prior to driving. All splicing shall conform to details shown on the plans and will be considered incidental to the completion of the Work and no payment will be made therefore.

151.3.4 All welding shall conform with American Welding Society Standard Specifications for Welding Highway and Railroad Bridges.

151.3.5 Structural Steel Piles--Structural steel for bearing piles shall conform to the requirements of AASHTO M 183 or ASTM A 36. Camber and sweep in excess of the mill tolerance will not be accepted. Unless otherwise noted, HPS 10 x 57 piling may be substituted where HP 10 x 57 piling is called for on the plans.

151.3.6 Closed End Steel Pipe Piles--Steel pipe piles shall conform with ASTM A 252, Grade 2. Concrete for filling steel pipe piles shall have a minimum 28 day compressive strength of 3000 psi.

151.3.7 Steel Pipe Pile Columns--Steel pipe pile columns shall conform with ASTM A 252, Grade 2. Concrete for filling steel pipe columns shall have a minimum 28 day compressive strength of 3000 psi.

151.3.8 Structural Steel Pile Columns--Structural steel for pile columns shall conform with AASHTO M 183 or ASTM A 36. Camber and sweep in excess of the mill tolerance will not be accepted. Unless noted otherwise, HPS 10 x 57 piling may be substituted where HP 10 x 57 piling is called for on the plans.

151.3.9 Steel sheet piles shall conform to ASTM A 328.

151.3.10 Steel sheet piling shall consist of standard interlocking sheet pile sections or as shown on the plans and specified herein.

151.4 MEASUREMENT AND PAYMENT

Structural or round bearing piles shall be measured by the linear foot, complete in place, to the specified cut off point including all splices. Sheet pile shall be paid for as specified in Bid Proposal. Payment for driving piling shall be as specified in Section 502.

SECTION 152

CONCRETE PILES

152.1 GENERAL

Four types of concrete piles are covered by these specifications; namely, precast piles, cast-in-place piles, prestressed piles, and centrifugal cast piles. The type to be used or furnished shall be as indicated on the drawings or specified in the Supplementary Specifications. The manufacture of prestressed piles shall be performed in accordance with Section 502. Driving of pile shall conform to Section 502.

152.2 REFERENCES

152.2.1 ASTM

A 252
C 31

152.2.2 This publication

SECTION 101
SECTION 102
SECTION 502
SECTION 512

152.3 PRECAST PILES

152.3.1 Precast concrete piles shall be constructed of concrete of such quality that the finished piles can be handled and driven to required bearing without cracking or other damage which would impair their strength or durability. Concrete shall have a strength at 28 days of not less than 4,000 pounds per square inch in compression and shall be mixed and proportioned in accordance with the requirements of Section 101 with a minimum cement content of 6.5 sacks per cubic yard. Reinforcing steel placed therein shall conform to the requirements of Section 102.

152.3.2 Concrete for precast concrete piles shall be poured in smooth, mortar-tight forms so supported as to prevent appreciable deformation or settlement during pouring or curing. The piles after being poured shall be cured by water curing, steam curing, application of curing compound, or such other method of curing as may be approved by the ENGINEER. Curing shall be continued until specimens of the concrete from which the piles were poured, cured in the same manner as the piles, attain a compressive strength of at least 4,000 pounds per square inch. Piles shall not be driven until completion of the curing.

152.3.3 Upon completion, the piles shall present true, smooth, even surfaces, free from honeycombs or voids and shall be sufficiently straight that a line stretched from butt to tip along any face will not deviate therefrom nor be deflected more than 1 inch in 50 feet at any point. Repaired defects in any pile may be accepted by the ENGINEER if repaired to his satisfaction.

152.3.4 If dowel extensions are required, the piles may be cast the full length of the reinforcing rods provided that the tops are cut off after driving to expose the ends of the rods as specified or indicated by the drawings.

152.3.5 Precast piles must at all times be so handled as to avoid and prevent cracking, breaking, or chipping the edges thereof. Slings shall be provided at or near the quarter points for raising and transporting long piles.

152.4 CAST-IN-PLACE CONCRETE PILES

152.4.1 METAL CASED CAST-IN-PLACE CON- CRETE PILES:

152.4.1.1 Concrete shall have a minimum strength at 28 days of 3,000 pounds per square inch in compression and shall be Mixed and proportioned in accordance with the requirements of Section 101. Reinforcing steel placed therein shall conform to the requirements of Section 102.

152.4.1.2 Piles shall be cast in steel shells that have been previously driven to the penetration and bearing value specified or indicated on the drawings.

152.4.1.3 The sheet shall be cylindrical, fluted, step-tapered, or uniformly tapered from butt to tip.

152.4.1.4 The shells shall be of such material and construction as to properly and satisfactorily serve the intended purpose. Those that are driven without a mandrel shall be constructed of material conforming to the requirements prescribed in ASTM A 252, Grade 2, being of sufficient thickness, strength, and rigidity to withstand distortion as a consequence of driving, soil pressure, or the driving of adjacent piles.

152.4.1.5 After being driven, but prior to placing of the reinforcing steel and concrete, the shells shall be examined for collapse or reduced diameter at any point, the CONTRACTOR being required to provide and have available at all times a suitable light for the inspection of the shell throughout the entire length thereof. Shells that are improperly driven or are broken or show partial collapse will not be accepted and shall be replaced by and at the expense of the CONTRACTOR. Driven shells shall be clean and free

of water before reinforcing steel and concrete is placed therein. The replacement of the shell shall be made by withdrawing the entire shell and driving another in its place. Driving one shell within a shell already driven will not be permitted. If the withdrawal of the defective shell is impossible or impracticable as decided by the ENGINEER, the CONTRACTOR shall fill the defective shell with concrete and shall replace the defective pile with another pile driven alongside. Any enlargement of the footing required to accommodate such piling shall be at the expense of the CONTRACTOR. Partial collapse of pile shells shall be interpreted to mean any collapse which reduces any diameter of the shell at any point in its length to less than 80 percent of the original diameter at such point, and such partial collapse shall be cause for rejection.

152.4.2 CAST IN DRILLED HOLE PILES:

152.4.2.1 All holes for concrete piles cast in drilled holes shall be drilled dry to the tip elevations shown on the plans or to the elevations determined by the ENGINEER. All holes shall be examined for straightness and any hole which on visual inspection from the top shows less than 1/2 of the diameter of the hole at the bottom of the hole shall be rejected. Suitable casings shall be furnished and placed when required to prevent caving of the hole before concrete is placed therein.

152.4.2.2 All loose material existing at the bottom of the hole after drilling operations have been completed shall be removed before placing concrete in the hole.

152.4.2.3 The use of water for drilling operations or for any other purpose where it may enter the hole will not be permitted. Surface water shall not be permitted to enter the hole and all water which may have infiltrated into the hole shall be removed before placing concrete therein.

152.4.2.4 Casing, if used in drilling operations, shall be removed from the hole as concrete is placed therein. The bottom of the casing shall be maintained not more than 5 feet nor less than 1 foot below the top of the concrete during withdrawal and placing operations, unless otherwise permitted by the ENGINEER. Separation of the concrete during withdrawal operations shall be avoided by hammering or otherwise vibrating the casing.

152.4.2.5 Care shall be exercised to insure that the concrete in the hole is dense and homogeneous. Vibration of the concrete during placing will not be required, however, rodding may be required. After the hole has been filled with concrete, the concrete at the top 10 feet of the hole or for the length of the reinforcing, whichever is the greater, shall be vibrated.

152.4.2.6 The reinforcing cage shall be placed and secured symmetrically about the axis of the pile and shall be securely blocked to clear the sides of the hole.

152.5 PRESTRESSED CONCRETE PILES

152.5.1 MATERIAL

152.5.1.1 Piles shall be homogeneous, high strength concrete from head to tip, stressed with high tensile cold drawn strands. Piles of cross section differing from the section shown on the drawings for bearing piles may be accepted by the ENGINEER provided the surface area, sectional area, bending resistance, and prestress are equivalent to that indicated.

152.5.1.2 Bearing piles showing defects when forms are stripped in the upper 10 feet of the pile which reduce the cover over the steel to less than required will be rejected. Defects in the remainder of the pile may be repaired and the pile accepted if repaired in a manner satisfactory to the ENGINEER.

152.5.1.3 Upon completion, the piles shall present true, smooth, even surfaces, free from honeycombs or voids and shall be sufficiently straight that a line stretched from butt to tip along any face will not deviate therefrom nor be deflected more than 1 inch in 50 feet at any point. Defects in any pile may be repaired and the pile accepted by the ENGINEER if repaired to his satisfaction.

152.5.2 HANDLING

152.5.2.1 Piles may be removed from the prestressing bed for transportation of storage after the concrete has reached a compressive strength of 3,500 pounds per square inch, but they shall not be driven until they have attained a minimum compressive strength of 5,000 pounds per square inch as determined by tests on concrete cylinders cast and cured under the same conditions as the piles. The compressive strength test specimens shall be made in accordance with ASTM C 31 at no additional cost to the OWNER.

152.5.2.2 Lifting shall be only at predetermined points of pickup and in such a manner as to avoid cracking, spalling, excessive bending, or other injurious results.

152.6 CENTRIFUGAL CAST CONCRETE PILES

152.6.1 Materials shall conform to the requirements of Section 101 unless otherwise specified in the Supplementary Specifications. Concrete casings shall be manufactured by the centrifugal process. They shall be formed and compacted by centrifugal force in a machine of suitable type so designed that the casing molds may be revolved without harmful vibration at sufficient speeds to insure even distribution and dense packing of the concrete true design.

152.6.2 Filling of the mold and spinning shall be a continuous operation, and the spinning shall take place before any of the concrete in the mold has taken an initial set.

152.6.3 When filled, the mold shall be placed on the spinning machine in a horizontal position and rotated at a gradually increasing speed until maximum rotation is attained. Excess water and laitance forced to the center of the mass shall be drained or expelled in a suitable manner.

152.6.4 The concrete casing shall not be removed from the mold until the concrete has attained sufficient strength to prevent deformation. The casing shall be cast full length in one piece and the finished casing shall have a wall thickness not less than the thickness shown on the plans.

152.6.5 The casing shall be reinforced in accordance with the details shown on the plans. Prior to spinning the casing, each longitudinal bar shall be prestressed to a value of 10,000 pounds per bar and such prestresses shall be maintained in each bar until after the concrete has set.

152.6.6 The proportion of Portland cement in the concrete mixture for the casings shall not be less than 6 sacks per cubic yard of concrete. The concrete aggregate shall be so graded and proportioned and thoroughly mixed in a batch mixer with such proportions of cement and water as will produce a homogeneous concrete mixture of such quality that the resulting casing shall be of sufficient strength to resist the stresses resulting from handling and driving without cracking or other damage which would impair its strength or durability.

152.6.7 Following removal from the molds, the finished casings shall be cured for such period of time as may be necessary to produce a strength satisfactory for handling and driving. Curing may be any of the following methods:

152.6.7.1 Continuous spraying with water for at least 72 hours.

152.6.7.2 Covering with heavy burlap or other suitable material which is kept saturated with water for at least 72 hours.

152.6.7.3 Steam Curing--The manufacturer shall provide adequate facilities for curing the piles including a suitable enclosure. Humidity in the enclosure shall be provided to keep the surfaces of the piles moist at all times and the temperature shall be maintained continuously between 120 degrees F and 170 degrees F. Piles shall be cured for not less than 30 hours and for a longer time when so directed by the ENGINEER.

152.7 MEASUREMENT AND PAYMENT

Measurement shall be by the linear foot in place to the specified cut-off point. Payment shall be made at the unit price per linear foot.

SECTION 157

PAINT

157.1 GENERAL

This work shall consist of furnishing paint and other materials, cleaning the surfaces to be painted, and applying the paint in substantial compliance with the specifications and as shown on the plans or directed by the ENGINEER.

157.2 REFERENCES

157.2.1 AASHTO

M 67
M 68
M 69
M 70
M 72

157.2.2 Federal Specifications

TT-E-496

157.3 MATERIALS

157.3.1 The various types of paint and other materials shall be furnished in accordance with the following specifications:

157.3.1.1 Unless otherwise provided, red lead shall conform to the provisions of AASHTO M 72, Type 1.

157.3.1.2 Aluminum paint shall conform to the provisions of AASHTO M 69, Type I.

157.3.1.3 Foliage green bridge paint shall conform to the provisions of AASHTO M 67, Type II.

157.3.1.4 White paint shall conform to the provisions of AASHTO M 70, Type II.

157.3.1.5 Black bridge paint shall conform to the provisions of AASHTO M 68.

157.3.1.6 Black paint shall conform to the provisions of FSS TT-E-496, Type II.

157.3.1.7 Graphite shall be natural or synthetic. Graphite shall be free from grit, dirt, or other deleterious substances. Natural graphite shall contain not less than 65 percent carbon. The other ingredients shall be silica, iron, and aluminum. Not less than 97 percent of the graphite material shall pass the No. 325 sieve. Flake graphite will not be accepted.

157.3.2 The manufacturer shall submit to the ENGINEER the required number of certified copies of the paint analysis, prior to delivery of such paint. When required, the manufacturer shall submit samples of paint in the amounts required by the ENGINEER prior to delivery of such paint.

157.4 CONSTRUCTION REQUIREMENTS

157.4.1 All surfaces to be painted shall be clean and dry before paint is applied. Paint shall be applied only when the atmospheric temperature is above 50 degrees F. When paint is applied in cold or damp weather, adequate heated enclosures shall be provided and maintained until the paint is dry.

157.4.2 All paint shall be thoroughly mixed before and during application with approved mechanical mixers. Thinner shall not be added unless approved by the ENGINEER. The amount of thinner to be added shall not exceed 5 percent by volume. For minor structural steel items, red lead paint for field applications by spraying may be thinned with not more than one part of mineral spirits to 8 parts of paint, as packaged, by volume.

157.4.3 Shop and field paint may be applied by brush, roller, or spray. Paint spraying equipment for field painting shall be approved by the ENGINEER prior to use. Each coat of paint shall be applied in a continuous film of uniform thickness, free from pinholes, and shall be thoroughly dry before the next coat of paint is applied. The shop coat shall have a minimum dry film thickness of 1.5 mils, and each field coat shall have a minimum dry film thickness of 1.0 mils. Defective areas shall be repainted and permitted to dry before the next coat of paint is applied.

157.4.4 When requested by the CONTRACTOR and after shop inspection, steel work shall be given a shop coat of paint. Prior to applying the paint, the surfaces shall be cleaned of loose rust, loose mill scale, dirt, grease, and other deleterious material by sand blasting or other approved methods, without damage to the surface of the steel. After the shop coat has been applied and prior to shipment, areas that have been damaged or that are defective shall be cleaned and repainted.

157.4.5 Contact surfaces which are to be riveted, welded, or bolted with high strength bolts, in the shop or in the field, and surfaces that are to be embedded in concrete shall not be painted. Surfaces that will be inaccessible after fabrication or field erection shall be painted prior to erection.

157.4.6 After erection, rust, dirt, grease, and other deleterious material shall be removed from the steel members as directed by the ENGINEER. The heads of rivets and bolts, nuts, field welds, edges of contact surfaces, and all surfaces from which the shop coat was omitted shall be thoroughly cleaned and painted with one coat of the same type of paint as the shop coat. Field painting shall consist of the type of paint and the number of coats as specified. Where successive paint coats are of the same color, the initial coat shall be tinted slightly to permit distinction between the coverage of each coat. The final coat shall not be tinted.

157.4.7 Wood surfaces shall be painted as specified.

157.4.8 All structural steel shall receive a prime coat of red lead paint and two field coats of aluminum paint, conforming with the requirements of Section 157.3. Red lead paint may be applied either in the shop or in the field. Red lead paint conforming with the requirements of AASHTO M72, Type III or Type IV, may be used for the prime coat, provided the steel is thoroughly cleaned by sandblasting immediately prior to application of the paint. Structural steel contact surfaces, including surfaces to be embedded in concrete, shall not be painted. Surfaces of steel railing posts to be in contact with concrete and post shims shall receive the three required coats of paint before erection. No increase in the computed pay weight of steel will be allowed for paint.

157.5 TRAFFIC PAINT

Traffic paint shall conform to the requirements of the New Mexico State Highway Department.

157.6 MEASUREMENT AND PAYMENT

Paint and the application thereof shall be considered a subsidiary item and no separate measurement or payment will be made.

SECTION 160

STEEL CASTINGS

160.1 GENERAL:

160.1.1 Steel castings shall be as shown on the plans and specified herein, including rockers and rocker plates. The castings shall be true to pattern in form and dimension and free from pouring faults, sponginess, cracks, blowholes, or defects that would affect the service value of the casting.

160.1.2 Blowholes shall not have a depth sufficient to affect injuriously the strength of the castings. Minor defects which do not impair the strength of a casting may, with the approval of the ENGINEER, be welded by an approved process. Defects shall be cleaned out to solid metal by chipping or other satisfactory means and after welding, the castings shall be annealed, if so required by the ENGINEER. Castings which have been welded without the permission of the ENGINEER shall be rejected.

160.2 REFERENCES:

160.2.1 ASTM

A 27
A 148
E 10
E 30

160.3 FINISH:

160.3.1 The dimensions of the finished castings shall be not less than the specified dimensions. Castings shall be not more than 7 1/2 percent overweight.

160.3.2 The bearing surfaces of rockers and rocker plates shall be machined accurately to the dimensions shown on the plans. The final surface shall be produced by a finishing cut. They shall be straight, smooth, and free from flows.

160.3.3 Chemical analysis shall be performed in accordance with ASTM E 30.

160.4 TEST SPECIMENS:

160.4.1 Test coupons from which tension test pieces are prepared shall be attached to the castings where practicable. If, in the opinion of the manufacturer, the design of the casting is such that test coupons should not be attached thereon, the test coupons shall be cast attached to separate cast blocks. Sufficient coupons shall be cast to represent each lot with additional specimens for use in case retests should be required. A lot shall be considered as all castings in a melt which have constituted part or all of a heat-treatment charge.

160.4.2 Coupons shall remain attached until after the annealing process has been completed. Coupons may be identified by a representative of the ENGINEER. Where test coupons are cast separately from the castings, a representative of the ENGINEER may be present at the time of pouring to identify both coupons and castings. Coupons cast separately from the castings shall not be detached from the block to which they are fastened until identified.

160.4.3 The test coupons shall be of such size that test specimens can be machined to dimensions as specified in the ASTM procedure referred to herein. Where a specimen or machining appears faulty and is intended as a true sample of the lot of casting to which it belongs, the representative of the ENGINEER may substitute another coupon of the lot in question. Test specimens shall be furnished and machined at the CONTRACTOR's expense.

160.5 RETESTS: If the results of the physical test for any lot do not conform to the requirements specified, the manufacturer may reheat-treat such lot. Representative coupons shall be reheat-treated with the lot to serve as retest specimens.

160.6 HIGH-STRENGTH STEEL CASTINGS FOR STRUCTURAL PURPOSES: Castings shall conform to ASTM A 148, Grade 80-50 except that the steel shall contain not less than 0.60 percent of manganese and not less than 0.20 percent of silicon.

160.7 MILD-TO-MEDIUM STRENGTH CARBON-STEEL CASTINGS FOR GENERAL APPLICATION: Casting shall conform to ASTM A 27, Grade 65-35. The metal shall have a minimum Brinell hardness number of 130, when tested in accordance with ASTM Test E-10.

160.8 MEASUREMENT AND PAYMENT

Payment shall be per unit price as specified in the Bid Proposal or may be included in the major construction item unit cost.

SECTION 161

GRAY IRON CASTINGS

161.1 GENERAL

161.1.1 Gray iron castings shall be as shown on the construction plans or the Standard Detail Drawings, and shall be as specified herein. The castings may include: rockers, rocker plate bearings, bearing plates, manhole frames and covers, water valve frames and covers, railings, railing posts, wheel guards, gratings, etc.

161.1.2 The castings shall be true to patterns in form and dimension and free from pouring faults, sponginess, cracks, blowholes, or other defects in locations affecting their strength and value for the service intended. Castings shall be filleted at angles, and risers shall be sharp and true.

161.2 REFERENCES

161.2.1 American Society for Testing and Materials (Latest Editions) (ASTM)

A-48 Standard Specification for Gray Iron Castings

A-438 Standard Test Method for Transverse Testing Of Gray Cast Iron

161.3 TEST SPECIMENS

161.3.1 The number of tension test specimens and their machined dimensions shall be as specified in ASTM A-48.

161.3.2 Depending on the configuration and use of the castings, the ENGINEER may specify that transverse tests of the castings material shall be made in accordance with ASTM A-438. These tests shall be made in addition to the tensile tests.

161.3.3 The manufacturer shall furnish a notarized certificate of compliance which states that the casting material meets or exceeds the requirements for the specified class of material. Test results shall be included with the certificate. The CONTRACTOR shall forward the manufacturer's certificate of compliance and test results to the ENGINEER for each project on which the casting are installed. The CONTRACTOR shall also furnish the ENGINEER with a copy of the manufacturer's shop drawing at the time the certificate of compliance is submitted.

161.4 STORM DRAIN MANHOLE FRAMES AND COVERS

161.4.1 Castings shall conform to ASTM A-48, Class 30B.

161.4.2 The frame and cover dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

161.4.3 The bearing surfaces of the frames and covers shall be machined or ground to provide a uniform, flat, non-rocking seat for the cover on the frame.

161.4.4 The contact sides of the frame and cover shall be tapered as shown on the Standard Detail Drawing.

161.4.5 Manhole frame shall weigh 145 pounds with a plus or minus tolerance of five percent, and the cover shall weigh 180 pounds with a plus or minus tolerance of five percent.

161.4.6 The words "STORM" and "CITY OF ALBUQUERQUE" shall be cast on the manhole cover to indicate the respective system and the name of the city. The letter size shall be 1 inch in height. The words shall be placed as shown in the Standard Detail Drawing. In addition, the name of the foundry shall be cast on the top of the cover, either in the center or within one of the inner concentric circles.

161.5 SANITARY SEWER AND WATER MANHOLE FRAMES AND COVERS (excluding 24-inch covers)

161.5.1 Castings shall conform to ASTM A-48, Class 30B.

161.5.2 The frame and cover dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

161.5.3 The bearing surfaces of the frames and covers shall be machined or ground to provide a uniform, flat, non-rocking seat for the cover on the frame.

161.5.4 The contact sides of the frame and cover shall be tapered as shown on the Standard Detail Drawing.

161.5.5 The weight of the manhole frame and cover shall conform to the weights as shown on the Standard Detail Drawing.

161.5.6 The words “SANITARY” or “WATER” shall be cast on the manhole cover to indicate the respective system. The words shall be placed as shown in the Standard Detail Drawings.

161.6 WATER VALVE, FIRE LINE, AND VACUUM SEWER VALVE FRAME AND COVER

161.6.1 Castings shall conform to ASTM A-48, Class 30B.

161.6.2 The frame and cover dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

161.6.3 The bearing surfaces of the frames and covers shall be machined or ground to provide a uniform, flat, non-rocking seat for the cover on the frame.

161.6.4 The words “WATER”, “FIRE”, or “SEWER” shall be cast on the ring and cover to indicate the respective system. The letters “USA” and the manufacturer’s logo shall be cast on the ring and cover as shown on the Standard Detail Drawing.

161.7 RAILINGS, RAILING POSTS, AND WHEEL GUARDS

161.7.1 Castings shall conform to ASTM A-48, Class 40B.

161.8 ROCKERS, ROCKER PLATE BEARINGS, AND BEARING PLATES FOR BRIDGES

161.8.1 Castings shall conform to ASTM A-48, Class 50B.

161.8.2 Castings shall be machined and finished as specified on the plans. Tool marks on sliding contact surfaces shall run in the direction of plate movement, and in case of rocker plate bearings marks shall be perpendicular to the rocker movement.

161.9 UNCLASSIFIED CASTINGS

161.9.1 All castings not specifically classified, shall conform to the minimum requirements of ASTM A-48, Class 30.

161.10 COATINGS

161.10.1 Manhole frames and covers, and other castings will show bare metal. If specifically required, the castings shall be painted with or dipped in commercial quality asphaltum paint.

161.11 ORIGIN OF MANUFACTURE

161.11.1 To ensure that the specified quality of castings will be guaranteed, only castings manufactured in the United States of America will be acceptable.

161.12 MEASUREMENT AND PAYMENT

161.12.1 Measurement and payment shall be per unit price per defined unit in the bid proposal, or the cost of the castings may be included in major construction item unit costs, such as manhole frame and cover may be included in the cost of the manhole.

SECTION 162

ALUMINUM CASTINGS

162.1 GENERAL

Aluminum castings will be used for water valve extension collar and insert, and may be used for other items as per construction requirements.

162.2 REFERENCES

162.2.1 ASTM B 108

162.3 MATERIAL

162.3.1 The casting shall be true to pattern in form and dimension and shall be free form pouring faults, cracks, blowholes, or other defects in locations affecting the units strength and value of service.

162.3.2 Unless otherwise approved by the ENGINEER, the units shall be cast in permanent molds, using aluminum alloy No. 356, meeting the chemical and tensile strength requirements, as specified in ASTM B 108.

162.3.3 The surfaces, requiring grinding or machining, shall be noted on the drawings.

162.4 WATER VALVE EXTENSION COLLAR AND INSERT

The aluminum water valve extension collar and insert shall be cast and finished in accordance with Standard Detail Drawing.

162.5 OTHER ALUMINUM CASTINGS

For other aluminum casting configurations or uses, detailed or shop drawings shall identify the required dimensions, finishes, and aluminum alloy number.

162.6 MEASUREMENT AND PAYMENT

Measurement and payment shall be the unit price per unit, as specified in the Bid Proposal or may be included in the major construction item's unit cost.

SECTION 163

DUCTILE IRON CASTINGS

163.1 GENERAL:

Ductile iron castings will be used for water meter covers and lids and 24-inch water and 24-inch sanitary sewer manhole covers.

163.2 REFERENCES

163.2.1 American Society for Testing and Materials (Latest Editions) (ASTM)

A-536Specifications for Ductile Iron Castings

163.2.2 American Association of State Highway and Transportation Officials

M 306 Specification for Drainage, Sewer, Utility, and Related Castings

163.3 MATERIALS

163.3.1 The casting shall be true to pattern in form and dimension and shall be free from pouring faults, cracks, blowholes, or other defects in locations affecting the unit's strength and value of service.

163.3.2 Unless otherwise approved by the ENGINEER, the units shall be cast in sand molds, using ductile iron, meeting the chemical and tensile strength requirements, as specified in ASTM A536, Grade 70-50-05.

163.3.3 The surfaces requiring grinding or machining, shall be noted on the drawings.

163.4 TESTING

163.4.1 Separately cast test bars shall be tested and conform to specified tensile requirements including tensile strength, yield strength, and elongation as per ASTM A536.

163.4.2 Castings shall pass proof load testing as specified in AASHTO Std. M 306 for heavy duty, H-20, traffic loads.

163.4.3 The manufacturer shall furnish a certificate of compliance which states that the casting material meets or exceeds the requirements for the specified material. Test results shall be included with the certificate. The CONTRACTOR shall forward the manufacturer's certificate of compliance and test results to the ENGINEER for each project on which the castings are installed. The CONTRACTOR shall also furnish the ENGINEER with a copy of the manufacturer's shop drawing at the time the certificate of compliance is submitted.

163.5 METER COVER AND LID

163.5.1 The meter cover and lid dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

163.5.2 The bearing surface of the lid and cover shall be machined or ground to provide a uniform, flat, non-rocking seat for the lid on the cover.

163.5.3 The words "WATER AUTHORITY" shall be cast on the lid.

163.6 24-INCH MANHOLE COVERS

163.6.1 The cover dimensions shall conform to the dimensions shown on the Standard Detail Drawing.

163.6.2 The bearing surfaces of the frames and covers shall be machined or ground to provide a uniform, flat, non-rocking seat for the cover on the frame.

163.6.3 The contact sides of the frame and cover shall be tapered as shown on the Standard Detail Drawing.

163.6.4 The weight of the manhole frame and cover shall conform to the weights as shown on the Standard Detail Drawing.

163.6.5 The words "SANITARY" or "WATER" shall be cast on the manhole cover to indicate the respective system. The name of the foundry shall be cast on the cover. The words "ALBUQUERQUE BERNALILLO COUNTY WATER UTILITY AUTHORITY" shall be cast on the 24" covers. The words shall be placed as shown in the Standard Detail Drawings.

163.7 COATINGS

163.7.1 Manhole covers and water meter covers and lids will show bare metal. If specifically required, the castings shall be painted with or dipped in commercial quality asphaltum paint or other approved bituminous seal coat.

163.8 ORIGIN OF MANUFACTURE

163.8.1 To ensure that the specified quality of castings will be guaranteed, only castings manufactured in the United States of America will be acceptable.

163.9 MEASUREMENT AND PAYMENT

163.9.1 Measurement and payment shall be per unit price per defined unit in the bid proposal, or the cost of the castings may be included in major construction item unit cost such as meter box rehabilitation, installation, or relocation.

SECTION 170
ELECTRONIC MARKER DEVICES

170.1 GENERAL: Electronic location markers shall consist of devices having a passive inductive device capable of reflecting a specifically designated impulse frequency, unique to the utility being installed. Devices shall be color-coded in accordance with the American Public Works Association's Utility Location and Coordinating Council Standards. Electronic Marker Devices (EMDs) shall be from a listed manufacturer on the current Water Authority Approved Product List

170.2 REFERENCES

170.3 INSTALLATION: Marker devices shall be installed approximately 6-inches over the point to be located, and a minimum of 6-inches from any metal object. However, depth of burial shall not be less than 2-1/2-feet nor more than 6-feet. Devices shall be hand backfilled to 1-foot above the device to prevent movement or damage.

170.4 PLACEMENT: Electronic Marker Devices shall be installed at the following locations:

170.4.1 SANITARY SEWER

170.4.1.1 At all manholes, one foot upstream of the manhole over the centerline of the main line.

170.4.1.2 At temporary dead ends of lines.

170.4.1.3 At the property line for all service laterals, including service stubs from vacuum pits.

170.4.1.4 At the centerline of the gravity main line over all taps, risers, wyes or deflections (points of curvature).

170.4.1.5 At all plugged tees.

170.4.1.6 At upper bend on vacuum sewer lifts.

170.4.1.7 At wye for branch line connection to vacuum sewer main.

170.4.1.8 At valves on vacuum sewer mains, one foot north or west of the valve over the line.

170.4.1.9 On Sanitary Sewer Force Mains:

170.4.1.9.1 At valves, one foot north or west of the valve over the main line.

170.4.1.9.2 At pipe deflections and bends, 11¼ degrees and larger.

170.4.1.9.3 At capped or plugged ends.

170.4.1.9.4 At tees over the main line.

170.4.1.9.5 For single services, over the main line at the service tap.

170.4.1.9.6 On runs of main line, the maximum spacing between EMDs shall be 100 feet.

170.4.2 WATER LINES:

170.4.2.1 At valves, one foot north or west of the valve over the main line.

170.4.2.2 At flanged outlets on concrete cylinder pipes.

170.4.2.3 At pipe deflections and bends 11¼ degrees and larger.

170.4.2.4 At capped or plugged ends.

170.4.2.5 At tees over the main line.

170.4.2.6 For single services, over the main line at the service tap.

170.4.2.7 For double services, over the main line halfway between the service taps.

170.4.2.8 On runs of main line, the maximum spacing between EMDs shall be 100 feet.

170.5 CERTIFICATION

170.5.1 The CONTRACTOR shall certify in writing that the Electronic Marker Device is in place, prior to paving over any of the above locations. Electronic Marker Devices that are found to be missing shall be installed at the CONTRACTOR's expense.

170.6 MEASUREMENT AND PAYMENT: No separate measurement or payment will be made for Electronic Marker Devices.