AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT		1. CONTRACT ID CODE	PAGE OF PAGES 1 of 3

2. AMENDMENT/MODIFICATION NO.	3. EFFECTIVE DATE	4. REQUISITION/PURCHASE REQ. NO.	5. PROJECT NO. *(If applicable)*
6	28-Mar-2003		

6. ISSUED BY	CODE	7. ADMINISTERED BY *(If other than item 6)*	CODE
US Army Corps of Engineers, Kansas City District 760 Federal Building, 601 East 12th Street Kansas City, Missouri 64106-2896			

8. NAME AND ADDRESS OF CONTRACTOR *(No.,street, county, State and ZIP Code)*	(x)	9a. AMENDMENT OF SOLICITATION NO.
	X	DACW41-03-R-0063
		9B. DATED *(SEE ITEM 11)* 3/1/2003
		10A. MODIFICATION OF CONTRACT/ORDER NO.
		10B. DATED *(SEE ITEM 13)*
CODE FACILITY CODE		

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

[X] The above number solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers [ ] is extended, [X] is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitaiton or as amended, by one of the following methods: (a) By completing Items 8 and 15, and returning____ copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegraph which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFEF If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA *(If required)*

13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS,
IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(X)	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: *(Specify authority)* THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A.
	B. THE ABOVE NUMBER CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES *(such as changes in paying office, appropriation date, etc.)* SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF:
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER *(Specify type of modification and authority)*

E. IMPORTANT: Contractor [ ] is not, [ ] is required to sign this document and return copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION *(Organized by UCF section headings, including solicitation/contract subject matter where feasible.)*

Prospect Bridge and Brush Creek Re-Channelization
Kansas City, Missouri

The Solicitation is amended in accordance with the attached pages.

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER *(Type or print)*		16A. NAME AND TITLE OF CONTRACTING OFFICER *(Type or print)*	
15B. CONTRACTOR/OFFEROR *(Signature of person authorized to sign)*	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY *(Signature of Contracting Officer)*	16C. DATE SIGNED

The SOLICITATION is amended as follows:

1. SPECIFICATIONS:

~~Narrative Changes~~: The following are changes made narratively to the Specifications.

~~Pages 153 and 154 of 167~~: Delete paragraph 3, PROPOSAL CONTENT under SUBMISSION REQUIREMENTS AND INSTRUCTIONS, and replace in its entirety with the following:

"**SUBMISSION REQUIREMENTS AND INSTRUCTIONS**

3. PROPOSAL CONTENT

"FACTOR 3. Schedule. This factor considers the offeror's capability to execute this work in a timely manner. Offerors shall submit a schedule which includes the milestone dates required by this solicitation and additional major activities, which will reflect the offeror's planned sequence of execution to develop the most expeditious completion date for this project. A minimum of twenty (20) milestones and major activities shall be provided with the offeror's proposal. Offerors shall use durations, not calendar dates., to describe their schedule except for specified milestones. (For example: "The offeror will complete task XX within 10 days after the government issues notice to proceed.") Schedule shall be displayed on a "Gantt Chart" which indicates sequence, duration and milestones. For the sole purpose of evaluating this factor, offerors shall assume a Notice To Proceed to be issued on April 15th, 2003 to base the specified milestones and activity durations on.
The Government reserves the right to incorporate proposed schedule into the contract."

~~Pages 162 and 163 of 167:~~ Delete paragraph 1. PROPOSAL EVALUATION under PROPOSAL EVALUATION AND CONTRACT AWARD and replace in its entirety with the following:

"PROPOSAL EVALUATION AND CONTRACT AWARD

1. PROPOSAL EVALUATION

FACTOR 3 - SCHEDULE: This factor considers the offeror's capability to execute this work in a timely manner. Offerors shall submit a schedule which includes the milestone dates required by this solicitation and additional major activities, which will reflect the offeror's planned sequence of execution to develop the most expeditious completion date for this project. A minimum of twenty (20) milestones and major activities shall be provided with the offeror's proposal. Schedule shall be displayed on a "Gantt Chart" which indicates sequence, duration and milestones. For the sole purpose of evaluating this factor, offerors shall assume a Notice To Proceed to be issued on April 15th, 2003 to base the specified milestones and activity durations on.

a. EXECUTION OF WORK TASKS: At a minimum, the proposal must demonstrate that the offeror can meet the schedule in the solicitation. Proposals that fail to demonstrate this will not be considered technically acceptable. The schedule is contained in Specifications Section 01100 GENERAL, paragraph 1.46 and 1.47.

b. NETWORK ANALYSIS: Milestones dates and activities must be based upon a network analysis, which satisfies the requirements of this solicitation.

c. REASONABLENESS OF DATES: Project completion date or intermediate milestones/activity durations which are not reasonable or realistic will result in the proposal being considered not technically unacceptable."

~~Section 01100 GENERAL, paragraph 1.12 UNAVAILABILITY OF RIGHT-OF-WAY:~~ Delete the subparagraph titled "TEMPORARY CONSTRUCTION EASEMENTS" in its entirety.

~~Section 02466 DRILLED FOUNDATION CAISSONS (PIERS), paragraph P.2.1.2 Reinforcing Steel~~ is

changed to read as follows:

"Reinforcing steel shall conform to ASTM A 6.15 Grade 60. Steel shall be welded into cages in accordance with AWS D1.4 or wire tied into the cages and inserted securely in the caissons, in position and alignment, as shown, prior to concrete placement. Wire ties are specified in Section 03210."

~~Revised Sections:~~

Section 00010 BIDDING SCHEDULE: A complete bidding schedule incorporating all amendments is attached.

Section 03311 CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS is deleted and replaced with a revised section of the same number and name. Revisions have been underlined for convenience. However, all portions of the revised section apply whether or not changes have been indicated. A copy of the revised section is attached.

Section 02200 PAVEMENT, which was a new section added by Amendment 0003, is attached.

2. DRAWINGS:

~~Narrative Changes:~~ The following are changes made narratively to the Drawings.

Sheet M1.4:

Section A: At "14 inch Ductile Iron Pipe" reference add the following:
24"x14" Ductile fitting. Transition to 24" Diameter PVC Pipe three (3) past the 24"x14" Ductile Iron Fitting. Ductile Iron Fitting to occur five (5) feet from the pump well. Pipe shall be sloped for drainage into the pump well. Use a mechanical type joint fitting for the transition between 24" Ductile Iron and 24" PVC Pipe."

Section B: Add the following to the access hatch note:
Access hatch to be Hydr-O-Matic aluminum S12 door and frame assembly or equal. Contractor to verify exact location of hatchway and confirm all dimensions with pump manufacturer to ensure proper alignment of pumps, rails, and hatchway.

Sheet T1.4:

Delete notation and arrow leader to "Staging Area" and associated boundary lines to indicated area.

Sheet T1.5:

Delete all references to "Temp Easement". Delete Note 2. which states "LOT 308 AND PORTIONS OF 273 & 274 SHALL BE ACQUIRED AS CONSTRUCTION EASEMENT.

3. Offerors are required to acknowledge receipt of this amendment in the space provided on the SF30, or by separate letter or telegram prior to receipt of offers. Failure to acknowledge all amendments may cause rejection of the offer.

4. Proposals will be received until 2:00 p.m., local time, 3 April 2003, in Room 760 Federal Building, 601 E. 12th Street, Kansas City, Missouri 64106-2896. Points of Contact are as follows:

Contract Specialist:	Gregg Gulledge	816-983-3808
Project Manager:	Kent Myers	816-983-3399

Section 00010 - Solicitation Contract Form

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0001		1	Lump Sum		

Demolition, General
FFP
"Demolition General", includes but not limited to, channel paving to be broken, removed and placed in areas noted on the drawings or in the specifications; channel paving to be broken and remain in place; asphalt pavement; all pipe shown to be grouted full in place, and all pipe shown to be removed.
PURCHASE REQUEST NUMBER: W58XUW-2347-3613

NET AMT

FOB: Destination

ITEM NO.	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0001a		1	Lump Sum		

Demolition of Prospect Bridge
FFP
“Demolition of Prospect Bridge” includes full removal of the asphalt/ concrete approach slabs, concrete paved deck, utility line hanging on the bridge, any retaining wing walls shown as being removed on the drawings, and south abutment and foundation. Remove north abutment as shown on the drawing.

NET AMT

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0002		1	Allowance		$50,000.00

KCPL
FFP
KCPL", Reimbursement of work done by KCPL. Adjustment will be made to the contract to match the amount billed by KCPL.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0003		1	Lump Sum		

Sanitary Sewer
FFP
Sanitary Sewers" and 0004, "Storm Sewers" includes all earthwork, trenching, pipe, Manholes (includes the construction of manholes, including modifications to existing manholes, excavations, bracing of excavations, materials used for manhole construction, backfilling and manhole lids), Drop Inlets (includes construction of drop inlets, including modifications to existing drop inlets, excavations, bracing of excavations, materials used for drop inlet construction and backfilling), Curb Inlets (includes construction of curb inlets, including modifications to existing curb inlets, excavations, bracing of excavations, materials used for curb inlet construction and backfilling), Field Inlets (includes construction of field inlets, including modifications to existing field inlets, excavations, bracing of excavations, materials used for field inlet construction and backfilling), manhole lining, connections, temporary service and any other incidental work.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0004		1	Lump Sum		
	Storm Sewer FFP				

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0005		1	Lump Sum		
	Clearing and Grubbing FFP Clearing and Grubbing" is for the clearing and grubbing work required and defined in SECTION: CLEARING, GRUBBING AND DEMOLITION.				

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0006		28,560	Cubic Yard		

Rock Excavation
FFP
" Rock Excavation", includes all work required to excavate all rock units below the top of hard rock. Hard rock is defined as limestone.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0007		226,930	Cubic Yard		

Common Excavation
FFP
" Common Excavation", includes excavation of all clay, silts, sand, gravel, pebbles, cobbles, boulders and shale.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0008		58,700	Cubic Yard		

Random Fill
FFP
" Random Fill", includes all placement of clay, silts, sands, gravel, pebbles, cobbles and top soil.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0009		2,690	Cubic Yard		

Impervious Fill
FFP
" Impervious Fill", includes all placement of clays (CH and CL).

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0010		12,000	Cubic Yard		

Pervious Fill
FFP
" Pervious Fill", includes all delivery and placement of siliceous and natural sand to be used as backfill for channel walls.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0011		815	Cubic Yard		

Coarse Filter
FFP
"Coarse Filter", includes all delivery and placement of crushed limestone (ASTM C-33, size 7) to be used as backfill for channel walls.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0012		14,000	Ton		

Quarry-Run Rock
FFP
" Quarry-Run Rock", includes all delivery and placement of tough, durable particles well graded between the maximum and minimum sizes. The upper limit of size for this material shall not exceed the layer thickness required. Not more than 15 percent shall pass the 2-inch sieve.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0013		10,200	Square Yard		

Paved Slope Protection
FFP
"Paved Slope Protection", includes concrete and rock slope protection, placed into the concrete matrix, at the spacing indicated on the drawings.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0014		10,980	Square Foot		

Modular Block Walls
FFP
" Modular Block Walls", includes un-reinforced concrete footings, geogrid strips, granular backfill, and related excavation.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0015		4,500	Square Yard		

6-inch Concrete Sidewalk
FFP
" 6-Inch Concrete Sidewalk", includes concrete with wire mesh, surface subgrade preparation, crushed rock, concrete curb and detectable paver blocks where required.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0016		1,200	Square Yard		

8-inch Concrete Ramp Accessway
FFP
"8-inch Concrete Ramp Accessway", includes concrete with wire mesh, surface subgrade preparation and crushed rock.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0017		800	Square Yard		

18-inch Concrete Channel Pavement
FFP
"18-inch Concrete Channel Pavement", includes anchors, reinforcing steel, and drains as shown on the drawings.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0018		1,330	Square Yard		

12-inch Concrete Channel Pavement
FFP
" Concrete Channel Pavement", concrete with reinforcing steel.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0019		3,200	Square Yard		

6-inch Concrete Channel Pavement
FFP
"6-inch Concrete Channel Pavement", includes reinforced concrete and anchors

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0020			Lump Sum		

Seeding and Mulching
FFP
Seeding and Mulching", includes seed and mulch

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0021			Lump Sum		

Swope Parkway Trail
FFP
"Swope Park Trail", includes modular block wall with footings, crushed rock, subgrade preparation, 6-inch sidewalk, curbing and outlook concrete; reinforcing steel, expansion joints materials, handrails, handrail footings, signage and bike gap bollards. 8-inch concrete paving (8") is covered in the options.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0022			Lump Sum		

Drop Structure
FFP
"Drop Structure", includes select material; 4-inch drainpipe; 1-inch sponge rubber; coarse filter; reinforced drop structure concrete and 4-inch perforated pipe.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0023			Lump Sum		

Dam No.1
FFP
"Dam No. 1", includes structural dam reinforced concrete and gravity wall concrete.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0024			Lump Sum		

Dam No. 2
FFP
"Dam No. 2", includes structural dam reinforced concrete and gravity wall concrete.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0025			Lump Sum		

Dam No. 3
FFP
"Dam No. 3", includes 1, structural dam reinforced concrete and rock anchors. Channel walls that are monolithic with dam structures are also included in this bid item.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0026			Lump Sum		

Dam No. 4
FFP
"Dam No. 4", includes structural dam reinforced concrete and select material

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0027			Lump Sum		

Dam No. 5
FFP
Dam No. 5", includes structural dam reinforced concrete and select material.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0028			Lump Sum		

Dam No. 6
FFP
Dam No. 6", includes structur al dam reinforced concrete and select material

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0029		660	Square Yards		

Anchored Walls
FFP
"Anchored Walls", includes reinforced concrete, wall anchors and drains. This quantity accounts for channel support walls and access ramp support walls outside the definition of the dam in other bid items.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0030		100	Cubic Yards		

Gravity Walls
FFP
"Gravity Walls", includes gravity wall concrete outside of the definition of the dam in other bid items. This quantity accounts for channel support walls and access ramp support walls outside of the definition of the dam in other bid items.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0031		2,195	Cubic Yards		

L- Walls
FFP
"L-Walls". This quantity accounts for channel support walls and access ramp support walls outside the definition of the dam in other bid items.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0032		200	Cubic Yards		

T-Wall
FFP
"T-Walls". This quantity accounts for channel support walls and access ramp support walls outside of the definition of the dam in other bid items.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0033		6	Each		

Dam Intake Drainage Structure
FFP
"Dam Intake Drainage Structures", includes the cost excavate the soils or shore and brace soils, place concrete with all steel and backfill control structure. The reinforced concrete pipe will be associated with each structure is considered incidental. Trash racks, grating, manhole covers, gate and gate assembles, that are associated with the Dam Intake Drainage Structures are included in this bid item.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0034			Lump Sum		

Pumpwell
FFP
"Pumpwell", includes all work required to construct the Pumpwell and to furnish and install the Pump. The grating and manhole cover associated with the Pumpwell are included in this bid item.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0035			Lump Sum		

New Prospect Bridge
FFP
"New Prospect Bridge" includes all costs to maintain all traffic controls, miscellaneous excavations, place foundations supports, drilled foundation caissons (piers), H-piles, construct steel support, abutments, construct all bridge decking materials, aesthetic facing requirements, graffiti protection, all miscellaneous metals, permanent concrete traffic barriers, bridge railings, and geotextile fabric and bridge approach slabs indicated on the drawings.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0036		110	Cubic Yard		

Monolith Walls
FFP
"Monolith Walls", includes all work required to construct reinforced concrete Monoliths A, B, C D and E.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0037			Lump Sum		

Electrical Work
FFP
"Electrical Work", includes 16 bridge lights, 4 light fixtures mounted to the bridge sub-structure for walkway illumination, panel board HA, conduit crossing at Station 8+00 +/-, pullboxes PB1 and PB2, all associated work to connect with the KCPL switchgear and transformer, all associated power and control wiring of recirculating pump, water probes and associated wiring, and fountain conduit rough-in as shown on the drawings. It also includes, "Traffic Intersection Signal Work", all traffic signs and signals not covered in the New Prospect Bridge bid item.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0038			Lump Sum		

Prospect Ave-Pavement Curbs & Gutters, Walks & Islands, and Pavement Markings
FFP
"Prospect Ave - Pavement, Curbs & Gutters, Walks & Islands, and Pavement Markings", includes asphalt intermediate course, surface course, subgrade preparation, base course, prime coat, and tack coat. The work also includes earthwork, concrete curbs and gutters, concrete sidewalks, ramps, and traffic islands, new pavement markings, and temporary signage and flagmen, as required.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0039			Lump Sum		

Ramp Bollards with Chains
FFP
" Ramp Bollards with Chains", include Bollards and equipment associated with access to the channel; and all excavations and backfill required to install the system.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0040			Lump Sum		

Detour Signage
FFP
"Detour Signage", includes obtaining permits from Mo. Department of Transportation and the City of Kansas City, Missouri, placing and maintaining detour signs, barriers, barricades, and signal lighting.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0041			Lump Sum		

Re-circulation System
FFP
"Re-circulation System", includes excavation, bedding, backfill, pipe, thrust blocks, valves, valve housings, reducers, and grate as indicated for the recirculation system and excavation, bedding, and backfill for fountain piping.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0042		1	Lump Sum		

Water Line
FFP
"Water Line" includes water line pipe, thrust blocks, valves, concrete, trenching, bedding, connections, and the disinfecting and testing of the new water line.

NET AMT

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0043			Lump Sum		
OPTION					

Swope Parkway Concrete Pavement
FFP
"Swope Parkway Concrete Pavement", includes forms, reinforcing, 400 cubic yards of 8-inch concrete pavement with joints, finishing & curing.

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0044			Lump Sum		
OPTION	Sidewalk Lights FFP "Sidewalk Lights", includes, but is not limited to light poles, conduit, wiring, lighting cabinet, as indicated on the drawings.				

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045					
OPTION	Plantings FFP “Plantings”, includes providing the list of planting shown in the specifications and planting at locations to be determined by the Kansas City, Missouri, Parks and Recreation Department.				

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AA OPTION	Red Sunset Maple (2 1/2-in. cal.) FFP	12	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AB OPTION	Heritage River Birch (2 1/2-in. cal.) FFP	7	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AC OPTION	Cercis Canadensis Redbud (1 1/2-in. cal) FFP	6	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AD OPTION	Flowering Dogwood (1 1/2-in. cal) FFP	8	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AE OPTION	Autumn Purple Ash (2 1/2-in. cal) FFP	15	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AF OPTION	American Holly (2-in. cal) FFP	4	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AG OPTION	Sargent Crabapple (1 1/2-in. cal) FFP	12	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AH OPTION	Black Gum (2-in. cal) FFP	3	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AJ OPTION	White Pine (8-feet in height) FFP	31	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AK OPTION	London Planetree (2 1/2-in. cal) FFP	10	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AL OPTION	Swamp White Oak (2 1/2-in cal) FFP	5	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AM OPTION	Red Oak (2 1/2-in. cal) FFP	6	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AN OPTION	Bald Cypress (2 1/2-in. cal) FFP	7	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AP OPTION	Chanticleer Pear (2 1/2-in. cal) FFP	12	Each		

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0045AQ			Allowance		$10,000
OPTION	Watering all Trees FFP				

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0046		120,000	Square Foot		
OPTION	Turf Reinforcement Mat FFP "Turf Reinforcement Mat", includes all work required to provide furnish and install the Turf Reinforcement Mat, as indicated in the specifications				

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0047		4,000	Square Yard		
OPTION	Paved Slope Protection FFP "Paved Slope Protection", includes all work required to furnish and install the additional rock and concrete slope protection, as indicated in the specifications.				

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0048			Lump Sum		
OPTION	Invert Channel Protection FFP "Invert Channel Protection", (Sta. 12+70 to 30+80), includes all work required to provide 12,000 tons of tabular blocks of sound durable limestone, and 12-inch concrete accessway, reinforcing steel and foam rubber and 12-inch quarry run rock material.				

NET AMT

FOB: Destination

ITEM NO	SUPPLIES/ SERVICES	QUANTITY	UNIT	UNIT PRICE	AMOUNT
0049		2,275	Square Yard		
OPTION	18-inch Concrete Channel Pavement FFP "18-inch Concrete Channel Pavement", includes all work required to provide 18-inch concrete channel pavement, in the Reach between the Prospect Bridge and Dam No. 3. The work includes anchors, reinforcing steel and drains, as shown on the drawings.				

NET AMT

FOB: Destination

SECTION 2201 SUBGRADE PREPARATION

Referenced Standards: The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM
D 698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2201.1 Summary: This section includes subgrade preparation at locations which have been previously graded in accordance with the requirements of Section 2100 entitled "Grading and Site Preparation".

2201.2 Definitions:

A. **Subgrade:** Subgrade is defined as a well graded and compacted layer on which base and subsequent courses are placed.

B. **Subgrade Preparation:** Subgrade preparation is the repeated operation of fine-grading and compacting the subgrade until the specified lines, grades, and cross-section, as indicated on the plans are obtained and the materials are compacted to the specified depth and density.

2201.3 Construction:

A. **General:** The subgrade surface shall be brought to the specified lines, grades and cross-section by adding or removing material and compacting to the specified density. Tolerance allowed on all lines, grades and cross-sections shall be no more than 1/4 inch (6 mm).

B. **Compacting the Subgrade:** The top 6 inches (15.24 cm) of subgrade for pavements shall be compacted to 95% of the standard proctor maximum density for the material used as determined by ASTM D 698 and within a tolerance of plus 3% and minus 2% of the optimum moisture content. The tolerance applies only to the top 6 inches (15.24 cm).

C. **Protection and Maintenance of Subgrade:** The subgrade shall be protected from action of the elements or others. Any action (eg. settlement or erosion) that damages the subgrade prior to placing the pavement thereon, shall be repaired and the specific lines, grades, cross-section, tolerance, density, and moisture content range reestablished.

The Contractor shall protect all existing improvements from damage resulting from his subgrade operation. Any improvement damaged shall be repaired or replaced by the Contractor at his own expense.

D. **Cleanup:** Subgrade cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, surplus or discarded material, unsuitable material, and any equipment, tools and temporary construction items used for the preparation of the subgrade.

E. **Roll Testing:** Once the subgrade has been brought to the final plan elevation, but prior to approval of the subgrade for paving, all lanes shall be roll tested in their entire length. The subgrade will not be acceptable if rutting, pumping, or deformation of the subgrade results from the roll test. This testing will be done by the contractor, and will be in addition to the applicable moisture and density testing.

Equipment for roll testing shall be a tandem dump truck (one front and two rear axles) carrying the maximum allowable legal load.

The truck shall proceed slowly along each traffic lane, allowing the Engineer to walk alongside and observe the results. Areas failing the roll test will be reworked and retested prior to approval of the subgrade for paving.

2201.4 Methods of Measurement: Subgrade Preparation will generally not be listed in the Proposal as a separate item.

2201.5 Basis of Payment: Subgrade Preparation will generally be included in payment for other items listed in this proposal.

SECTION 2202 UNTREATED COMPACTED AGGREGATE

Referenced Standards: The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM
C 88 - Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142 - Test Method for Clay Lumps and Friable Particles in Aggregates

D 4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

AASHTO
T 99 - The Moisture-Density Relations of Soils Using a 5.5-lb. (2.5 kg) Rammer and a 12-in. (305 mm) Drop

2202.1 Summary: This section includes the construction of aggregate base course as outlined in the contract special provisions and on the plans.

2202.2 Material: The base course material shall consist of crushed stone aggregate with not more than 1.0% clay lumps and friable particles in accordance with ASTM C 142, and free from vegetable or other deleterious substances. The abrasion loss shall be no more than 35% when tested in accordance with ASTM C 131. That fraction passing the 1 inch (25.0 mm) sieve and retained on the No. 4 (4.75 mm) sieve shall have a loss not greater than 15% by weighted average at 5 cycles of ASTM C 88 (Magnesium Sulfate) Soundness Test. That fraction of the material passing the 1-inch (25.0 mm) Sieve and retained on the No. 4 (4.75 mm) Sieve shall contain less than 20% by weight of flat and elongated particles (flat being a ratio of 1 to 3 between thickness and least width and a ratio of 1 to 3 between the least width and length). The material shall consist of angular particles with no less than 90% of particle count having two or more fractured surfaces. The gradation in percentages by weight passing square mesh sieves shall be in accordance with ASTM C 136 and as follows:

U. S. Standard Square Mesh Sieve	Percent Passing
1-1/4" (31.5 mm)	100
1" (25.0 mm)	72-100
3/4" (19.0 mm)	60-90
3/8" (9.5 mm)	43-74
No. 4 (4.75 mm)	28-60
No. 10 (2.00 mm)	16-40
No. 40 (425 um)	3-22
No. 200 (75 um)	0-15

In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 percent.

That fraction of the material passing the No. 40 (425 um) sieve shall have a plasticity index not to exceed 8 when tested in accordance with ASTM D 4318.

2202.3 Placement:

A. **Subgrade:** Prior to placement of base course material the previously prepared subgrade surface shall be cleared of all foreign substances and restored in shape, tolerance and density as specified in Section 2201 entitled "Subgrade Preparation".

B. **Material Placement:** The material shall be uniformly spread in successive layers to such depth that when compacted, the base will have the minimum thickness specified. The contractor may construct the base in any number of layers that he chooses except that in no case shall any individual layer have a compacted thickness of more than 4 inches (10.16 cm). Each layer shall be compacted as hereinafter specified before any succeeding layer is placed.

After spreading a layer of material, water in an amount sufficient to insure the desired compaction shall be added and uniformly mixed with the aggregate in a manner to prevent segregation. Excess moisture resulting in runoff shall be avoided. If for any reason, the material and subgrade become too wet to permit satisfactory work, they shall be allowed to dry to a moisture content that will permit satisfactory work.

C. The material shall meet the required specifications immediately before compaction operations are commenced. If, for any reason, segregation occurs in excess of 10% variation from the gradation required under the above paragraph "Material" or the materials become contaminated, such segregated or contaminated materials shall be removed and replaced with suitable materials at the expense of the Contractor. The limited segregation of 10% variation will be ascertained by a sieve analysis of a

minimum 100 pound (45.36 Kg) sample taken from the in-place base course. However, when crushed stone is used, segregated surface areas may be corrected by adding limestone screenings of such gradation and quantity as required to fill the surface voids and firmly bind the loose material in place. Screenings so used in correcting segregated surface areas will be paid for as a part of the aggregate base material.

D. Shaping and compacting shall be carried on continuously until a true, even and uniform surface of proper grade and cross-section is obtained, and until the density of the complete base is at least 95% of maximum density as determined by AASHTO T 99. The proper moisture content shall be maintained by wetting the surface as required during shaping and compacting operations. Final rolling shall be accomplished by use of a self-propelled smooth-wheeled roller.

2202.4 Methods of Measurement: Untreated Compacted Aggregate Base will be measured by one of the following:

A. Per square yard (square meter) or tenth part thereof for the specified depth.

B. Per ton (metric ton) or tenth part thereof.

2202.5 Basis of Payment: Untreated Compacted Aggregate Base will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2203 DRAINABLE BASE COURSE

Referenced Standards: The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM

C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 33 - Standard Specification for Concrete Aggregates
C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 88 - Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117 - Test Method for Materials Finer than 75- um (No. 200) Sieve in Mineral Aggregates by Washing
C 131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 150 - Standard Specification for Portland Cement
D 75 - Practice for Sampling Aggregates
D 695 - Test Method for Compressive Properties of Rigid PlasticsD 946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
D 1621 - Test Method for Compressive Properties Of Rigid Cellular Plastics
D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
D 3034 - Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
D 3666 - Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D 4716 - Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D 4791 - Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
D 5821 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
F 758 - Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

AASHTO

M 252 Corrugated Polyethylene Drainage Tubing

T 102 Spot Test of Asphaltic Materials

2203.1 Summary: This section includes the requirements for drainable base courses.

2203.2 Materials: All drainable base materials shall have a minimum coefficient of permeability of 1000 ft/day (305 m/day) as determined by the test method described in 2203.7.

2203.3 Crushed Aggregate Base Course

A. **Materials:**

1. Aggregates shall consist of clean, sound, durable particles of crushed stone or crushed gravel and shall be free from coatings of clay, silt, vegetable matter, and other objectionable materials and shall contain no clay balls.

2. Fine aggregate (passing the No. 4 (4.75 mm) sieve) shall consist of fines from the operation of crushing the coarse aggregate. If necessary, additional fine aggregate may be added to produce the correct gradation. All fine aggregate shall be produced by crushing stone or gravel that meets the requirements for wear and soundness specified for the coarse aggregate.

3. The crushed aggregate portion which is retained on the No. 4 (4.75 mm) sieve shall contain not more than 15%, by weight, of flat and elongated pieces as defined in ASTM D 4791 (ratio = 5:1) and shall have at least 90% by weight of particles with at least two fractured faces and 100% with at least one fractured face. The area of each face shall be equal to at least 75% of the smallest midsectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

4. The percentage of wear shall not be greater than 35% when tested in accordance with ASTM C 131.

5. The magnesium sulfate soundness loss shall not exceed 15%, after 5 cycles, when tested in accordance with ASTM C 88.

6. The fraction passing the No. 40 (0.42 mm) sieve shall have a liquid limit no greater than 25 and a plasticity index of not more than 8 when tested in accordance with ASTM D 4318. The fine aggregate shall have a minimum sand equivalent value of 35 when tested in accordance with ASTM D 2419.

B. **Sampling and Testing**: Aggregates for preliminary testing shall be furnished by the Contractor prior to the start of production. All tests for initial aggregate submittal necessary to determine compliance with the specification requirements shall be made by the Contractor at no expense to the Engineer.

1. Samples of aggregates shall be furnished by the Contractor at his expense at the start of production and at intervals during production. The sampling points and intervals will be designated by the Engineer. The samples will be the basis of approval of aggregates from the standpoint of the quality requirements of this Section.

2. Sampling may be observed by and shall be subject to the approval of the Engineer. Samples shall be large enough to provide ample material to the satisfaction of the Engineer. No aggregate shall be incorporated in the Work without prior approval by the Engineer.

3. In lieu of testing, the Engineer may accept certified test results performed by an approved independent testing laboratory indicating that the aggregate meets specification requirements. Certified test results shall be less than 6 months old.

4. Samples of the aggregate to check gradation may be taken by the Engineer at least once daily. Sampling shall be in accordance with ASTM D 75, and testing shall be in accordance with ASTM C 136 and C 117.

C. **Gradation Requirements:** The gradation (job mix) of the final mixture shall fall within the design range indicated in Table 1, when tested in accordance with ASTM C 117 and C 136.

TABLE 1. REQUIREMENTS FOR GRADATION OF AGGREGATE		
Sieve Size	Design Range Percentage by Weight Passing Sieves	Job Mix Tolerances Percent
2 in (50 mm)	100	
1-1/2 in (37.5 mm)	100	+/- 5
1 in (25.4 mm)	70-100	+/- 8
3/4 in (19 mm)	55-100	+/- 8
1/2 in (12.5 mm)	40-80	+/- 8
3/8 in (9.5 mm)	30-70	+/- 8
No. 4 (4.75 mm)	10-45	+/- 8
No. 8 (2.36 mm)	0-25	+/- 5
No. 16 (1.18 mm)	0-5	+/- 3

The job mix tolerances in Table 1 shall be applied to the job mix gradation to establish a job control grading band. The resulting job control grading band must comply with the Design Range criteria.

2203.4 Portland Cement Concrete Drainable Base

A. **Summary:** This item shall consist of an open-graded drainable base composed of mineral aggregate, Portland cement and water mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses and typical cross sections shown on the plans.

B. **Materials:**

1. **Course Aggregate:**

   a. **General:** Course aggregate shall be ¾ inch (19 mm) maximum size consisting of crushed gravel or crushed stone and shall meet the requirements of ASTM C 33 and quality requirements of 2203.3a.

   b. Gradation shall be ASTM C 33, Size 67.

2. **Fine Aggregate:** Fine aggregate shall consist of natural sand or manufactured sand meeting the requirements of ASTM C 33.

3. **Cement:** Portland cement shall conform to the requirements of ASTM C 150, Type I or Type II. Substitution of fly ash or other pozzolan for Portland cement shall be in conformance with Section 2208.

4. **Water:** Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable or other substances injurious to the finished product as possible. Water known to be of potable quality may be used without testing.

5. **Admixtures:** The use of any material to be added to the mixture shall be approved by the Engineer.

C. The Contractor shall furnish vendor's certified test reports for the materials used in the project. The report shall be delivered to the Engineer as part of the mix design before permission to use the cement is granted.

D. **Proportions:** The Contractor shall submit a mix design containing the quantity of each material to the the Engineer including certifications of materials used. The Contractor will be responsible for preparing the drainable base mix design at no cost to the Owner. The testing laboratory preparing the mix design shall comply with Section 2203.5F. The mix design shall include the following:

Cement Content.

Water-Cement Ratio. Approximately 0.36.

Coarse Aggregate.

Fine Aggregate.

All Admixtures.

Coefficient of Permeability. Tested per Section 2203.7.

Compressive Strength. Proportions will be such to produce a compressive strength of 800 psi (5.52 Mpa) in 28 days as determined by test cylinders made in accordance with ASTM C 31 and tested in accordance with ASTM C 39. A strength of 500 psi (3.45 MPa) will be required prior to any traffic being allowed on the surface.

E. **Spreading:** The base material shall be spread to the lines and grades shown on the Plans. Any material which becomes mixed with soil or other contaminants shall be removed and replaced with fresh mixture.

F. **Compaction:** After spreading and/or trimming, the base material shall be uniformly compacted by making a minimum of 2 coverages with a steel wheeled roller meeting the requirements of Section 2205.7 B 1. The compaction process may be adjusted on the project by the Contractor with approval of the Engineer to assure uniform compaction of the drainable base material. In areas not accessible by the roller, the base material shall be compacted by mechanical hand methods. Compaction must be completed within 2 hours of the time water is introduced to the mixture.

If after spreading and compacting the base is not to the required lines and grade, the Contractor shall trim the base by means of an electronically controlled machine utilizing string line controls for grade. The Engineer reserves the right to direct the Contractor to suspend all operations if the Contractor produces excessive fines in the trimming process which are viewed by the Engineer to be detrimental to the permeability of the base. Appropriate corrections to the trimming process shall be made by the Contractor prior to beginning again.

After compaction of the drainable base, the Contractor shall protect the surface from damage and/or contamination. If the integrity of the drainable base is disturbed at any time prior to placement of the succeeding pavement course the area shall be removed and replaced with new material and compacted to conform to the original lines and grades at the Contractor's expense. Any removed material shall not be reincorporated into the drainable base or other drainage features.

G. **Curing Of The Drainable Base Material:** The Contractor will be required to provide a curing plan to the Engineer.

H. **Temperature Limitations:** The air temperature must be between 50°F (10°C) and 90°F (32°C) for drainable base construction. The engineer may order operations to cease in hot windy conditions if it appears the mixture is drying out prior to achieving initial set.

I. **Construction Joints:** The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture and smoothness as other sections of the course.

All contact surfaces of previously constructed courses shall be cleaned of all dirt or other objectionable materials, and thoroughly moistened with water prior to placing the new material.

J. **Thickness:** The thickness of the base course shall be measured by cores taken at intervals determined by the Engineer.

2203.5 Plant Mix Bituminous Drainable Base Course

A. **Summary:** This item shall consist of an asphalt stabilized drainable base course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with the specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the plans. Each course shall be constructed to the depth, typical section, or elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course. A prime coat will be used on the subbase prior to placement of the first course, and no tack coat will be used between courses.

B. **Materials:**

1. **Aggregate:** Aggregate shall consist of crushed stone or crushed gravel and be free of organic materials.

   a. **Course Aggregate:** Course aggregate shall comply with Section 2303.3a except wear may not exceed 50 % in accordance with ASTM C 131 and the magnesium sulfate soundness loss shall not exceed 15%, after five cycles, when tested in accordance with ASTM C 88.

   b. Aggregate shall contain at least 70% by weight of individual pieces having two fractured faces and 85% by weight having at least one fractured face as determined by ASTM D 5821

   c. The aggregate shall not contain more than 8%, by weight, of flat and elongated pieces, when tested in accordance with ASTM D 4791 (ratio = 5:1).

   d. **Sampling:** ASTM D 75 shall be used in sampling the coarse aggregate.

2. **Bituminous Material:** The asphalt cement shall be in conformance with Section 2205.2A. The type and grade of asphalt used shall be specified in the mix design but shall not be lower than a PG 64-22.

C. **Preliminary Material Acceptance:** Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

Coarse Aggregate
- Percent of wear.
- Soundness.

Bituminous Material

The certification(s) shall show the appropriate ASTM test(s) for each material, the test results, and a statement that the material meets the specification requirement.

D. **Job Mix Formula. (JMF):** No bituminous mixture for payment shall be produced until the Engineer has approved a JMF in writing. The method of determining the proper asphalt content is to store the mix trial batches in the laboratory overnight (15-18 hrs) at 140°F (60°C). The proper asphalt content will then be selected visually. The asphalt content mix is selected from the batch from which a small amount of asphalt drains to the bottom of the pan and the mix still appears glossy. A heat resistant, clear glass dish may be used for better visibility of the drained asphalt. The asphalt content may be varied as necessary during construction to meet this requirement.

The aggregate shall be of such size that the percentage composition by weight will conform to the gradation of gradations specified in Table 2, when tested in accordance with ASTM Standards C 117 and C 136. The gradation shall be on the coarse side of the Master Band.

TABLE 2. PLANT MIX BITUMINOUS DRAINABLE BASE MASTER GRADATION	
Sieve Designation (Square Opening)	Percentage by Weight Passing Sieve
1-1/2" (37.5 mm)	100
1" (25.4 mm)	90-100
3/4" (19 mm)	75-100
1/2" (12.5 mm)	70-90
3/8" (9.5 mm)	50-70
No. 4 (4.75 mm)	20-40
No. 8 (2.36 mm)	15-25
No. 30 (637 um)	5-15
No. 200 (75 um)	0-3

Recommended Asphalt Cement Content 2.0 – 3.5%

The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the supply source.

The job mix tolerance shown in Table 3 shall be applied to the JMF to establish a job control-grading band. The resulting job control grading band must comply with the Master Gradation criteria..

TABLE 3. JOB MIX FORMULA TOLERANCES(Based on a Single Test)	
Material	**Tolerance Plus or Minus**
Aggregate passing No. 4 (4.75 mm) sieve or larger	5%
Bitumen*	0.40%
Temperature*	20 degrees F. (-7 degrees C.)

*Unless otherwise approved by the Engineer.

The aggregate gradation may be adjusted within the limits of Table 2 as directed, without adjustments in the contract unit prices.

Should a change in sources of materials be made, a new JMF shall be established before the new material is used.

Dry aggregate gradations will be made at least twice daily. The aggregate gradation shall be tested by the Contractor in accordance with ASTM C 117 and C 136.

The JMF shall be submitted in writing by the Contractor and approved by the Engineer prior to the start of paving operations. The job mix shall have been prepared no more than 12 months prior to submittal and shall include as a minimum:

Percent passing each sieve.
Percent of asphalt cement.
Asphalt designation and certifications
Mixing temperature.
Compaction temperature.
Temperature of mix when discharged from the mixer.
Percent fractured faces.
Percent elongated particles.

The Contractor shall submit samples to the Engineer, upon request, for job mix formula verification testing.

E. **Test Section:** Prior to full production, the Contractor shall prepare and place a section of drainable base according to the JMF. The amount of mixture should be 80 tons (72.6 metric tons) and may be placed as part of the project. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

Two random samples of mixture may be taken at the plant and tested for aggregate gradation and asphalt content. The test section shall be considered acceptable if the gradation and asphalt content are within the limits specified in Tables 2 and 3.

If the initial test section should prove to be unsatisfactory to the Engineer, the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Any additional sections that do not conform to specification requirements shall be removed at the Contractor's expense. Full production shall not begin until a satisfactory section has been constructed and accepted by the Engineer. The test sections that meet the specification requirements shall be paid for in accordance with project quantities

The Contractor shall perform Job mix control testing at the start of plant production and in conjunction with the calibration of the plant for the JMF. It should be recognized that the aggregates produced by the plant may not satisfy the gradation requirements or produce a mix that exactly meets the JMF. In those instances, it will be necessary to reevaluate and redesign the mix using plant-produced aggregates. Specimens should be prepared and the optimum bitumen content determined in the same manner as for the original design tests.

F. **Testing Laboratory:** The laboratory used to develop the JMF formula shall meet the requirements of ASTM D 3666.

G. **Construction Methods:**

1. **Weather Limitations:** The bituminous mixture shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than 40 degrees F (4.4 degrees C) or the wind chill factor is less than 35 degrees F (1.7 degrees C). The temperature requirements may be waived by the Engineer, however, all other requirements including compaction shall be met.

2. These materials will be placed, handled, hauled and accepted based on requirements of Section 2205.

2203.6 Underdrains:

A. **Summary:** Underdrain construction shall consist of furnishing of all labor, equipment and materials necessary for the complete installation of underdrains, including pipe, geotextiles and granular filter material in accordance with these specifications, standard drawings, the contract special provisions, and as shown on the Plans or established by the Engineer.

B. **Materials:**

1. **Aggregate:** Blanket Underdrain Aggregate and Pipe Underdrain Aggregate shall conform to requirements of Section 2203.3.a with the following gradations:

TABLE 1. BLANKET UNDERDRAIN AGGREGATE	
Sieve Size	Percent Passing By Weight
1-1/2 inch (38.1 mm)	100
1-inch (25.4 mm)	90-100
¾-inch (19 mm)	60-90
3/8-inch (9.5 mm)	--
No. 4 (4.75 mm)	0-20
No. 8 (2.4 mm)	--
No. 16 (1.2 mm)	0-10
No. 30 (0.6 mm)	--
No. 50 (0.3 mm)	0-7
No. 100 (150 µm)	0-2

TABLE 2. PIPE UNDERDRAIN AGGREGATE	
Sieve Size	Percent Passing By Weight
1-1/2 inch (38.1 mm)	--
1-inch (25.4 mm)	--
¾-inch (19 mm)	100
3/8-inch (9.5 mm)	85-100
No. 4 (4.75 mm)	--
No. 8 (2.4 mm)	40-60
No. 16 (1.2 mm)	--
No. 30 (0.6 mm)	5-30
No. 50 (0.3 mm)	--
No. 100 (150 µm)	0-2

2. **Underdrain Pipe:**

a. Polyvinyl chloride pipe shall meet the requirements of ASTM

b. Corrugated Polyethylene Tubing. may be used only outside of traffic areas and driving surfaces. The tubing shall be the heavy duty type and shall meet the requirements of AASHTO M 252. In addition, the tubing shall have a minimum pipe stiffness of 30 psi (210 kPa) at 10% deflection.

c. All underdrain pipes shall have a nominal minimum inside diameter of six inches (150 mm) unless shown otherwise on the Plans.

d. Perforations shall be approximately circular and cleanly cut; shall have nominal diameters not less than 3/16-inch (5 mm) nor more than 3/8-inch (10 mm); and shall be arranged in at least two rows parallel to the axis of the pipe.

e. Fittings shall be of the same composition and have the same physical properties as the pipe and shall not restrict flow.

3. **Geocomposite Edge Drain:**

a. Edge drain shall consist of a plastic core completely surrounded by geotextile. The core shall provide a minimum of 10 percent open area to facilitate water entry or cross flow and shall be composed of plastic which is physically and chemically stable under a normal range of conditions.

b. The edge drain shall have nominal dimensions of 1 to 1-1/2 inches (25 to 40 mm) in thickness and 12 inches (305 mm) in height.

c. The edge drain shall have a minimum flow capacity of 15 gallons per minute per foot of width (1.9 liters/cm) as determined by ASTM D4716 when tested under a confining stress of 10 psi (70 kPa) or more at a gradient of 0.1 or less.

d. The edge drain shall have a minimum compressive strength of either 7,000 psf (335 kPa) at a maximum deformation of 10 percent of the original thickness when tested in accordance with ASTM D1621, or 8,000 psf (385 kPa) at a maximum deformation of 20 percent when tested in accordance with ASTM D695.

e. Geotextile shall have an apparent opening size (AOS) corresponding to a U.S. sieve number greater than 50 (0.3 mm) but not exceeding 100 (150 µm).

4. **Geotextile:** Geotextile for use with pipe and edge underdrains shall be a nonwoven geotextile and shall meet the requirements of Section 2605.2.C.2.

C. **Construction:**

1. **General:** The exact location and layout of underdrains and/or edge drains as shown on the Plans shall be subject to revision by the Engineer as determined during construction.

2. **Excavation:**

   a. Trenches for all lateral and longitudinal underdrains shall be excavated to the dimensions, depths and elevations or as ordered by the Engineer. In case of a conflict, where the actual elevation of the strata or stratum to be intercepted is found to vary from Plan elevation, the stratigraphy shall govern in the installation of underdrains.

   b. Trench bottoms for perforated pipe underdrain and edge drain shall be in firm material (no mucky or soupy condition existing) and constructed to permit the placing of three inches (75 mm) of aggregate underneath the pipe. If unstable material is encountered in the bottom of the trench, the trench shall be over excavated to firm material.

   c. Minimum width of trench shall be as shown on the Standard Plan.

3. **Laying Pipe:**

   a. All underdrain pipe shall be laid carefully to line and grade.

   b. All pipe shall be laid on a minimum grade of one percent unless otherwise shown on the Plans.

   c. All dead ends of pipe underdrains shall be completely closed with a cap of the same material as the pipe.

   d. All junctions and turns shall be made with wyes, tees, and bends as supplied by the manufacturer of the pipe.

   e. Perforations shall be laid down unless otherwise indicated on the Plans.

4. **Installing Edge Drain:**

   a. Installation shall be in accordance with manufacturer's instructions.

b. Each length of drain shall be joined to the adjacent length prior to installation. Splices shall keep adjoining lengths in proper alignment, shall not separate during installation, shall have the same or greater compressive strength than the geocomposite drain, and shall be sealed against infiltration of backfill material.

c. Drain shall be placed in the center of the trench and held in place with a temporary support while blanket underdrain aggregate backfill is placed.

d. The placement of the edge drain and the first lift of backfill shall be accomplished in a single continuous operation.

5. **Backfilling:**

a. Backfilling the trenches of lateral and longitudinal underdrains shall not be started until approved by the Engineer.

b. The trenches shall be backfilled to the elevations shown on the Plans, in accordance with the Standard Plan.

c. The backfill material shall be placed in such a manner as to prevent formation of large cavities in the backfill and walls of the trench.

d. Overbreakage due to blasting of rock in trench excavation and widening due to caving of trench walls or overbreakage at construction outcrops shall be backfilled with aggregate.

2203.7 Permeability Test Procedure:

A. **Summary:** This test method is used to determine the permeability of unbound and bound aggregate base material. Bound base material will use Portland Cement, Fly Ash or Asphaltic Cement as a cementing agent.

B. **Unbound Base and Base Bound with Fly Ash or Portland Cement:**

1. **Apparatus:**

a. **Mold:** A cylindrical metal mold with an approximate inside diameter of 152 mm (6") and a minimum height of 152 mm (6"). The mold shall be equipped with a removable collar at least 51 mm (2") in height and a removable base plate. The base plate may be used as part of the

top of the base plate to prevent test material from being lost through the base plate during compaction and permeability testing.

b. **Standpipe:** A standpipe with the same diameter as the removable collar for the mold with a minimum height of 216 mm (8.5"). The standpipe shall be equipped with an overflow outlet.

c. **Rammer:** A mechanically operated metal rammer equipped to control the height of drop to 305 mm (12") plus or minus 2 mm (1/16") above the elevation of the sample. The rammer shall be equipped to distribute the blow uniformly over the sample surface. The rammer shall have a rigid flat faced "pie shaped" foot and a nominal weight of 25 kg (5.50 lbs.). The "pie shaped" foot shall be a sector of 152 mm (6") diameter circle and shall have an area equal to that of 51 mm (2") circular foot.

d. Straight edge: A rigid steel straight edge with one edge beveled, at least 203 mm (8") in length.

2. **Sample preparation:**

a. Obtain a 22.7 kg (50 lb.) to 27.2 kg (60 lb.) sample, dry if necessary.

b. Mix a sufficient amount of aggregate and cementing agent, if required, to fill the mold 1 and 1/2 times.

c. Add the appropriate amount of water and thoroughly mix.

d. Place the assembled mold on the rigid base and fill approximately 1/2 full of the loose moist material. Compact the layer with 25 blows of the rammer with the blows being distributed uniformly over the surface of the layer. Place three additional approximately equal layers of material in the mold and compact each layer in a similar manner (four layers total).

e. After the fourth layer has been compacted, remove the collar and trim excess material level with top of the mold.

f. Cure Portland Cement and Fly Ash treated specimens by covering with plastic, to prevent drying for 3 days at room temperature.

g. Unbound specimens do not need to be cured before testing.

2203.7

a. **Mold:** A cylindrical mold with an inside diameter of approximately 152 mm (6") and a minimum length of 114 mm (4.5"). The mold is open at each end and is equipped with a removable collar and a base plate about 13 mm (0.5") thick.

b. **Specimen Mold Holder:** The specimen mold holder has a semi circular base and a flanged top to hold the specimen mold in place during the compaction process. Any equivalent hold down device that performs the same function is satisfactory.

c. **Compaction Hammer:** The compaction hammer consists of a hammer having a flat circular tamping face 149 mm (5.88") in diameter and appropriate extension rod with handle which acts as guide for a free falling weight. The weight shall weigh 10 kg (22.5 lbs.) and have a free fall of 547 mm (18") plus or minus 2 mm (0.1"). The hammer may be operated manually or be driven with a motor.

d. **Compaction Pedestal:** The compaction pedestal is a wood block approximately 305 mm x 305 mm x 457 mm (12" x 12" x 18"). A 305 mm x 305 mm x 25 mm (12" x 12" x 1") steel plate is securely fastened to the top of the block. The pedestal is set on and securely fastened to a solid concrete slab with the vertical axis plumb and the top level.

e. **Heating Equipment:** Ovens or hot plates for heating aggregates, bituminous material, specimen molds, compaction hammers and other associated items required for mixing and molding. It is recommended that, when possible all heating units be thermostatically controlled to maintain the required temperature within ± 2.8°C (5°F). Suitable shields, thick steel plates or pans of sand shall be used on the surfaces of hot plates to minimize locally overheating.

f. **Mixing Apparatus:** Mechanical mixing is recommended. Any type of mechanical mixer may be used provided it will produce a well coated, homogeneous mixture of the required amount in the allowable time and further that the mixing paddle or whip does not fracture or pulverize aggregate fractions during the mixing process. The bowl employed with the mixer shall be such a nature that essentially all of the batch can be removed. More than one mixing bowl is recommended unless the mixer is equipped with a heating jacket to keep the bowl heated during the mixing process.

2. **Determination of Mixing and Compacting Temperature:**

a. The temperature to which the asphalt cement must be heated to produce a viscosity of 85 ± 10 SFS shall be the mixing temperature.

b. The temperature to which the asphalt cement must be heated to produce a viscosity of 130 ± 15 SFS shall be the compacting temperature.

3. Sample Preparation for Laboratory Prepared Mix:

a. Combine the dry individual aggregates to produce desired combined aggregate with a batch weight of approximately 4050 grams (8.9 lbs.). This should be sufficient to produce a compacted specimen 95 ± 3 mm (3.75 ± 0.125 inches) thick. Adjust the weight of the batch as needed to produce a compacted specimen of 95 ± 3 mm (3.75 ± 0.125 inches) thick.

b. Prepare a minimum of two aggregate and asphalt specimens. The first specimen shall be mixed and thrown away. This sample is to "butter" the mixing bowl and paddle and thus reduce material loss when mixing the test specimen.

c. Heat the aggregate and asphalt within the limits of mixing temperature determined in paragraph 2203.7 C2a. Charge the mixing bowl with the heated aggregate and form a crater in the top. Add the required amount asphalt and mix the aggregate and asphalt until coated at least 2 minutes. Care should be taken to keep all of the sample in the mixing bowl during this process.

4. Compaction of Specimen:

a. Prior to the addition of the asphalt to the batches, thoroughly clean the specimen mold assembly and the face of the compaction hammer and heat the mold assembly and hammer to a temperature between 93.3°C (200°F) and 176.7°C (350°F). Assemble the mold, base plate and collar and place a paper disc cut to size in the bottom of the mold.

b. Place the hot batch of aggregate-asphalt mixture in the mold, spade vigorously with a heated spatula or trowel 15 times around the perimeter and 10 times over the interior of the mold. Smooth the surface of the mix to a slightly rounded shape. The temperature of the mix prior to compaction shall be within the limits in 2203.7 C2b. Place a paper disc on top of the mix.

c. Place the mold assembly, including the collar, on the pedestal, fasten securely with the mold holder and apply 20 blows with the compaction

hammer. Each blow must have the prescribed free fall of 457 mm (18") with the axis of the compaction hammer held perpendicular to the base of the mold assembly during the compaction process. Remove the base plate and collar, and reverse and reassemble the mold. Apply the specified number of blows to the reversed specimen. After compaction remove the mold assembly from the pedestal, remove the collar and base plate and cool the specimen in the mold until the mold can be handled comfortable with bare hands. Asphalt treated samples do not need to be cured before testing, only cool to the touch.

D. Test Procedure:

1. Assemble test equipment, base plate, mold with specimen, and standpipe.

2. Prior to conducting the test, allow a sufficient amount of water to pass through the specimen to cause all air to be expelled from the specimen. (Establish reservoir around the base with water open to atmospheric pressure.)

3. Conduct Constant-Head Permeability test and report coefficient of permeability "k" in meters (feet) per day. Repeat a minimum of two additional times until two runs agree reasonably well.

4. Constant-Head Permeability:

$$K = \frac{QL}{Aht}$$

Q = quantity of water discharged (volume)
L = length of specimen
A = cross-sectional area of specimen
h = hydraulic head (height column of water above discharge)
t = elapsed time of test
K = coefficient of permeability (length/time)

Note: For very permeable material, maintain elevation of water above the sample for 3 minutes then measure Q (flow).

2203.8 Methods of Measurement:

A. Crushed Aggregate Drainable Base will be measured by one of the following:

1. Per square yard (square meter) or tenth part thereof for the specified depth.

2. Per ton (metric ton) or tenth part thereof.

B. Portland Cement Concrete Drainable Base may be included in the Proposal as a single item or as separate items (Portlande Cement and Base Aggregate) and measured by one of the following:

1. Per square yard (square meter) or tenth part thereof for the specified depth.

2. Per ton (metric ton) or tenth part thereof.

C. Plant Mix Bituminous Drainable Base may be included in the Proposal as a single item or as separate items (Asphaltic Cement and Base Aggregate) and measured by one of the following:

1. Per square yard (square meter) or tenth part thereof for the specified depth.

2. Per ton (metric ton) or tenth part thereof.

D. Pipe Underdrains will be measured per lineal foot (meter) or tenth part thereof. Drainable Base Aggregate shall be subsidiary to the PipeUnderdrain.

E. Blanket Underdrains will be measured by the actual quantities used as follows:

1. Pipe Underdrain will be measured per lineal foot (meter) or tenth part thereof.

2. Drainable Base Aggregate will be measured by one of the following:

a. Per square yard (square meter) or tenth part thereof for the specified depth.

b. Per ton (metric ton) or tenth part thereof.

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SECTION 2204 PRIME AND TACK COAT

Referenced Standards: The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM
D 140 - Practice for Sampling Bituminous Materials

2204.1 Summary: This section includes the application of liquid asphalt to a prepared pavement (concrete, asphaltic concrete), or granular base. The type and grade of asphalt material to be used as prime or tack coat, is as specified in the Special Provisions or as indicated by the plans.

2204.2 Liquid Asphalt Material: The liquid asphalt material to be used for surface preparation shall be as listed in the following table:

Material to be Treated	Application Usage	Type of Emulsion or Grade of Cutback	Application Rate Gal/SY (L/SM)	Application Temperature °F (°C)	Cure Time at 70°F (21°C)
Existing Asphalt or Concrete Surface	Tack	RC-70	0.03-0.10 Gal/SY (0.23-0.46 L/SM)	150-225 (65 – 107)	1-6 hrs
	Tack	SS-1 SS-1h CSS-1 CSS-1h	0.03-0.15 Gal/SY (0.23–0.69 L/SM)	70 – 160 (22.5- 42)	1-3 hrs
Treated Base (ex, lime, fly/ash, cement	Prime	MC-30 MC-70	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	85–120 (29-49)	12-24 hrs
	Prime	SS-1 SS-1h CSS-1 CSS-1h	0.1-0.3 Gal/SY/in (0.46-1.38 L/SM/mm)	70-160 (20-70)	24-48 hrs
Untreated Aggregate Base w/ Fines	Prime	MC-30, MC-70	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	85–120 (29-49)	12-24 hrs
W/o Fines	Prime	MC-250	0.2-0.5 Gal/SY (0.92-2.30 L/SM)	85–120 (29-49)	12-24 hrs
Untreated Aggregate Base	Prime	SS-1 SS-1h CSS-1 CSS-1h	0.1-0.3 Gal/SY/in (0.46-1.38 L/SM/mm)	70-160 (20-70)	24-48 hrs
	Prime	EAP PAE, or PEP	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	70-160 (20-70)	12-24 hrs

The asphalt material shall conform to the latest ASTM specifications for "Asphalt Cements and Liquid Asphalts." Sampling shall be in accordance with ASTM D 140.

2204.3 Sand Cover: Sand Cover, if used, shall be any clean granular mineral meeting the following grading requirements. When tested with laboratory sieves 100% shall pass the No. 4 (4.75 mm) sieve and not more than 2% shall pass the No. 200 (75 um) sieve. The moisture content of the sand shall not exceed 3% by weight.

2204.4 Approval of Materials: Asphalt materials shall be approved by the Engineer prior to use in the work. The Engineer may accept a certified analysis by the material supplier laboratory when a copy of the certified analysis accompanies each shipment of asphalt to the project. The Engineer reserves the right to perform tests of the asphalt received on the job.

2204.5 Pressure Distributor: The distributor shall be so designed, equipped, maintained and operated that liquid asphalt at even heat may be applied uniformly on variable widths of surface up to 15 feet (4.5 m) at readily determined and controlled rates from 0.02 to 1.00 gallon per square yard (100 to 5000 milliliters per square meter), with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallons per square yard (100 milliliters per square meter). Distributor equipment shall include a tachometer, pressure gauges, a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically. The calibration of all distributors must be approved by the engineer, and the contractor shall furnish all equipment, material and assistance necessary if calibration is required.

2204.6 Preparation of Existing Surface:

A. **For tack coats:** The existing surface shall be free of all dust, loose material, grease or other foreign material at the time the tack is applied. Any excess surface oil on the roadway or bituminous joint material will be removed by others without cost to the contractor before the tack is applied.

B. **For prime coats:** the surface to be primed shall be shaped to the required grade and cross section, shall be free from all ruts, corrugations, segregated material or other irregularities, and shall be uniformly compacted by rolling. The surface shall be firm and slightly damp when primer is applied. Delays in priming may necessitate reprocessing or reshaping to provide a smooth compacted surface.

2204.7 Application of Asphalt Material:

A. **For Tack Coats:** Asphalt emulsion shall be applied uniformly with a pressure distributor at the rate specified in the contract, or as revised by the engineer to be within a minimum of 0.05 and a maximum of 0.15 gallons per square yard (minimum of 230 and a maximum of 690 milliliters per square meter). Water may be added to

2204.3 Sand Cover: Sand Cover, if used, shall be any clean granular mineral meeting the following grading requirements. When tested with laboratory sieves 100% shall pass the No. 4 (4.75 mm) sieve and not more than 2% shall pass the No. 200 (75 um) sieve. The moisture content of the sand shall not exceed 3% by weight.

2204.4 Approval of Materials: Asphalt materials shall be approved by the Engineer prior to use in the work. The Engineer may accept a certified analysis by the material supplier laboratory when a copy of the certified analysis accompanies each shipment of asphalt to the project. The Engineer reserves the right to perform tests of the asphalt received on the job.

2204.5 Pressure Distributor: The distributor shall be so designed, equipped, maintained and operated that liquid asphalt at even heat may be applied uniformly on variable widths of surface up to 15 feet (4.5 m) at readily determined and controlled rates from 0.02 to 1.00 gallon per square yard (100 to 5000 milliliters per square meter), with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallons per square yard (100 milliliters per square meter). Distributor equipment shall include a tachometer, pressure gauges, a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically. The calibration of all distributors must be approved by the engineer, and the contractor shall furnish all equipment, material and assistance necessary if calibration is required.

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2204.7 Application of Asphalt Material:

A. **For Tack Coats:** Asphalt emulsion shall be applied uniformly with a pressure distributor at the rate specified in the contract, or as revised by the engineer to be within a minimum of 0.05 and a maximum of 0.15 gallons per square yard (minimum

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SECTION 2205 ASPHALTIC CONCRETE SURFACE AND BASE

Referenced Standards: The following standards are referenced directly in this section. The latest version of these standards shall be used.

ASTM

C 88 - Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

C 117 - Test Method for Materials Finer than 75- um (No. 200) Sieve in Mineral Aggregates by Washing

C 127 - Test Method for Specific Gravity and Absorption of Coarse Aggregate

C 128 - Test Method for Specific Gravity and Absorption of Fine Aggregate

C 131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

C 136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates

C 142 - Test Method for Clay Lumps and Friable Particles in Aggregates

D 75 - Practice for Sampling Aggregates

D 140 - Practice for Sampling Bituminous Materials

D 290 – Practice for Bituminous Mixing Plant Inspection

D 979 - Practice for Sampling Bituminous Paving Mixtures

D 1188 - Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

D 2041 - Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

D 2172 - Test Methods for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures

D 2726 - Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures

D 2950 - Test Method for Density of Bituminous Concrete in Place by Nuclear Methods

D 3666 - Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials

D 4552 - Practice for Classifying Hot-Mix Recycling Agents

D 5444 - Test Method for Mechanical Size Analysis of Extracted Aggregate

D 6307 - Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method

D 6373 - Specification for Performance Graded Asphalt Binder

AASHTO

PP 26 Practice for Certifying Suppliers of Performance Graded Asphalt Binders

T 245 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

T 283 Resistance of Compacted Bituminous Mixture to Moisture Induced Damage

Asphalt Institute
"Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types", MS-2, Sixth Edition

National Bureau of Standards
Handbook #44, "Specifications, Tolerance and other Technical Requirements for Commercial Weighing and Measuring Devices"

2205.1 Summary: This section includes the construction of asphalt concrete base and/or asphalt concrete surface.

2205.2 Materials: No material shall be used until it has been approved by the Engineer. All costs associated with material testing, certification and the preparation of trial mixes to determine the job mix formula shall be the responsibility of the contractor. Representative samples of all materials proposed for use under these specifications shall be submitted to the testing laboratory by the Contractor, at the Contractor's expense, for testing and the preparation of trial mixes to determine the job-mix formula. Additional tests necessary for determining conformance with the requirements specified herein will be performed under the supervision of the Engineer without cost to the Contractor, unless testing is the responsibility of the contractor in the contract.

A. **Asphalt:** Asphalt cement used in the manufacture of asphalt paving mixtures shall conform to the Performance Graded system. The PG graded material used shall conform to the provincial grade used by the local DOT or as designated by the Engineer. In the Kansas City Metropolitan area, the provincial grade is a PG64-22.

These general usage guidelines may not address all project conditions. APWA strongly recommends that the engineer apply sound pavement design principles when designating mix type and selecting asphalt cement grade based upon individual project conditions. The Federal Highway Administration makes available LTPPBIND software that will assist with asphalt grade selection for specific projects.

The asphalt cement shall conform to ASTM D 6373. Sampling shall be in accordance with ASTM D 140.

The contractor or asphalt supplier shall submit a quality assurance plan for the asphaltic cement to the engineer that conforms to AASHTO PP 26. He shall also submit a temperature-viscosity chart showing the recommended mix and compaction temperatures for non-modified asphalts, and shall provide the specific gravity of the asphalt.

B. **Aggregate:** The quality of aggregates used in Asphaltic Concrete shall conform to the following:

Course Aggregate (Retained on the No. 4 Sieve)	
LA Abrasion (ASTM C 131)	35% loss (maximum)
Soundness using Mag. Sulfate (ASTM C 88 5 cycles)	15% loss (maximum)
Total shale, clay, coal and lignite content ASTM C 142	1.0% by weight (max)
Fine Aggregate (Passing the No. 4 Sieve)	
Organic content	1% maximum
The parent material of manufactured sand must also meet the requirements for coarse aggregate shown above.	

Sampling shall be in accordance with ASTM D 75. Gradation analysis shall be in accordance with Standard Method of Test for Material Finer than No. 200 (75 um) Sieve in Mineral Aggregates by Washing, ASTM C 117 and Standard Method Test for Sieve Analysis of Fine and Coarse Aggregate, ASTM C 136.

2205.3 Mixing and Proportioning:

A. **Composition of the Mix:** Asphaltic concrete mixtures shall consist of Mineral Aggregates and Asphalt Cement within the following limits for the type specified.

	ASPHALTIC CONCRETE-TYPE					
	1-01	**2-01**	**3-01**	**4-01**	**5-01**	**6-01**
Percent by Weight of Total Mixture						
Asphalt Cement	4-6	4-7	4-7	5-7.5		
Aggregate-U. S.Standard Square Sieve SizeTotal Percent Passing by Weight						
1 ½" (37.5 mm)	100	--	--	--	--	--
1" (25.0 mm)	75-100	100	--	--	100	--
¾" (19.0 mm)	60-85	80-100	100	--	95-100	100
½" (12.5 mm)	--	--	85-100	100	--	86-100
3/8" (9.0 mm)	40-65	60-80	70-90	85-100	--	75-100
No. 4 (4.75 mm)	30-50	48-65	50-70	55-75	--	--
No. 8 (2.4 mm)	19-36	35-47	37-47	39-50	28 min	28 min
No. 16 (1.2 mm)	13-26	25-36	26-36	27-38	--	--
No. 30 (0.6 mm)	--	18-30	18-30	19-30	--	--
No. 50 (0.3 mm)	--	12-22	12-22	11-23	--	--
No. 100 (150 µm)	4-12	6-14	6-15	6-16	--	--
No. 200 (75 µm)	2-10	3-10	4-10	4-10	2-6	2-6

In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 for types 1-01, 2-01, 3-01, and 4-01.

That fraction of material retained on the No. 4 (4.75-mm) Sieve-shall be composed of particles with not less than 75% having two or more fractured faces for asphalt types 1-01, 2-01, 3-01, and 4-01, and not more than 20% by weight of that fraction shall be composed of flat or elongated particles as described in Section 2202.2.
For Asphalt Types 5-01 and 6-01 only, the total aggregate (course aggregate, fine aggregate, and the material passing the No. 200 sieve (75um) shall contain not less than 85% crushed material for intermediate course and surface course.

It shall be noted that when the gradation varies appreciably from the single point gradation used in the mix-design, the test properties of the mix will be out of specifications. This condition can occur even though the gradation meets the tolerances below.

The job-mix formula shall be within the limits specified above. The maximum permissible variation from the job-mix formula, within the specification limits, shall be as followed:

Permissible Gradation Variation from Mix Design Percent by Wt. of Total Mix

U. S. Standard Sieve Size	Type 1-01, 5-01 & 6-01	Type 2-01, 3-01, & 4-01
No. 4 (4.75 mm) and larger	5.0	4.0
No. 8, 16, 30 and 50 (2.4, 1.2, 0.6, 0.3 mm)	4.0	3.0
No. 200 (75 um)	2.0	1.0
Asphalt Cement	0.5 (1-01 only)	0.3

B. Asphalt Mix General Usage

	Surface	Base
Arterial	3-01, 5-01, 6-01	1-01, 5-01
Collector	3-01, 5-01, 6-01	1-01, 2-01, 5-01
Local/Access	2-01, 3-01, 5-01	1-01, 2-01, 5-01
Paved Trail	2-01,3-01, 4-01,5-01	1-01,2-01,5-01
Recreational Surface	4-01	1-01, 2-01, 5-01
Parking Lot	2-01, 3-01, 5-01	1-01, 2-01, 5-01

Generally, mix types 1-01, 2-01, 3-01 and 4-01 are composed of local materials and are appropriate for general use. Mix types 5-01 and 6-01 are engineered to have

better mix properties to increase durability and life of the pavement, and as such are best used on high-type pavements.

Mix type 2-01 is acceptable for surfacing, but is generally more open-graded than the other surface mixes, and may not provide a tightly sealed surface.

Mix type 4-01 is very susceptible to rutting and is only recommended for non-vehicular use.

C. **Asphalt Hot-Mix Recycling:**

1. **General:** Except as modified herein, Recycled Asphaltic Concrete (RAC) shall be equal to that produced as new material. Reclaimed Asphalt Pavement (RAP) and/or Reclaimed Aggregate Materials (RAM) shall represent no more than 30% of the composition for all surface mixtures and no more than 50% of the composition for all base mixtures except type 5-01 and 6-01 (no more than 30%). Only virgin materials shall be used in the surface course for new construction projects. Recycled or virgin materials may be used on restoration projects. Recycled Asphaltic Concrete may contain combinations of RAP, RAM, coarse aggregate, fine aggregate, mineral filler, asphalt cement, recycling agent, anti-stripping agent and approved additives to produce an acceptable mixture. Recycled Asphaltic Concretes shall be designated by prefacing the type with "RC," such as "RC-Type 1-01"

2. **Materials Evaluation:** All recycled materials shall have the following additional tests:

   a. A sieve analysis shall be performed on RAP and/or RAM in accordance with ASTM C 117, "Standard Test Method for Material Finer than No. 200 Sieve (75 um) in Mineral Aggregates by Washing" and ASTM C 136, "Standard Method for Sieve Analysis of Fine and Coarse Aggregates" after extraction of asphalt.

   b. Asphalt content analysis shall be performed for RAP in accordance with Method "A" of ASTM D 2172 , "Standard Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures" where the RAP content exceeds 30%. For mixtures with RAP contents less than 30%, asphalt content may be determined using ASTM D6307.

   c. The asphalt cement used shall be determined as follows:

For RAP contents of up to 20%, the asphalt grade shall be as specified in the mix design.

For RAP contents from 20% up to 30%, the asphalt grade shall be decreased one temperature range. For example, a design PG 64-22 would be decreased to a PG 58-22 with a viscosity in the range of 800 to 1200 poises.

For RAP contents from 30% to 50%, the asphalt grade of the new asphalt shall be determined using the procedures outlined in MS-2, 6th Edition, Appendix A.

d. All sources of material for use in RAC must be approved by the Engineer prior to use.

3. **Material Requirements:**

a. New asphalt cements added to the aged asphalt shall meet the requirements of Section 2205.2A

b. Recycling Agents, if used, shall meet the requirements of ASTM D 4552, "Standard Practice for Classifying HOT MIX Recycling Agents."

c. The RAP and/or RAM stockpiled at the plant site shall be maintained in stockpiles separated into surface and base. The RAP and/or RAM shall be processed such that 100% will pass the 1-1/2 inch (38 mm) sieve and 90% will pass the 1-inch (25.4 mm) sieve.

d. The final product shall be free of foreign matter (e.g., old planer teeth, ice, wood, soil, broken sewer castings, loop detector wire, protective membranes, rubberized joint filler materials and foil turn lane markers, trash, debris, etc.)

4. **Mix Design Requirements:** The necessary steps for a final mix design for recycled mixtures, shall be done in accordance with the Asphalt Institute's Manual MS-2 Sixth Edition in the appendix entitled "Mix Design Using RAP

When a change in the RAP and/or RAM percentage exceeds 15% of the original amount of RAP and/or RAM in the mix design, a new mix design must be submitted.

5. **Asphalt Plant Requirements**: All delivery tickets shall designate the type of recycled mix, (RC-Type 1-01, RC-Type 2-01, RC-Type 3-01, or RC-Type 4-01).

D. **Mix Design Criteria**: Laboratory Test Specimen(s) of the Paving Mix, combined in proportions of the job-mix formula, shall be prepared and tested in accordance with AASHTO T 245 and the volumetric properties of the compacted paving mixtures as calculated by ASTM procedures using Chapter 4 of the Mix Design Methods for Asphalt Concrete and other Hot-Mix types (MS-2), Sixth Edition, Asphalt Institute referred hereafter as "MS-2". The Marshall procedure and the Voids in the Mineral Aggregate (VMA) shall be as specified in Chapter 5 of the MS-2. The automatic Marshall Hammer may be used when it has been calibrated with a manual hammer.

Optionally,for mix type 5-01 and/or 6-01 a SuperGyratory Compactor (SGC)may be used to prepare the asphalt samples for design and quality control testing. The gyratory values to be used for this purpose are $N_{initial} = 6$, $N_{design} = 50$, and $N_{max} = 75$. If this option is selected, Marshall stability and flow measurements will be waived during design and production. At $N_{initial}$ the specific gravity of the specimen must be 90.5% or less of G_{mm}, at N_{max} the specific gravity of the specimen must be 98% or less of G_{mm}.

The material for the theoretical specific gravity ASTM D 2041 and the material for the Marshall specimens (mucks) shall be cured at 285+/-5°F (140+/-3° C) for two hours in a closed oven after the mix is produced in the laboratory. Also, the plant-produced mixture shall be tested when the mix is two hours old. The mixture shall be transported to the laboratory in an insulated container and then stored in a laboratory oven at 140 +/-3°C (285 +/-5°F) for the remainder of the curing period. This procedure shall be used when the water-absorption as determined by ASTM C 127 and ASTM C 128 of any aggregate in the mixture exceeds 1.25%. The mixture shall be compacted at 140 +/-3°C (285 +/-5°F).

Test requirements and criteria for the paving mixes under these specifications shall be as follows:

Marshall Stability: 1500 lbs. (6672 N) Min (Types 1-01, 2-01, 3-01, and 4-01),
1800 lbs (8000 N) (Types 5-01 & 6-01)

No. of compaction blows: 50 (for Types 1-01, 2-01, 3-01, and 4-01),
75 (for Types 5-01 & 6-01)

Flow: 0.08-0.16 inches (2-4 mm) max (Types 1-01 – 4-01),
.14 inches (3.5 mm) max (Types 5-01 & 6-01)

Air Voids: (Laboratory Specimen)	Percent
Base	3-5
Surface	3-5

Voids filled with asphalt:
percent (VFA) Types 5-01 & 6-01 65-75 Percent

Voids in Mineral Aggregate (VMA)

(Nominal Max Size as defined in MS-2)	Percent (min.)
1 1/2" (38 mm)	11
1" (25.4 mm)	12
¾" (19 mm)	13
½" (12.5 mm)	14
3/8" (9.5 mm)	15

The VMA properties for mixes 1-01,2-01,3-01, & 4-01 shall be measured in accordance with the procedure described herein and reported on the material data forms; however, there is no minimum criteria controlling VMA associated with these material gradations.

The VMA for Mix Types 5-01 & 6-01 shall be the minimum value allowed. For these mixes, the asphalt content should be just to the left side of the low point on the VMA vs. Asphalt Percent curve, not to the "wet" or right (increasing) side of the curve.

The VMA requirements shown represent values that may be higher than those obtained in the KC Metropolitan area using locally available materials. The minimum values are values recommended by the Asphalt Institute in MS-2 6th Edition for high

quality asphaltic concretes, but may require the use of non-local aggregates. VMA values shown are for 4% air voids and should be used for the design of conventional roadway pavements. During production, the voids can be expected to vary plus or minus 1% of this design value of 4%. Under these conditions, the minimum allowable VMA values should be calculated by interpolation of the chart in MS-2, 6th Edition. For mix types 1-01, 2-01, 3-01, and 4-01, 3% air voids may be used for design. and production may be allowed to vary plus or minus 1% of the design value.

The ratio of minus 200 (75 um) material to % Effective asphalt cement (P_{ef}) based on the weight of the aggregate shall be between 0.6-1.2 for Types 5-01 and 6-01.

The blend of RAP and/or RAM and virgin aggregates or non recycled asphalts shall be checked for resistance to stripping using AASHTO T 283 to determine if an anti-stripping agent is needed for the same asphalt chosen for the project. The index of retained strength shall exceed 75% for Types 1-01 – 4-01, and 80% for types 5-01 and 6-01.

E. **Sampling and Testing of the Mixture**: Mixes shall be sampled in accordance with ASTM D 979 and tested in accordance with AASHTO T 245. The mixtures will be tested for binder content in accordance with ASTM D 2172 or D 6307. The recovered aggregate will be sieved in accordance with ASTM D 5444.

F. **Mixture Temperature Requirements**: The temperature of the completed mix at the plant and at the paver shall be set by the Contractor who shall consider hauling and placing conditions, asphalt specifications as set forth in section 2205.2, and weather limitations set forth in section 2205.8 (B). The temperature of Types 5-01 and 6-01 shall not exceed 315° F (157° C) at the point of discharge from the asphalt plant when using PG 64-22 asphaltic oil.

When the mix is produced in a batch-type plant, the aggregate shall be weighed accurately in the designated proportions to provide the specified batch weight. The temperature of the aggregate at the time of introduction into the mixer shall be determined by the contractor, with a tolerance of + or - 25° F (16° C). In no case, however, shall the temperature of the mixture exceed the maximum temperature recommended by the manufacturer or supplier of the asphaltic cement (generally 350° F (177° C).

G. **Control of Mixing Time**: The contractor shall control mixing time to produce asphaltic concrete that is uniformly and thoroughly coated with asphaltic cement.

H. **Preparation of Asphalt Cement**: The asphalt shall be heated so that it can be distributed uniformly throughout the mix. For mixing applications, the specified

temperature generally will be such that the asphalt viscosity is within the range of 150-190 centistokes and shall not exceed 350° F (177° C). The material shall be sufficiently fluid to produce a complete coating on every particle of aggregate within the specified mixing time.

The contractor shall maintain calibrated temperature monitoring equipment at the point of discharge from the asphalt plant and at the asphalt tank, and shall supply temperature records upon request.

I. **Preparation and Handling of Aggregate**: Coarse and fine aggregate shall be stored at the plant in such a manner that the separate sizes will not become intermixed. Cold aggregates shall be carefully fed to the plant in such proportions that surpluses and shortages in the bins will not cause breaks in the continuous operation. When loading aggregate into stockpiles, and into cars, barges, and trucks, the material shall be placed in such a manner as to prevent segregation of aggregate sizes. Stockpiles shall be built in uniform layers not exceeding 5 feet (1.52 m) in depth.

    1. Samples of coarse and fine aggregate shall be submitted to the Engineer for testing upon request. The contractor shall be responsible for the preparation and handling of aggregates to insure that the cold-feed gradations fall within the mix design limits. Cold-feed gradation tests shall be taken as requested by the Engineer.

    2. **Drying**: The aggregate shall be thoroughly dried and heated to provide a paving mix temperature within a tolerance of + or – 25° F. (4° C), of that specified by the approved mix design. The moisture content of the heated and dried aggregate shall not exceed 0.5%. The quantity of material fed through the dryer shall in all cases, be held to an amount which can be thoroughly dried and heated.

J. **Inspection and Control of Asphalt Mixing Plant**:

    1. **Tests:** During production the plant shall have the following tests performed by an approved laboratory: AC content, extracted gradation, Marshall density, stability, voids, vma, vfa and max theoretical density. Laboratories shall be approved if they are:

        a. Accredited in accordance with ASTM D3666; and/or

        b. Approved for Superpave asphalt testing by the State Highway Department in the state where the plant is located.

1). The individual performing the test must carry a state certification for Superpave testing.

2). The laboratory must have an annual certification by an independent testing agency of all testing equipment used for Superpave mix designs, and must also have the Marshall hammer weight and height of drop certified by that same agency.

2. **Availability of test reports:** The results of the latest current test report shall be furnished to the Engineer upon request.All test reports shall be kept at the plant, and shall be made available upon request. If the mix is found to be outside of tolerance, or outside the specification limits as specified in Section 2205.3, correction shall be made. Test reports shall be furnished on the following "Asphalt Concrete Test" form.

3. **Frequency of testing:** For mixes 1-01 through 4-01, the tests listed in paragraph 1 shall be performed every 3000 tons (2700 metric tons) of asphalt production except during initial startup, or whenever the production asphalt fails one of the following conditions at which time they will be tested every 1000 tons (900 metric tons) until four consecutive tests show compliance with the specifications:

   a. Production void content measured at the plant disharge is 1% below laboratory mix design void content, or more than 5% total void content.

   b. Extracted gradation of the production asphalt exceeds the permissible gradation variation for the mix type being produced.

   c. Asphalt cement exceeds the content variation for the mix type being produced.

4. **Frequency of testing:** For mixes 5-01 and 6-01, the tests listed in paragraph 1 shall be performed once per day of production, or every 1000 tons (900 metric tons), whichever is less frequent except during initial startup; or whenever the production fails one of the following conditions at which time they will be tested every 500 tons (450 metric tons), or twice per day of production, whichever is less frequent until 4 consecutive tests show compliance with the specifications:

   a. Production void content measured at the plant discharge is less than 3% or more than 5%

ASPHALTIC CONCRETE TEST (Verified Mix Design)

Description:				
APWA Type:				
LAB I.D.:		LOT		
Sample Date:		Belt		Tons
Sample I.D.:		Hot Mix		Tons
Supplier:				

Sieve Size	Belt Sample	Hot-Mix Sample*	Single Point Job-Mix Formula	Job-Mix Formula Tolerances	ASTM C 136, C 117, D 5444
25mm(1")					
19mm (3/4")					
12.5mm (1/2")					
9.5mm (3/8")					
4.75mm (No. 4)					
2.36mm (No. 8)					
1.18mm (No. 16)					* Uncompacted Behind paver
600 um (No 30)					
300 um (No 50)					** total mix basis
150 um (No 100)					***total aggregate Basis
75 um (No 200)					

EXTRACTION DATA-ASTM D6307		Plant Setting**	Sample*
(method B except sec. 12)	% AC		

Aggregate Type	%***	Aggregate Type	%***

MARSHALL CHARACTERISTICS (ACCEPTANCE CRITERIA)			
Compaction Blows (average of 3 specimens) Circle one (50 Types A-D, 75 Types E-F)			
	Sample*	Specifications	
Stability, lbs (kg)		Min	AASHTO T 245
Flow, 1/100 in (mm)		Max	AASHTO T 245
% Voids		3-5	
% VMA		__ min	
% VFA			
Density, pcf (kg/cu.m)		—	ASTM D 2726
Ratio (-) 75 um (No. 200) to % Eff. Binder			
Max Theoretical Specific Gravity Gmm		—	ASTM D 2041
Bulk Spec. Gr. Of total Agg. Gsb		—	ASTM C 127 & 128
COMMENTS:			

LOT DENSITY SHALL BE TIED TO THE LOT AND DATE
Laboratories shall conform to ASTM D 3666.

b. Extracted gradation of the production asphalt exceeds the permissible gradation variation for the mix type being produced.

c. Production vma measured at the plant discharge is below the design minimum vma.

d. Production vfa measured at the plant discharge is outside the allowable range.

5. **Redesign of Asphalt mixes:** If four consecutive tests performed as described in paragraph 3 or 4 above show noncompliance with the specifications as enumerated in the subparagraphs of paragraph 3 or 4 above, production of that type of asphalt will immediately cease, and may not be resumed until a new mix design is submitted and approved, or the plant can demonstrate to the engineer an ability to meet specifications. Resumption of asphalt production after a mix redesign or failure of four consecutive tests to meet specifications will be treated as a initial startup for testing purposes.

2205.4 Asphalt Mixing Plant: Plants used by the Contractor for preparation of the asphalt paving mix shall conform to the following requirements:

A. **Field Testing Laboratory**: The Contractor shall provide a laboratory building or room at the plant site, for the exclusive use of the Engineer for performing tests, keeping records, and making reports at such times as the Engineer is performing those actions.

   The Contractor shall also furnish necessary laboratory sieves and a powered shaker device for sieve analysis, scales, extractor and supplementary equipment to make aggregate sieve analysis, asphaltic concrete paving mixture analysis, and paving mixture density tests.

B. The asphalt producer shall establish a quality control plan and shall maintain records. The quality control plan required by the state highway agency is a suggested standard.

2205.5 Transportation of Mix: The mix shall be transported to the job site in vehicles with tight metal bottoms, clean of all foreign material which may affect the mix. If a release agent is used, it must comply with State and Federal environmental regulations. The dispatching of the vehicles shall be so scheduled that all materials delivered may be placed in daylight unless the Engineer approves artificial light. Delivery of the material to the paver shall be at a uniform rate and in an amount within the capacity of the paving and compacting equipment.

Haul trucks shall be provided with covers of sufficient size and weight to completely cover the truck bed to protect the load and to prevent cooling of the upper surface. Failure to have the load completely covered shall be sufficient cause for rejection of the entire load. The load shall remain covered until the truck is next in line to be unloaded. In no case shall a load remain uncovered for more than 10 minutes before starting to use the load. If for any reason there is a delay in completely using a load, the remaining part of the load shall be recovered until it can be used. It shall be the responsibility of the Contractor to inform all truck drivers of these provisions before starting work.

2205.6 Scales and Weighing of Vehicles: The vehicle's tare and gross weight shall be established by actually weighing the vehicle on a certified scale. The tare weight will be established at least twice each day. The vehicle, when establishing tare, shall be clean, bed empty, fuel tanks filled and shall have all side and back boards in place.

A. **Measurement by weight**: Measurement will be made by weighing each truck load on scales conforming to the requirements of 2205.6 B "Vehicle Scales."

B. **Vehicle Scales**: Vehicle scales shall be approved by the engineer and shall conform to the requirements specified herein. The specifications, tolerances, and other technical requirements for weighing and measuring devices as recommended by the National Conference on Weights and Measures and published in the National Institute of Standards and Technology Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, and supplements thereto or revisions thereof, shall apply to all vehicles scales used.

C. **Scale acceptance shall be based on one of the following:**

1. A valid certification or seal of approval by the Division of Weights and Measures from the state.

2. A certification of calibration from a commercial scale service company showing that the scale meets the requirements of these specifications. The contractor shall furnish the certification of calibration to the Engineer.

D. **Scale Calibration:** Scales shall have been calibrated within the nine month period prior to any material being delivered, or at any time the Engineer has cause to question the accuracy of the scale. Scales shall meet the requirements of Accuracy Class III L as defined in Handbook 44 (above).

Verification of a vehicle scale may be required by weighing a hauling unit on another recently calibrated and certified scale.

If equipment to be weighed is of such length that all axles cannot be weighed simultaneously, a level paved surface shall be provided permitting those axles not on the scale platform to be supported by the paved surface. The approach shall be at least as wide as the platform and of sufficient length to insure the level positioning of vehicles during weight determinations. The weighing shall be performed with all brakes released. If equipment to be weighed is equipped with an air bag suspension unit on any axle, the equipment including semi-trailers or pup trailers shall be weighed on vehicle scales of sufficient size to weigh all axles of the combination simulataneously.

All cost incurred in obtaining a certification of calibration or verification shall be borne by the contractor.

2205.7 Requirements for Asphalt Paving Equipment: All asphalt paving equipment used by the Contractor shall meet the requirements of this section and shall be maintained in acceptable mechanical condition. Equipment shall be serviced and lubricated away from the paving site. Units that drip fuel, oil, grease or other fluids shall be removed from the project until such leakage is corrected.

A. **Pavers and Laydown Machines**: Mechanical self-powered pavers shall be capable of spreading the mix within the specified tolerances, true to the line, grade and crown indicated on the plans.

Pavers shall be equipped with quick and efficient steering devices and shall be capable of traveling both forward and in reverse. They shall be equipped with hoppers and distributing screws that place the mix evenly in front of the adjustable screeds. They shall be equipped with either a vibrating screed or a tamping bar immediately preceding a static screed.

There shall be sufficient auxiliary attachments for the paving machine so that it may be operated to lay the necessary width as determined in the field by the engineer. Vibrating screed or tamp bars shall be provided for the full width of all paving operations.

The screed shall include a strike-off device which is effective on mixes at workable temperatures without tearing, shoving or gouging them, and which produces a finished surface of an even and uniform texture. The screed shall be adjustable as to the height and crown and shall be equipped with a controlled heating device for use when required. However, for irregular width paving, hydraulic extensions without tamping bars or a vibrating screed may be used only along the curb or outer edge of pavement.

1. **Automatic Screed Controls**: The paver shall be equipped with and use an approved system capable of automatically controlling the elevation and transverse slope of the paver screed unless otherwise directed by the Engineer. An erected stringline, traveling stringline or other approved device operating on the roadbed being paved or the surface of the previously placed lane shall be used to establish the grade reference. The grade reference device shall operate on either or both sides of the paver as required and shall be capable of maintaining the desired transverse slope regardless of changes in the screed elevation.

2. The traveling stringline shall be constructed in such a manner that it does not vibrate or cause the sensor to make erroneous readings during the laydown operation. The length of the beam to be used shall be approved by the Engineer and shall be between 20 feet and 40 feet (6.1 and 12.2 m).

3. The use of the automatic screed control devices on asphalt pavers will not be required for paving small irregular areas, entrances, approaches, or side street connections.

4. Automatic screed control devices will be required for matching the joint with all previously laid strips, except for those areas noted above.

B. **Rollers**: Compaction equipment shall consist of vibratory steel wheel, static steel wheel and pneumatic-tired rollers unless otherwise directed by the engineer. They shall be self-propelled and equipped with such controls that starting, stopping and reversing direction can be accomplished without displacing the hot asphaltic concrete pavement.

Rollers shall be equipped with adjustable scrapers to keep the wheel surfaces clean and with efficient means of keeping them wet to prevent mixes from sticking. The roller surfaces shall have no flat areas, openings or projections that will mar the surface of the pavement.

1. **Steel-Wheeled Rollers**: Steel-Wheeled Rollers shall be vibratory two-axle tandem rollers. These rollers shall develop contact pressure of 250 to 350 pounds per inch of width (45 to 62.5 kg per cm of width) (vibratory mode) or 150 to 180 pounds per inch of width (26.8 to 32 kg per cm of width) (static). Rollers shall be in good working condition.

2. **Pneumatic-Tired Rollers**: Heavy pneumatic-tired rollers shall be self-propelled and shall consist of two axles on which are mounted an odd number of pneumatic tired wheels. The roller shall have at least nine pneumatic-tired wheels mounted in such a manner that the rear group of wheels will not follow in the tracks of the forward group, but shall be spaced to give essentially uniform coverage with each pass. Axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Tires shall be smooth, inflated to 90 p.s.i. (620 kPa). Construction of the roller shall be such that each wheel is loaded to a minimum of 2,300 pounds (1043 kg.).

3. **Trench Rollers**: Trench rollers shall have an auxiliary wheel that operates outside the area to be compacted at such a distance from the pavement edge as to cause no damage thereto. It shall be mounted upon an axle that is adjustable in height. The auxiliary wheel shall be kept in adjustment so that the compression wheels will develop a smooth, compacted surface true to crown and grade.

   The contact pressure of the compression wheels shall be from 250 to 350 pounds per inch of width (45 to 62.5 kg per cm of width).

4. In lieu of the above requirements pertaining to non-vibratory compaction equipment, consideration will be given to use other types of equipment that are capable of producing equivalent results consistent with the requirements of the specifications.

C. **Pressure Distributor**: The pressure distributor shall meet the requirements of Section 2204.5 entitled "Pressure Distributor."

D. **Hand Tools**: The Contractor shall provide sufficient lutes, rakes, shovels, tamping tools and other equipment as required to produce results consistent with the specifications.

2205.8 Construction Requirements:

A. **Preparation of the Area to be Paved**: The area to be paved shall be true to line and grade, and shall have a properly prepared surface prior to the start of the paving operations. It shall be free from all loose or foreign material.

   Where a base is rough or uneven, a leveling course shall be placed and properly compacted before the placing of subsequent courses.

   When leveling course is not required, all depressions and other irregularities shall be patched or corrected, and the work approved by the Engineer before the paving operation begins.

   The area to be paved shall be primed or tacked uniformly in accordance with the provisions of Section 2204 entitled "Prime and Tack Coat".

   The surfaces of curbs, gutters, vertical faces of existing pavements and all structures in actual contact with asphalt mixes shall be painted with a thin, complete coating of asphaltic material to provide a closely bonded, watertight joint.

B. **Weather Limitations**: When the moisture of the aggregate in the stockpile or from the dryer interferes with the quality of mix production, or with normal plant operations, or when pools of water are observed on the surface to be paved, the mixing and placing of hot-mix asphalt will not be permitted without the permission of the Engineer.

Hot Mix asphalt paving shall not be mixed or placed when the ambient air or base temperature is below 40° F (4.4° C), or when there is frost in the subgrade or any other time when weather conditions are unsuitable for the type of material being placed without expressed approval of the Engineer.

Asphalt mix laydown temperatures and rolling times shall conform to the following table:

Minimum Laydown Temperature			
Base Temp.	**1-1/2"**	**2"**	**3" and Greater**
40-50° F (4.4-10° C)	300° F (149° C)	285° F (141° C)	275° F (135° C)
50-60° F (10-16° C)	295° F (146° C)	280° F (138° C)	270° F (132° C)
60-70° F (16-21° C)	285° F (141° C)	275° F (135° C)	265° F (129° C)
70-80° F (21-27° C)	280° F (138° C)	270° F (132° C)	265° F (129° C)
80-90° F (27-32° C)	270° F (132° C)	265° F (129° C)	260° F (127° C)
90°+ F (32°+ C)	265° F (129° C)	260° F (127° C)	255° F (124° C)
Rolling Time	12 minutes	15 minutes	15 minutes

Regardless of the temperature, final acceptance of the asphalt mat shall be based on density determined in accordance with section 2205.8 (E). Rolling times shown are maximum times during which target density must be achieved.

C. **Spreading and Finishing**: The spreading and finishing of each course shall be to the thickness and width indicated on the plans or Special Provisions. The thickness of individual layers shall not exceed the following for the respective type of mixture. The suggested minimum lift thickness shall be three times the nominal maximum size of the mix. Nominal maximum is defined as the first sieve size larger than the sieve which retains at least 10% of the aggregate by weight.

Asphalt Type	**Max. Compacted Lift Thickness**
Type 1-01	6" (150 mm)
Type 2-01	4" (100 mm)
Type 3-01	3" (76 mm)
Type 4-01	2" (50 mm)
Type 5-01	4" (100 mm)
Type 6-01	3" (76 mm)

Spreading and finishing shall be conducted in the following manner:

1. **Mechanical Pavers:** The base and surface courses shall be spread and struck-off with a mechanical paving machine meeting the requirements of Section 2205.7A entitled "Pavers and Laydown Machines." The paving machine shall be operated so that the material does not accumulate and remain along the sides of the receiving hopper. The wings of the spreader hopper shall not be emptied (flipped) between truck loads.

    a. Equipment which leaves tracks or indented areas which cannot be corrected in normal operation, or which produces other permanent blemishes or fails to produce a satisfactory surface, shall not be used. The screed auger shall be operated approximately ¾ full and the hopper conveyor shall not be allowed to run out of material during the paving operation.

    b. Longitudinal joints and edges shall be constructed to true lines. Lines for the paver to follow in placing individual lanes will be established parallel to the centerline of the proposed roadway. The paver shall be positioned; and operated to follow closely the established line.

    c. Sufficient trucks shall be used to continuously supply asphalt to the paver. Delays in the paving operation shall be kept to a minimum.

    d. The Contractor shall make every effort to minimize the number of passes heavy equipment makes over uncompleted roadway sections.

    e. When using pavers in echelon, the second paver shall follow the edge of the material placed by the first paver. The length of each laydown pass shall be limited, depending on weather conditions, to assure a hot joint and obtain proper compaction.

    f. As soon as the first load of material has been spread, the texture of the unrolled surface shall be checked to determine its uniformity. Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediately suspended until the cause is determined and corrected.

    g. Transverse joints in succeeding courses shall be offset at least 2 feet (0.6 m). Longitudinal Joints shall be offset at least 6 inches (150 mm). The longitudinal joints shall be laid out so that the surface joint is under the lane markings where possible.

h. Any irregularities in alignment left by the paver shall be corrected by trimming directly behind the machine. Distortion of the pavement during this operation shall be avoided.

i. Edges against which additional pavement is to be placed shall be placed on a 30° (2:1) bevel, or as specified by the engineer. Any irregularities in the surface of the pavement course shall be corrected directly behind the paver. Excess material forming high spots shall be removed by a shovel or lute. Indented areas shall be filled with hot mix and smoothed. Broadcasting of material shall not be permitted.

2. **Hand Spreading**: In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand. The material shall be distributed uniformly to avoid segregation of the coarse and fine aggregate. Broadcasting of material shall not be permitted. During the spreading operation, all material shall be thoroughly and uniformly distributed by lutes or rakes. Material that has formed into lumps and does not break down readily shall be removed. Following placing and before rolling, the surface shall be checked with templates and straightedges and all irregularities corrected.

D. **Compaction**:

1. **General**: A minimum of three rollers shall be used for compacting mixes unless otherwise approved by the engineer. These rollers shall meet the requirements of Section 2205.7B entitled "Rollers." Additional rollers shall be used as necessary to provide specified pavement density.

Immediately after spreading, each course of the pavement mixture shall be compacted by rolling. The initial or "breakdown" rolling shall be accomplished with a steel-wheeled vibratory roller. The pneumatic-tired roller shall be used to knead and compact the pavement mixture following the initial rolling and preceding the final rolling. Care shall be exercised in the use of the pneumatic-tired roller to ensure that the pavement mixture is sufficiently cooled to avoid "picking up" of the mixture on the tires of the roller, and also to ensure that the pneumatic-tired rolling is completed before the mixture becomes too cool to allow satisfactory finish rolling. Final, or finish rolling, shall be done with a steel-wheeled roller. The sequence of rolling operations may be changed with the approval of the engineer.
All rolling shall be longitudinal, starting near the edge of the pavement. Alternate trips of the roller shall be of slightly different lengths. The initial

rolling shall take place as closely behind the laydown machine as the temperature and condition of the mat will allow.

The motion of the roller shall be slow enough at all times to avoid displacement of the hot mixture. The initial compaction roll shall be accomplished with the roller drive wheel leading the tiller wheel. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected immediately by the use of rakes and fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excess water will not be permitted.

The surface of the mixture after compaction shall be smooth and true to established section and grade. Any surface which is segregated, or is in any way defective, shall be removed and replaced with fresh hot mixture at the Contractor's expense, and shall be immediately compacted to conform with the surrounding area.

2. **Rolling Procedure**:

   a. **Thin Layers (Lifts)**: When placing a thin lift (less than 2 in.[50 mm] compacted thickness) in single-lane width or full width, the mixture should be rolled in the following sequence:

      1). Transverse joint.

      2). Outside edge.

      3). Breakdown rolling, beginning on the low side.

      4). Intermediate rolling; same procedure as Step 3.

      5). Finish rolling.

   b. When paving a thin lift in echelon, or when abutting a previously placed lane or other lateral restraint, the mixture should be rolled in the following sequence:

      1). Transverse joint.

      2). Longitudinal joint.

3). Outside edge.

4). Breakdown rolling, beginning on the low side.

5). Intermediate rolling; same procedure as Step 4.

6). Finish rolling.

c. **Thick Layers (Lifts):** When placing a thick lift (2 in. [50 mm] or more compacted thickness) in single-lane width or full width, the mixture should be rolled in the following sequence:

1). Transverse joint.

2). Breakdown rolling, beginning 12 to 15 in.(300 to 380 mm) interior to the lower unsupported edge. The return pass shall be made with the edge of the roller 3 inches (76 mm) exterior to the unsupported edge of the pavement.

3). Breakdown rolling of outside edge. Repeat the process described in Step 2 above on the other longitudinal edge.

4). Intermediate rolling, beginning on the low side.

5). Finish rolling.

d. When paving a thick lift in echelon, or when abutting a previously placed lane or other lateral restraint, the mixture should be rolled in the following sequence:

1). Transverse joint.

2). Longitudinal joint.

3). Breakdown rolling, beginning at the longitudinal joint.

4). Intermediate rolling, beginning on the low side.

5). Finish rolling.

e. When paving in echelon, 2-3 inches (5.08-7.62 cm) of the first mat shall be left unrolled, and rolled when the joint between the lanes is rolled and after the 2nd mat is placed. Edges shall not be exposed more than fifteen minutes without being rolled. Particular attention shall be given to the construction of transverse and longitudinal joints in all courses.

f. In laying a surface mix adjacent to any finished area, it shall be placed sufficiently high so that, when compacted, the finished surface will be true and uniform. Where the grade is slight a level will be used to insure drainage to the desired outlet.

3. **Transverse joints**: When the transverse joint is next to an adjoining lane, the first pass shall be made with a static steel-wheeled roller moving along the longitudinal joint for a few feet. The surface will then be checked with a straightedge and corrections shall be made if necessary. The joint then shall be rolled transversely, with 6 in.(150 mm) of the drum width on the newly laid material. This operation shall be repeated with successive passes, each covering an additional 6 to 8 in.(150 to 200 mm) of the new mat, until the entire width of a drive roll is on the new mixture. During transverse rolling, wooden boards of the proper thickness should be placed at the edge of the pavement to give the roller a surface to drive on once it passes the edge of tile Mat. if boards are not used, transverse rolling must stop 6 to 8 in. (150 to 200 mm) short of the outside edge to prevent damaging it, and the edge must be compacted later during longitudinal rolling. Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. If the joint has been distorted, it shall be trimmed to a line. The joint face shall be tacked before the fresh material is placed against it.

4. **Longitudinal joints**: Longitudinal joints shall be rolled directly behind the paving operation. The edge to be joined shall be tack coated. The paver screed shall be set to overlap the first mat by 1-2 inches (25-50 mm). The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. For large aggregate mixes, the coarse aggregate in the material overlapping the cold joint should be carefully removed and wasted, leaving only the finer portion of the mixture to be pressed into the compacted lane at the time the joint is rolled. For mixes with smaller coarse aggregate, such as surface courses, the overlapping material should be pushed with a lute into a hump over the joint area prior to compaction.

5. **Edges**: The edges of the pavement shall be rolled concurrently with or immediately after rolling the longitudinal joint. In rolling pavement edges, roller wheels shall extend 2-4 inches (50-100 mm) beyond the pavement edge provided the lateral displacement is not excessive.

6. **Breakdown Rolling**: Breakdown rolling shall immediately follow the rolling of the longitudinal joint and edges. Rollers shall be operated as close to the paver as necessary to obtain adequate density without causing undue displacement. The breakdown roller shall be operated with the drive wheel nearest the laydown machine. Exceptions may be made by the Engineer when working on steep slopes or super-elevated curves.

7. **Intermediate Rolling**: Pneumatic-tired rollers as specified in Section 2205.7B entitled "Rollers" shall be used for intermediate rolling. The intermediate rolling shall follow the breakdown rolling as closely as possible and while the paving mix is still of a temperature that will result in maximum density from this operation. Pneumatic-tired rolling shall be continuous after the initial rolling until all of the mix placed has been compacted to the required density. Turning of pneumatic-tired rollers on the hot paving mix which causes displacement shall not be permitted.

8. **Finish Rolling**: The finish rolling shall be accomplished while the material is still warm enough for the removal of roller marks. All roller marks shall be removed by the finish rolling operation. All rolling operations shall be conducted in close sequence.

9. In places inaccessible for the operation of standard rollers as specified, compaction shall be performed by trench rollers or others meeting the requirements of Section 2205.7B entitled "Rollers." The trench roller shall be operated until the lift is thoroughly compacted. Hand tamping, manual or mechanical, may be used in such areas, if such operations will give the required density.

E. **Density and Surface Requirements**: The completed asphalt concrete paving shall have a density equal to or greater than 95% for Type 1-01 and 5-01 Asphalt Concrete Base and 96% for Types 2-01, 3-01, 4-01, 5-01 and 6-01 Asphalt Concrete Surface. Density is based on laboratory specimens prepared as specified in Section 2205.3B entitled "Mix Design Criteria" and made from plant mix conforming to the job mix formula. Density testing shall conform to ASTM D 2950 or ASTM D 2726 or D 1188.

If cores are used to determine density, one or more tests (one test equals three cores) will be taken for each tonnage lot and averaged to determine acceptance. Two cores will be taken from the lane being paved, and one core centered on the longitudinal joint with the adjoining lane. The Engineer will mark the locations of all cores.

The compacted surface shall be 0-1/4 in. (0-6 mm) above the edge of curb. All unsatisfactory work shall be repaired, replaced or corrected. The surface of the final course shall be of a uniform texture and conform to line and grade shown on the plans.

The field control density will be based on the density of plant produced mix compacted in a laboratory in accordance with Section 2205.3 (C).

2205.9 Method of Measurement: Asphaltic concrete base, asphaltic concrete surface, or asphaltic concrete base and surface may be included in the proposal as separate items, or as a single item, and may be measured by one of the following:

A. Per square yard (square meter) or tenth part thereof for the specified depth.

B. Per ton (metric ton) or tenth part thereof.

C. If pavement smoothness is required in the proposal, pay adjustments will apply to the traffic lane design driving width only in accordance with Section 2211.

2205.10 Basis of Payment: Asphaltic Concrete Surface, Asphaltic Concrete Base, or Asphaltic Concrete Base and Surface whether used for paving, patching, or leveling courses will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

C. Testing described in Section 2205.3 paragraph I is subsidiary to the price bid for asphalt unless otherwise provided for in the contract.

END of SPECIFICATION

SECTION 03311

CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 117/117R	(1990; Errata) Standard Tolerances for Concrete Construction and Materials
ACI 207	(1996) Mass Concrete
ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 214	(1977; R 1997) Recommended Practice for Evaluation of Strength Test Results of Concrete
ACI 229	(1994) Controlled Low Strength Materials (CLSM)
ACI 303R	(1991) Guide to Cast-in-Place Architectural Concrete Practice
ACI 305R	(1999) Hot Weather Concreting
ACI 318/318R	(1992; Rev 1992; Errata) Building Code Requirements for Reinforced Concrete
ACI 318M/318RM	(1995) Building Code Requirements for Structural Concrete and Commentary (Metric)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31/C 31M	(2000) Making and Curing Concrete Test Specimens in the Field

ASTM C 33	(1999 ae1) Concrete Aggregates
ASTM C 39/C 39M	(1999) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	(1999) Organic Impurities in Fine Aggregates for Concrete
ASTM C 42/C 42M	(1999) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C 87	(1983; R 1995e1) Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM C 117	(1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	(1998) Lightweight Particles in Aggregate
ASTM C 127	(1988; R 1993el) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1997) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 142	(1978; R 1997) Clay Lumps and Friable Particles in Aggregates
ASTM C 143/C 143M	(2000) Slump of Hydraulic Cement Concrete
ASTM C 150	(1999a) Portland Cement
ASTM C 171	(1997a) Sheet Materials for Curing Concrete
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 192/C 192M	(2000) Making and Curing Concrete Test Specimens in the Laboratory

ASTM C 231	(1997e1) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2000) Air-Entraining Admixtures for Concrete
ASTM C 295	(1998) Petrographic Examination of Aggregates for Concrete
ASTM C 309	(1998a) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 441	(1997e1) Effectiveness of Mineral Admixtures or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C 494/C 494M	(1999a) Chemical Admixtures for Concrete
ASTM C 535	(1996e1) Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 566	(1997) Total Evaporable Moisture Content of Aggregate by Drying
ASTM C 595	(2000a) Blended Hydraulic Cements
ASTM C 597	(1983; R 1997) Pulse Velocity Through Concrete
ASTM C 618	(2000) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 666	(1997) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C 803/C 803M	(1997e1) Penetration Resistance of Hardened Concrete
ASTM C 805	(1997) Rebound Number of Hardened Concrete
ASTM C 881	(1999) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 989	(1999) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars

ASTM C 1017/C 1017M	(1998) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1059	(1999) Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C 1064/C 1064M	(1999) Temperature of Freshly Mixed Portland Cement Concrete
ASTM C 1077	(1998) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C 1107	(1999) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1260	(1994) Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM E 1155	(1996) Determining Floor Flatness and Levelness Using the F-Number System
ASTM E 1155M	(1996) Determining Floor Flatness and Levelness Using the F-Number System (Metric)

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 94	(1995) Surface Retarders
COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1997) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 130	(1989) Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 318	(1979) Cloth, Burlap, Jute (or Kenaf)

COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

CONCRETE INDUSTRY BOARD, INC. OF KANSAS CITY MID-WEST (MCIB)

Bulletin No. 20	Air Entraining Admixtures
Section 4	Materials-Fine Aggregate
Section 5	Concrete Mix Design Tables, Air Entrained Concrete
Section 8	Placing of Concrete
Section 9	Curing and Protection
Section 10	Cold Weather Concrete
Section 11	Hot Weather Concrete

MISSOURI HIGHWAY AND TRANSPORTATION COMMISSION. MISSOURI STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION, 1996 EDITION.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(1997) NIST Handbook 44: Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1996) Concrete Plant Standards

1.2 MEASUREMENT AND PAYMENT

No separate measurement or payment will be made for work covered under this Section and all costs shall be included in the contract unit or lump sum price for the item of work to which the materials and work is incidental.

1.3 SUBMITTALS

Item numbers within submittal packages shall be clearly identified. Information, including letters, test results, and certifications, shall be presented with headings relevant to this project.

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section, SUBMITTAL PROCEDURES.

SD-08 Statements

Concrete Mixture Proportioning ; GA-GD .

Requirements outlined in this paragraph shall be included in one transmittal. Concrete mixture proportions shall be determined by the Contractor, in accordance with the requirements in paragraphs, "MATERIALS" and "CONCRETE MIXTURE PROPORTIONING," and submitted for review. The concrete mixture quantities of all ingredients per cubicyard and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete shall be stated. Statements regarding cementious materials, aggregates, and chemical admixtures shall address all requirements specified. Proportions shall indicate the mass of cement, pozzolan and ground granulated blast-furnace (GGBF) slag, and water; the mass of fine and coarse aggregates in a saturated surface-dry condition; and the quantities of admixtures. The submission shall be accompanied by test reports from a laboratory complying with ASTM C 1077 which show that proportions thus selected will produce concrete of the qualities indicated. No substitution shall be made in the source or type of materials used in the work without additional tests to show that the quality of the new materials and concrete are satisfactory.

Non-Shrink Grout ; GA-GD .

Mixture proportions with laboratory report demonstrating compliance with specified requirements.

Flowable Backfill; GA-GD.

Mixture proportions with laboratory report demonstrating compliance with specified requirements.

Batch Plant ; GA-GD .

The Contractor shall submit batch plant data to the Contracting Officer for review for conformance with applicable specifications.

Concrete Mixers ; GA-EC .Capacity ; GA-GD.

The Contractor shall submit concrete mixer data which includes the make, type, and capacity of concrete mixers proposed for mixing concrete in conformance with the paragraphs, "CAPACITY" and "CONCRETE MIXERS."

Conveying Equipment and Methods; FIO-EC .

The conveying equipment and methods for transporting, handling, and depositing the concrete shall be submitted for review by the Contracting Officer for conformance with paragraphs, "CAPACITY" and "CONVEYING EQUIPMENT."

Placing Equipment and Methods; FIO-EC .

All placing equipment and methods shall be submitted for review by the Contracting Officer for conformance with paragraph, "CAPACITY."

Testing Technicians ; FIO-EC . Concrete Transportation Construction Inspector (CTCI) ; FIO-EC .

The Contractor shall submit statements that the concrete testing technicians and the concrete inspectors meet the requirements of paragraph, "TESTS AND INSPECTIONS."

Construction Joint Treatment ; GA-EC .

The method and equipment proposed for joint cleanup and waste disposal shall be submitted for review and approval for conformance with paragraph, "CONSTRUCTION JOINT TREATMENT."

Curing and Protection ; GA-EC .

The curing medium and methods to be used shall be submitted for review and approval for conformance with paragraph, "CURING AND PROTECTION."

Cold-Weather Placing ; GA-EC .

If concrete is to be placed under cold-weather conditions, the proposed materials, methods, and protection meeting the requirements of paragraph, "COLD-WEATHER PLACING" shall be submitted for approval.

Hot-Weather Placing ; GA-EC .

If concrete is to be placed under hot-weather conditions, the proposed materials and methods, meeting the requirements of paragraph, "HOT-WEATHER PLACING" and paragraph, "FINISHING," shall be submitted for review and approval.

The previous four submittals (Construction Joint Treatment, Curing and Protection, Cold-Weather Placing, and Hot-Weather Placing) shall be submitted in a single packet.

SD-09 Reports

Aggregate Quality ; GA-GD .

Aggregate quality tests shall be submitted at least 30 days prior to start of concrete placement, in accordance with paragraph, "QUALITY OF AGGREGATES."

Uniformity of Concrete Mixing ; GA-GD .

The results of the initial mixer uniformity tests as required in paragraph, "MIXER UNIFORMITY" shall be submitted at least 5 days prior to the initiation of placing.

Tests and Inspections ; GA-EC .

Test results and inspection reports shall be submitted daily and weekly as required in paragraph, "REPORTS."

SD-13 Certificates

All certificates shall be submitted in a single packet.

Cementitious Materials ; GA-GD

Cementitious Materials, including Cement and Pozzolan, and Ground Granulated Blast-Furnace Slag will be accepted on the basis of the manufacturer's certification of compliance, accompanied by mill test reports that materials meet the requirements of the specification under which they are furnished. Certification and mill test reports shall be from samples taken from the particular lot furnished. No cementitious materials shall be used until notice of acceptance has been given by the Contracting Officer. Cementitious materials will be subject to check testing from samples obtained at the source, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Material not meeting specifications shall be promptly removed from the site of work.

Impervious-Sheet Curing Materials ; GA-EC

Impervious-Sheet Curing Materials shall be certified for compliance with all specification requirements.

Air-Entraining Admixture ; GA-GD

Air-Entraining Admixture shall be certified for compliance with all specification requirements.

Other Chemical Admixtures ; GA-GD

Other Chemical Admixtures shall be certified for compliance with all specification requirements.

Membrane-Forming Curing Compound ; GA-GD

Membrane-Forming Curing Compound shall be certified for compliance with all specification requirements.

Epoxy Resin ; GA-EC

Epoxy Resin Bonding Compound shall be certified for compliance with all specification requirements.

Nonshrink Grout ; GA-GD .

Descriptive literature of the Nonshrink Grout proposed for use shall be furnished together with a certificate from the manufacturer stating that it is suitable for the application or exposure for which it is being considered.

SD-14 Samples

Aggregates ; GA-EC .

Samples of materials for government verification testing and approval shall be submitted as required.

1.4 GOVERNMENT VERIFICATION TESTING AND SAMPLING

The Government may sample and test aggregates and concrete to determine compliance with the specifications. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Concrete will be sampled in accordance with ASTM C 172.

1.4.1 Government Verification Sampling and Testing

1.4.1.1 Aggregates

The aggregate sources listed at the end of this section for aggregates have been previously tested and at the time testing was performed were capable of producing materials of a quality required for this project provided suitable processing is performed. Coarse aggregates shall be produced from Burlington Limestone, except for special aggregate concrete. The Government will inspect the Contractor's proposed aggregate sources, prior to determining requirement for initial Government Verification Sampling and Testing. Initial material acceptance will be based on the Government inspection and the results of material testing and evaluation specified in paragraph Tests and Inspections. Material sources shall be tested by an approved independent commercial testing laboratory, and certified copies of laboratory test reports and analysis shall be submitted in accordance with paragraph Tests and Inspections. The Contracting Officer will

determine when Government Verification Sampling and Testing is required, to verify compliance with specified requirements. Samples for Government Verification Sampling and Testing, shall be obtained from the source of coarse aggregate and sources of fine aggregate selected by the Contractor, shall be taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100 shall be delivered to the Corps of Engineer's Quality Control Laboratory for testing. Sampling and shipment of samples shall be at the Contractor's expense. Testing will be performed by and at the expense of the Government in accordance with the applicable COE CRD-C or ASTM test methods. If the Contractor selects more than one source for each aggregate size or selects a substitute source for any size aggregate after the original source was tested, the cost of that additional testing will be borne by the Contractor. Tests to which aggregate may be subjected are listed in paragraph QUALITY. The material from the proposed source shall meet the quality requirements of this paragraph. Testing of aggregates by the Government does not relieve the Contractor of the requirements outlined in paragraph TESTS AND INSPECTIONS.

1.4.2 Construction Testing by the Government

Government Verification testing will be performed by and at the expense of the Government except as otherwise specified. Samples for Government Verification Sampling and Testing shall be taken under the supervision of the Contracting Officer. Sampling and shipment of samples shall be at the Contractor’s expense. Testing will be performed by and at the expense of the Government. The government may require duplicate samples for independent parallel quality assurance testing by the city. All testing and evaluations shall be coordinated with the contracting officer

1.4.2.1 Chemical Admixtures Storage

Chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing shall be retested at the expense of the Contractor when directed by the Contracting Officer and shall be rejected if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with the requirements of paragraph, "CHEMICAL ADMIXTURES."

1.4.2.2 Concrete Strength

Compressive strength verification test specimens will be made by the Government and cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 500 psi. A "test" is defined as the average of two companion cylinders, or if only one cylinder is tested, the results of the single cylinder test. Additional analysis or testing, including nondestructive testing, taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

a. Investigation of Low-Strength Test Results - When any strength test of standard-cured test cylinders falls below the specified strength requirement by more than 500 psi 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 not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803, or ASTM C 805 may be permitted by the Contracting Officer to estimate the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests shall not be used as a basis for acceptance or rejection.

b. Testing of Cores - When the strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores will be determined by the Contracting Officer to least impair the performance of the structure. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement.

c. Load Tests - If the core tests are inconclusive or impractical to obtain or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test shall be corrected in a manner satisfactory to the Contacting Officer. All investigations, testing, load tests, and correction of deficiencies will be performed and approved by the Contracting Officer at the expense of the Contractor, except that if all concrete is in compliance with the plans and specifications, the cost of investigations, testing, and load tests will be at the expense of the Government.

1.5 DESIGN REQUIREMENTS

1.5.1 Concrete Strength

Specified compressive strength f'c shall be as follows:

COMPRESSIVE STRENGTH (PSI)	STRUCTURE OR PORTION OF STRUCTURE
4,000 @ 28 days	For all work, except special aggregate concrete.

Special aggregate concrete shall conform to the requirements herein and in MCIB, except as otherwise noted. Special aggregate

concrete shall conform to MCIB Mix No. SA-1 and SA-2. The mixtures shall be used at locations specified, and as indicated on the drawings. The work shall require constructing a full depth special aggregate concrete bridge deck within the area and to the depth shown on the drawings. The sidewalks, barrier and curb, diaphragms and approach slabs shall be special aggregate concrete.

4,000 @ 28 days	Mix No. SA-1
4,500 @ 28 days	Mix No. SA-2

1.5.2 Maximum Water-Cement (W/C) Ratio

Maximum W/C shall be 0.45 by mass for all work except special aggregate concrete. Maximum W/C for special aggregate concrete shall be 0.385 by mass. The W/C ratio may cause higher strengths than that required by paragraph "Concrete Strength" of this section.

1.6 CONSTRUCTION TOLERANCES

1.6.1 General

The definitions of the terms used in the following tables shall be as defined in ACI 117/117R. Level and grade tolerance measurements of slabs shall be made as soon as possible after finishing. When forms or shoring are used, the measurements shall be made prior to removal. Tolerances are not cumulative. The most restrictive tolerance controls. Tolerances shall not extend the structure beyond legal boundaries. Except as specified otherwise, plus tolerance increases the amount or dimension to which it applies, or raises a level alignment, and minus tolerance decreases the amount or dimension to which it applied, or lowers a level alignment. A tolerance without sign means plus or minus. Where only one signed tolerance is specified, there is no limit in the other direction. The application of the tolerances shall not be allowed to result in a reduction in the minimum required concrete clear cover over reinforcement or other metal embedment.

TOLERANCES FOR STRUCTURES (Includes Intakes)

(1) Vertical alignment

For heights 100 feet or less

Lines, surfaces, and arrises..... 1 in

Outside corner of exposed corner columns and control joint grooves in concrete

exposed. to view ..... 1/2 in

Sealing surfaces ..... 1/16 in

(2) Lateral alignment

In slabs, centerline location of
openings 12 inches or smaller
and edge location of larger openings ..... 1/2 in

Sawcuts, joints, and weakened
plane embedment in slabs ..... 3/4 in

Sealing surfaces ..... 1/16 in

(3) Level alignment
Top of slabs

Elevation of slabs-on-grade ..... 3/4 in

Lintels, parapets,
horizontal grooves, and other
lines exposed to view ..... 1/2 in

Sealing surfaces of sills and postwells.....1/16 in

(4) Cross-sectional dimensions
Members, such as abutments, postwells,
pedestals, walls (thickness
only), and slabs (thickness only)

12-in. dimension or less ..... +3/8 in
..... -1/4 in
More than 12 in. but not
over 3 ft. dimension .... +1/2 in
..... -3/8 in
Over 3 ft. dimension ..... +1 in
..... -3/4 in
Dimensions of unformed
members cast against soil
..... +3 in
..... -1/2 in

(5) Deviations from a planar
surface measured with a
10-foot straight edge

placed on high points:

General ..... 3/8 in
Sealing surface ..... 1/16 in

(6) The offset between adjacent pieces of formwork facing material shall not exceed:

Class A ..... 1/8 in
Class B ..... 1/4 in
Class C ..... 1/2 in
Class D ..... 1 in

TOLERANCES FOR TUNNEL LININGS, CONDUITS, PRECAST CONCRETE PIPE, FILLING AND EMPTYING CULVERTS AND INLET AND OUTLET STRUCTURES

(1) Lateral alignment

Centerline alignment

Water conveying, conduits, and culverts ..... 1/2 in

Others ..... 1 in

Inside dimensions ..... 0.005 times inside dimension

(2) Level alignment

Profile grade

Water conveying , conduits, and culverts 1/2in

Others ..... 1 in

Surface of invert ..... 1/4 in

Surface of side slope ..... 1/2 in

(3) Cross-sectional dimension

Thickness at any point

Conduits ..... +5 percent thickness but
not less than 1/2 in.
..... -2.5 percent thickness but
not less than 1/4 in.

1.6.2 Slabs on grade

Tolerances for finished surfaces of slabs on grade shall conform to the requirements specified herein. Measurements shall be accomplished along the alignment of each paving direction (slabs on grade) for gates, railroad crossings, and street pavements. The measurements in the transverse direction shall be accomplished at slab joints and at 5-foot intervals along the alignment. Measurements in the longitudinal direction shall be accomplished continuously along the alignment at the centerline and edges of each paving lane or row of slabs. Measurements shall be accomplished across joints in slabs on grade to determine gradual and abrupt variations in surface elevations across joints.

1.6.3 Appearance

Permanently exposed surfaces shall be cleaned, if stained or otherwise discolored, by a method that does not harm the concrete and that is approved by the Contracting Officer.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall be portland cement, Portland-pozzolan cement, portland cement in combination with pozzolan or GGBF slag and shall conform to appropriate specifications listed below. Use of cementitious materials in architectural concrete shall be restricted to one color, one source, and one type. Cement for special aggregate concrete mixtures shall conform to ASTM C 150 Type I. Fly ash (pozzolan), Blended Hydraulic Cement, Type IP cement or Type I (PM) cement, Ground Granulated Blast-Furnace Slag, shall not be used in the special aggregate concrete.

2.1.1.1 Portland Cement

Portland cement shall conform to ASTM C 150, Type I or II, except that the maximum amount of C3A in Type I cement shall be limited to a maximum of 15 percent, Type I and II shall meet the low alkali requirement. The same types and source of Portland cement shall be used throughout the entire project. White Portland cement shall meet the above requirements, and may only be used when specifically approved in writing.

2.1.1.2 High-Early-Strength Portland Cement

ASTM C 150, Type III, with C3A limited to 8 percent, meeting the low alkali requirement may be used only when specifically approved in writing.

2.1.1.3 Pozzolan, Other than Silica Fume

Pozzolan shall conform to ASTM C 618, Class C or F, Tables 1 and 3, including the Supplementry Optional Chemical Requirements in Table 2 for available alkalies, and the Supplementary Optional Physical Reqirements in Table 4.

2.1.1.4 Ground Granulated Blast-Furnace Slag

Ground Granulated Blast-Furnace Slag shall conform to ASTM C 989, Grade 100 or 120.

2.1.1.5 Blended Hydraulic Cement

Portland Pozzolan cement shall conform to ASTM C 595, Type IP, meeting the mortar expansion requirement.

2.1.2 Aggregates

2.1.2.1 General

Concrete aggregates may be furnished from any source capable of meeting the quality requirements as stated in paragraph QUALITY. Coarse aggregates shall be produced from Burlington limestone, except for special aggregate concrete. The sources listed at the end of this section were previously evaluated and were found at that time capable of meeting the quality requirements when suitably processed. No guarantee is given or implied that any of the listed sources are currently capable of producing aggregates that meet the required quality stated in paragraph QUALITY. The listed sources are provided for information only. The contractor shall sample and test all selected aggregates for compliance with specified requirements herein. All sampling and testing (except as otherwise specified) is the contractor's responsibility and shall be accomplished by an approved commercial testing laboratory. Material tests accomplished within 12 months shall be allowed for use in material compliance approvals. The nominal maximum size coarse aggregate for concrete, except special aggregate concrete, shall be as listed in paragraph NOMINAL MAXIMUM-SIZE COARSE AGGREGATE. Fine and coarse aggregates shall conform to the grading requirements of ASTM C 33, except special aggregate concrete.

Special Aggregate Concrete: Fine aggregate for special aggregate concrete shall conform to MCIB Section 4, sampling and testing shall conform to ASTM C 33. Coarse aggregate for special aggregate concrete shall be Iron Mountain Trap Rock, Nepheline Syenite or approved equal,

and shall conform to the requirements of MCIB. Coarse aggregate for special aggregate concrete shall conform to the following gradation:

Sieve Designation	Percentage Passing
1-inch (25.0 mm)	100
3/4 inch (19.0 mm)	90-97
1/2 inch (12.5 mm)	45-70
3/8 inch (9.5 mm)	20-55
No. 4 Sieve (4.75 mm)	0-10
No. 8 Sieve (2.36 mm)	0-5

The fineness modulus of aggregate for special aggregate concrete shall not vary more than plus or minus 0.20 from the fineness modulus of the gradation on which the mix is designed.

The combined weight of sulfides such as Pyrite, Marcasite and Chalcopyrite, shall not exceed 0.1 percent of the weight of special aggregate sample. The material finer than the No. 200 (75um) sieve shall not exceed one (1) percent of the weight of the special aggregate sample.

Methods of sampling and testing special aggregate shall conform to ASTM C 33.

Concrete, Except Special Aggregate Concrete: In addition to the grading limits in ASTM C 33, the fine aggregate, as delivered to the mixer shall have a fineness modulus of not less than 2.40 nor greater than 3.10. The grading of the fine aggregate shall also be controlled so that the fineness moduli of at least four of any five consecutive test samples of the fine aggregate as delivered to the mixer shall not vary more than 0.15 from the average fineness modulus of all samples taken during the first 30 days of concrete placement unless otherwise directed. The fineness modulus shall be determined by dividing by 100, the sum of the cumulative percentages retained on U.S. Standard Sieves Nos. 4, 8, 16, 30, 50, and 100. At the option of the Contractor, fine aggregate may be separated into two or more sizes or classifications, but the uniformity of grading of the separate sizes shall be controlled so that they may be combined throughout the job in fixed proportions established during the first 30 days of concrete placement.

2.1.2.2 Concrete Aggregate Sources

After the award of the contract, the Contractor shall designate in writing only one source or combination of sources from which he proposes to furnish each aggregate for all concrete. If the Contractor proposes to furnish aggregates from a source or from sources not listed at the end of this section, he may designate only a single source or single combination of sources for each aggregate. The contractor shall be responsible for sampling and testing the aggregates. All aggregates shall be tested for compliance with the specified requirements, and certified copies of laboratory test reports submitted for approval prior to the use of the aggregates in the work. If a source for coarse or fine aggregates so designated by the Contractor does not meet the quality requirements stated in

paragraph QUALITY, the Contractor shall replace the source. The contractor shall submit certified laboratory reports for the new source, showing compliance with the specified requirements prior to us in the work.

2.1.2.3 Quality

Concrete, Except Special Aggregate Concrete: (Aggregates for special aggregate concrete shall conform to the requirements specified for special aggregate concrete) Fine aggregates for all other concrete, shall conform to the aggregate quality requirements of ASTM C 33, except as modified herein. Coarse aggregates for all other concrete, shall conform to the aggregate quality requirements of ASTM C 33, Class 5S, except as modified herein. Aggregate particles shall be sound and durable and free from objectionable coatings. Coarse aggregate shall not contain more than 0.5 percent by weight of white tripolitic chert that has a specific gravity, saturated surface dry, of less than 2.40. Tripolitic chert is the white porous siliceous form of weathered chert found in nodules and beds within some Burlington limestone sources. The total amount of all types of chert shall not exceed 3 percent by weight. To keep chert from exceeding these specified maximum limits, it may be necessary to employ selective quarrying to utilize the lesser cherty portions of the limestone deposit and to remove cherty particles by processing, loading, and handpicking from the quarried material before and during final processing into finished aggregate sizes.

All aggregates (including special aggregate concrete) shall have a specific gravity, saturated surface dry of not less than 2.60, and an absorption of not more than 2.0 percent, as determined by ASTM C 127and ASTM C 128. All aggregates shall be tested in accordance with ASTM C 1260 and shall have an expansion of less than 0.1 percent at 16 days.

In addition, aggregates delivered to the mixer shall meet the following requirements:

PROPERTY TEST	TEST LIMITS FINE AGGREGATE	TEST LIMITS COARSE AGGREGATE	
Durability Factor using (Procedure A)	Greater than 50	Greater than 50	COE CRD-C 114 ASTM C 666
Clay Lumps and Friable Particles	1	2	ASTM C 142
Material Finer than 75-m (No. 200) Sieve	3	1	ASTM C 33
Organic Impurities	Not darker than No. 3		ASTM C 40
	Not less than 95 percent		ASTM C 87

Test Limits			
L.A. Abrasion		40	ASTM C 131 ASTM C 535
Total Lignite	0.1		ASTM C 123
Total Chert, than less 2.40 specific gravity		0.5	ASTM C 123

Coal and Lignite, less than 2.00 specific gravity	0.25	0.25	ASTM C 123
Petrographic Examination	Presence and types of Chert, Coal, Lignite, Shale and Alkali-Silica reactive aggregates		ASTM C 295

2.1.2.4 Particle Shape

The shape of the particles in the fine aggregate and in the coarse aggregate shall be generally spherical or cubical. The quantity of flat and elongated particles in the separated size groups of coarse aggregate, as defined and determined by CE specification CRD-C 119 shall not exceed 25 percent in any size group.

2.1.3 Chemical Admixtures

Chemical admixtures to be used, when required or permitted, shall conform to the appropriate specification listed.

2.1.3.1 Air-Entraining Admixture

The air-entraining admixture shall conform to ASTM C 260 and shall consistently cause the concrete to have an air content in the specified ranges under field conditions. Air-entraining agents used to produce special aggregate concrete shall conform to ASTM C 260 and MCIB Bulletin No. 20.

2.1.3.2 Accelerating Admixture

Accelerators shall meet the requirements of ASTM C 494/C 494M, Type C or E, except that calcium chloride or admixtures containing calcium chloride shall not be used.

2.1.3.3 Water-Reducing or Retarding Admixture

a. Water-Reducing or Retarding Admixtures: ASTM C 494/C 494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived. When the ambient air temperature is 85 degrees F or above ASTM C 494 Type D water-reducing and retarding admixture shall be used for special aggregate concrete.

b. High-Range Water Reducing Admixture: ASTM C 494/C 494M, Type F or G except that the 6-month and 1-year strength requirements shall be waived. The admixture may be used only when approved by the Contracting Officer, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan.

2.1.3.4 Other Chemical Admixtures

Other chemical admixtures for use in producing flowing concrete shall comply with ASTM C 1017/C 1017M, Type 1 or 2. These admixture shall be used only for concrete listed in paragraph SLUMP.

2.1.4 Curing Materials

2.1.4.1 Impervious-Sheet Curing Materials

Impervious-sheet curing materials shall conform to ASTM C 171, type optional, except polyethylene film shall not be used.

2.1.4.2 Membrane-Forming Curing Compound

The membrane-forming curing compound shall conform to ASTM C 309, Type 1-D or 2, except a styrene acrylate or chlorinated rubber compound meeting Class B requirements shall be used for surfaces that are to be painted or are to receive bituminous roofing, or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, coating, or flooring specified. Nonpigmented compound shall contain a fugitive dye and shall have the reflective requirements in ASTM C 309 waived.

2.1.4.3 Burlap

Burlap used for curing shall conform to COE CRD-C 318.

2.1.5 Water

Water for mixing and curing shall be fresh, clean, potable, and free of injurious amounts of oil, acid, salt, alkali, or organic compounds, except that nonpotable water may be used if it meets the requirements of COE CRD-C 400.

2.1.6 Nonshrink Grout

Nonshrink grout shall conform to ASTM C 1107 and shall be a commercial formulation suitable for the application proposed.

2.1.7 Flowable Backfill

Flowable backfill shall conform to State Specifications, Section 621 FLOWABLE BACKFILL. All ingredients used in the flowable backfill shall conform to the requirements herein.

2.1.8 Epoxy Resin

Epoxy resin for use in repairs shall conform to ASTM C 881, Type III, Grade I or II.

2.2 CONCRETE MIXTURE PROPORTIONING

2.2.1 Quality of Mixture

For each portion of the structure, mixture proportions shall be selected so that the strength and W/C requirements listed in paragraph DESIGN REQUIREMENTS are met.

2.2.2 Cement Content

Cement Content shall be measured by weight. Cement content per cubic yard of concrete shall be 564 pounds, minimum, for all work except special aggregate concrete. The cement content per cubic yard for special aggregate concrete shall conform to MCIB, and shall be at least 634 pounds for Mix No. SA-1 and at least 683 pounds for Mix No. SA-2, minimum.

2.2.3 Aggregate

The aggregate portion of the concrete mixtures shall contain at least 50 percent crushed Burlington limestone coarse aggregate, except for special aggregate concrete. Special aggregate concrete shall be from the special aggregate source list at the end of this specification.

2.2.4 Nominal Maximum-Size Coarse Aggregate

Nominal maximum-size coarse aggregate for all concrete shall be 3/4 inch, except special aggregate concrete shall conform to the specified gradation.

2.2.5 Air Content

Air content of all concrete as delivered to the forms and as determined by ASTM C 231 shall be between 4-1/2 and 7-1/2 percent, except for special aggregate concrete. Special aggregate concrete shall be between 5 and 7 percent.

2.2.6 Slump

The slump shall be determined in accordance with ASTM C 143/C 143M. All concrete shall have a slump within the range of 1 to 4 inch, except special aggregate concrete. Special aggregate concrete shall be designed to produce a 3 inch (75 mm) slump and shall be rejected at the job site if the slump exceeds 4 inches (100 mm). Where placement by pump is approved, the slump shall not exceed 6 inches. The slump of pumped concrete shall be determined at the discharge side of the pump. Flowable backfill may contain a chemical admixture for use in producing a flowable concrete mixture in accordance with ASTM C 1017/C 1017M. The slump of flowable backfill shall not exceed 8-inches.

2.2.7 Concrete Proportioning

Trial batches and testing requirements for various qualities of concrete specified shall be the responsibility of the Contractor. Samples of aggregates shall be obtained in accordance with the requirements of ASTM D 75. Samples of materials other than aggregate

shall be representative of those proposed for the project and shall be accompanied by the manufacturer's test reports indicating compliance with applicable specified requirements. Trial mixtures having proportions, consistencies, and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water-cement ratios, which will produce a range of strength encompassing those required for the work. The maximum water-cement ratios required in paragraph MAXIMUM WATER-CEMENT RATIO will be converted to a weight ratio of water to cement plus pozzolan by mass, or GGBF slag by mass equivalency as described in ACI 211.1. In the case where GGBF slag is used, the weight of the slag shall be included in the equations for the term P, which is used to denote the mass of pozzolan. If pozzolan (Fly Ash)is used in the concrete mixture, the pozzolan content shall be 20 percent of the total cementitious material. Trial mixtures shall be proportioned for maximum permitted slump and air content with due consideration to the approved conveying and placement method. The temperature of concrete in each trial batch shall be reported. For each water-cement ratio, at least three test cylinders for each test age shall be made and cured in accordance with ASTM C 192/C 192M. They shall be tested at 7 days and at the design age specified in paragraph DESIGN REQUIREMENTS in accordance with ASTM C 39/C 39M. From these test results, a curve will be plotted showing the relationship between water-cement ratio and strength. Flowable backfill shall conform to the requirements herein for concrete and to state specifications section 621.

2.2.8 Required Average Compressive Strength

In meeting the strength requirements specified in paragraph CONCRETE STRENGTH, the selected mixture proportion shall produce a required average compressive strength f'cr exceeding the specified strength f'c by the amount indicated below.

2.2.8.1 Average Compressive Strength from Test Records

Where a concrete production facility has test records, a standard deviation shall be established in accordance with the applicable provisions of ACI 214. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected, shall represent concrete produced to meet a specified strength or strengths (f'c) within 1,000 psi of that specified for proposed work, and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another test age designated for determination of f'c.

Required average compressive strength f'cr used as the basis for selection of concrete proportions shall be the larger of the equations that follow using the standard deviation as determined above:

$$f'cr = f'c + 1.34S$$
$$f'cr = f'c + 2.33S - 500$$

Where S = standard deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, a standard deviation shall be established as the product of the calculated standard deviation and a modification factor from the following table:

NUMBER OF TESTS*	MODIFICATION FACTOR FOR STANDARD DEVIATION Use tabulation in paragraph DETERMINING REQUIRED AVERAGE STRENGTH
less than 15	
15	1.16
20	1.08
25	1.03
30 or more	1.00

*Interpolate for intermediate numbers of tests.

2.2.8.2 Average Compressive Strength without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, the required average strength fcr shall be determined as follows:

If the specified compressive strength f'c is less than 3,000 psi,

f'cr = f'c + 1,000 psi

If the specified compressive strength f'c is 3,000 to 5,000 psi,

f'cr = f'c + 1,200 psi

If the specified compressive strength f'c is over 5,000 psi,

f'cr = f'c + 1,400 psi

PART 3 EXECUTION

3.1 EQUIPMENT

3.1.1 Capacity

The batching, mixing, conveying, and placing equipment shall have a capacity of at least 40 cubic yards per hour.

3.1.2 Batch Plant

Batch plant shall conform to the requirements of NRMCA CPMB 100and as specified; however, rating plates attached to batch plant equipment are not required. The batch plant may be located on or off the project site.

3.1.2.1 Batching Equipment

The batching controls shall be semiautomatic or automatic. The semiautomatic batching system shall be provided with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance. The batching system shall be equipped with an accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. Separate bins or compartments shall be provided for each size group of aggregate and cement, pozzolan, and GGBF slag. Aggregates shall be weighed either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Aggregate shall not be weighed in the same batcher with cement, pozzolan, or GGBF slag. If both cement and pozzolan or GGBF slag are used, they may be batched cumulatively provided that the portland cement is batched first. If measured by mass, the mass of the water shall not be weighed cumulatively with another ingredient. Water batcher filling and discharging valves shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. An accurate mechanical device for measuring and dispensing each admixture shall be provided. Each dispenser shall be interlocked with the batching and discharging operation of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Admixtures shall not be combined prior to introduction in water. The plant shall be arranged so as to facilitate the inspection of all operations at all times. Suitable facilities shall be provided for obtaining representative samples of aggregates from each bin or compartment. All filling ports for cementitious materials bins or silos shall be clearly marked with a permanent sign stating the contents.

3.1.2.2 Scales

The equipment for batching by mass shall conform to the applicable requirements of NIST HB 44, except that the accuracy shall be plus or minus 0.2 percent of scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. Tests shall be made at the frequency required in paragraph TESTS AND INSPECTIONS, and in the presence of a government inspector.

3.1.2.3 Batching Tolerances

a. Weighing Tolerances

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	0 to plus 2
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

b. Volumetric Tolerances - For volumetric batching equipment, the following tolerances shall apply to the required volume of material being batched:

Water: ..... Plus or minus 1 percent.
Chemical admixtures: ..... Zero to plus 6 percent.

3.1.2.4 Moisture Control

The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched. An electric moisture meter complying with the provisions of COE CRD-C 143 shall be provided for measuring moisture in the fine aggregate. The sensing element shall be arranged so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.

3.1.3 Concrete Mixers

The concrete mixers shall not be charged in excess of the capacity recommended by the manufacturer. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer. The mixers shall be maintained in satisfactory operating condition, and the mixer drums shall be kept free of hardened concrete. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired.

3.1.3.1 Stationary Mixers

Concrete plant mixers shall be tilting, nontilting, horizontal-shaft, vertical-shaft, or pugmill and shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity shall conform to all the requirements in ASTM C 94/C 94M applicable to central-mixed concrete. All special aggregate concrete used in the work shall be Ready-Mixed Concrete. Special aggregate concrete shall be mixed and transported in accordance with ASTM C 94. Special aggregate concrete mixtures which are non plastic and workable when placed in the work, shall be rejected.

3.1.3.2 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity shall conform to the requirements of ASTM C 94/C 94M. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Each truck shall be equipped with two counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

3.1.4 Conveying Equipment

The conveying equipment shall conform to the following requirements.

3.1.4.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

3.1.4.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers shall be capable of receiving concrete directly from delivery vehicles and have conical-shaped discharge features. The transfer hopper shall be equipped with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Concrete shall not be held in nonagitating transfer hoppers more than 30 minutes.

3.1.4.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C 94/C 94M. Nonagitating equipment may be used for transporting plant-mixed concrete over a smooth road when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

3.1.4.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes attached to this equipment by the manufacturer may be used. A discharge deflector shall be used when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

3.1.4.5 Belt Conveyors

Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete at the transfer

points and the point of placing. Belt conveyors shall be constructed such that the idler spacing shall not exceed 36 inches. The belt speed shall be a minimum of 300 feet per minute and a maximum of 750 feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, the conveyor shall discharge concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars.

3.1.4.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment shall be piston or squeeze pressure. The pipeline shall be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe shall be at least three times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 4 inches. Aluminum pipe shall not be used.

3.1.5 Vibrators

Vibrators of the proper size, frequency, and amplitude shall be used for the type of work being performed in conformance with the following requirements:

APPLICATION	HEAD DIAMETER INCHES	FREQUENCY VPM	AMPLITUDE INCHES
Thin walls, beams, etc.	1-1/4 to 2-1/2	9,000 to 13,500	0.02 to 0.04
General construction	2 to 3-1/2	8,000 to 12,000	0.025 to 0.05

The frequency and amplitude shall be determined in accordance with COE CRD-C 521.

3.2 PREPARATION FOR PLACING

3.2.1 Embedded Items

Before placement of concrete, care shall be taken to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Embedded items shall be free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable materials to prevent the entry of concrete into voids. Welding, including tack welding, will not be permitted on embedded metals within 2 feet of the surface of the concrete.

3.2.2 Concrete on Earth Foundations

Earth surfaces upon which concrete is to be placed shall be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, the earth foundation shall have been satisfactorily compacted in accordance with Section 02331 - EARTHWORK.

3.2.3 Concrete on Rock Foundations

Rock surfaces upon which concrete is to be placed shall be clean, free from oil, standing or running water, ice, mud, drummy rock, coating, debris, and loose, semidetached, or unsound fragments. Joints in rock shall be cleaned to a satisfactory depth, as determined by the Contracting Officer, and to firm rock on the sides. Immediately before the concrete is placed, all rock surfaces shall be cleaned thoroughly by the use of air-water jets or sandblasting as described in paragraph CONSTRUCTION JOINT TREATMENT. All rock surfaces shall be kept continuously wet for at least 24 hours immediately prior to placing concrete thereon. All approximately horizontal surfaces shall be covered, immediately before the concrete is placed, with a layer of mortar proportioned similar to that in the concrete mixture. The mortar shall be covered with concrete before the time of initial setting of the mortar.

3.2.4 Construction Joint Treatment

Construction joint treatment shall conform to the following requirements.

3.2.4.1 Joint Preparation

Concrete surfaces to which additional concrete is to be bonded shall be prepared for receiving the next lift or adjacent concrete by cleaning with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Air-water cutting will not be permitted on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces shall be free from all laitance and inferior concrete so that clean, well bonded coarse aggregate is exposed uniformly throughout the lift surface. The edges of the coarse aggregate shall not be undercut. The surface shall be washed clean again as the last operation prior to placing the next lift. There shall be no standing water on the surface upon which concrete is placed.

3.2.4.2 Air-Water Cutting

Air-water cutting of a construction joint shall be performed at the proper time and only on horizontal construction joints. The air pressure used in the jet shall be 90 to 110 psi, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, the Contractor shall furnish samples of the material to be used and shall demonstrate the method to be used in applications. After cutting, the surface shall be washed and rinsed as long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure water jet or sandblasting will be required as the last operation before placing the next lift.

3.2.4.3 High-Pressure Water Jet

A stream of water, under a pressure of not less than 3,000 psi, may be used for cleaning. Its use shall be delayed until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the water jet is incapable of a satisfactory cleaning, the surface shall be cleaned by sandblasting.

3.2.4.4 Wet Sandblasting

This method may be used when the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. The surface of the concrete shall then be washed thoroughly to remove all loose materials.

3.2.4.5 Waste Disposal

The method used in disposing of waste water employed in cutting, washing, and rinsing of concrete surfaces shall be such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal shall be subject to approval.

3.3 PLACING

3.3.1 Placing Procedures

The surfaces of horizontal construction joints shall be kept continuously wet for the first 12 hours during the 24-hour period prior to placing concrete. Surfaces may be dampened immediately before placement if necessary. Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement and consolidation. Concrete shall be deposited as close as possible to its final position in the forms and, in so depositing, there shall be no vertical drop greater than 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Depositing of the concrete shall be so regulated that it may be effectively consolidated in horizontal layers 2.0 feet or less in thickness with a minimum of lateral movement. The amount deposited in each location shall be that which can be readily and thoroughly consolidated. Sufficient placing capacity shall be provided so that concrete placement can be kept plastic and free of cold joints while concrete is being placed. Concrete shall be placed by methods that will prevent segregation or loss of ingredients. Any concrete transferred from one conveying device to another shall be passed through a hopper that is conical in shape. The concrete shall not be dropped vertically more than 5 feet, except where a properly designed and sized elephant truck with rigid drop chute bottom section is provided to prevent segregation and where specifically authorized. In no case will concrete be discharged to free-fall through reinforcing bars. Full depth special aggregate concrete deck: The Contractor shall place a full depth special

aggregate deck as shown. The prestressed panels are not required to be special aggregate concrete.

3.3.2 Placement by Pump

When concrete is to be placed by pump, the nominal maximum-size coarse aggregate shall not be reduced to accommodate the pumps. The distance to be pumped shall not exceed limits recommended by the pump manufacturer. The concrete shall be supplied to the concrete pump continuously. When pumping is completed, concrete remaining in the pipeline shall be ejected without contamination of concrete in place. After each operation, equipment shall be thoroughly cleaned, and flushing water shall be wasted outside of the forms. Grout used to lubricate the pumping equipment at the beginning of the placement will not be incorporated into the placement.

3.3.3 Time Interval Between Mixing and Placing

Concrete shall be placed within 30 minutes after discharge into nonagitating equipment. When concrete is truck-mixed or when a truck mixer or agitator is used for transporting concrete mixed by a concrete plant mixer, the concrete shall be delivered to the site of the work, and discharge shall be completed within 1-1/2 hours after introduction of the cement to the aggregates. When the length of haul makes it impossible to deliver truck-mixed concrete within these time limits, batching of cement and a portion of the mixing water shall be delayed until the truck mixer is at or near the construction site.

3.3.4 Cold-Weather Placing

When cold-weather placing of concrete is likely to be subjected to freezing temperatures before the expiration of the curing period, it shall be placed in accordance with procedures previously submitted in accordance with paragraph SUBMITTALS. The ambient temperature of the space adjacent to the concrete placement and surfaces to receive concrete shall be above 32 degrees F. The placing temperature of the concrete having a minimum dimension less than 12 inches shall be between 55 and 75 degrees F when measured in accordance with ASTM C 1064/C 1064M. The placing temperature of the concrete having a minimum dimension greater than 12 inches shall be between 50 and 70 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals, or other materials shall not be mixed with the concrete to prevent freezing. Concrete placements with a least dimension of 2.5 feet shall be protected from damaging thermal gradients and temperature conditions as recommended in ACI 207, except as otherwise specified or directed.

3.3.5 Hot-Weather Placing

Concrete shall be properly placed and finished with procedures previously submitted in accordance with paragraph SUBMITTALS. The concrete-placing temperature shall not exceed 85 degrees F when measured in accordance with ASTM C 1064/C 1064M. Cooling of the

mixing water and aggregates, or both, may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph WATER-REDUCING OR RETARDING ADMIXTURES may be used to facilitate placing and finishing. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120 degrees F. Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature. Concrete placements with a least dimension of 2.5 feet shall be protected from damaging thermal gradients and temperature conditions as recommended in ACI 207, except as otherwise specified or directed.

3.3.5.1 Large Placements

The concrete placing temperature, for placements with a least dimension of 2.5 feet shall be less than 75 degrees F. The temperature determination shall be made in the freshly placed concrete. Shaved ice may be used to replace a portion of the mixing water requirement on a direct weight substitution basis. Liquid nitrogen injection in the mixer may also be used. Methods of temperature control proposed for use in hot weather concreting shall be submitted for approval.

3.3.6 Consolidation

Immediately after placement, each layer of concrete, including Controlled Low Strength Material (CLSM) shall be consolidated by internal vibrating equipment. Vibrators shall not be used to transport concrete within the forms. Hand spading may be required, if necessary, with internal vibrating along formed surfaces permanently exposed to view. Form or surface vibrators shall not be used unless specifically approved. The vibrator shall be inserted vertically at uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator. The vibrator shall penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding unhardened layer if such exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly.

3.3.7 Placing Concrete Underwater

Concrete, used to seal the concrete caisions and other placements required in water, shall be deposited in water by a tremie or concrete pump. The methods and equipment used shall be subject to approval. Concrete buckets will not be permitted for underwater placement of concrete except to deliver concrete to the tremie. The tremie shall be watertight and sufficiently large to permit a free flow of concrete. The discharge end of the pump line or tremie shaft shall be kept continuously submerged in the concrete. The underwater seal shall be effected in a manner that will not produce undue turbulence in the water. The tremie shaft shall be kept full of concrete to a point well above the water surface. Placement shall proceed without interruption until the concrete has been brought to the required height. The tremie shall not be moved horizontally during a placing operation, and a sufficient number of tremies shall be provided so that the maximum horizontal flow will be limited to 15 feet.

3.4 FINISHING

The ambient temperature of spaces adjacent to surfaces being finished shall be not less than 40 degrees F. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 0.2 pounds per square foot per hour. Provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow. All unformed surfaces that are not to be covered by additional concrete or backfill shall have a float finish. Additional finishing shall be as specified below and shall be true to the elevation shown in the drawings. Surfaces to receive additional concrete or backfill shall be brought to the elevation shown on the drawings and left true and regular. Exterior surfaces shall be sloped for drainage unless otherwise shown in the drawing or as directed. Joints shall be carefully made with a jointing or edging tool. The finished surfaces shall be protected from stains or abrasions. Grate tampers or jitterbugs shall not be used.

3.4.1 Unformed Surfaces

3.4.1.1 Float Finish

All unformed surfaces shall be screeded and darbied or bullfloated to bring the surface to the required finish level with no coarse aggregate visible. No water, cement, or mortar shall be added to the surface during the finishing operation. The concrete, while still green but sufficiently hardened to bear a man's weight without deep imprint, shall be floated to a true and even plane. Floating may be performed by use of suitable hand floats or power-driven equipment. Hand floats shall be made of magnesium or aluminum.

3.4.1.2 Trowel Finish

A trowel finish shall be applied to unformed surfaces where indicated. Concrete surfaces shall be finished with a float finish, and after surface moisture has disappeared, the surface shall be troweled to a smooth, even, dense finish free from blemishes including trowel marks.

3.4.1.3 Broom Finish

A broom finish shall be applied as the final surface texturing for slabs on grade, which will be subject to vehicle or pedestrian traffic. The concrete surface shall be given a float finish. The floated surface shall be broomed with a fiber-bristle brush in a direction transverse to that of the main traffic

3.4.1.4 Wire-Comb Texturing

Surface texture transverse to the pavement centerline shall be applied using a mechanical wire comb drag. The comb shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the

comb shall be overlapped the minimum necessary to obtain a continuous and uniformly textured surface. The scores shall be 1/8 to 3/16 inch deep, 1/16 to 1/8 inch wide, and spaced 1/2 inch apart. Special aggregate concrete decks and other surfaces as shown shall be given a uniformly textured surface finish by use of a Kansas Mop. The finished texture shall consist of transverse grooves approximately 0.125 inches (3.2 mm) deep spaced at 1/2 inch (12.5 mm) centers. The Kansas Mop and the manner and time of it's use shall be such as to result in a uniform texture without tearing or unduly roughening the concrete.

3.4.2 Formed Surfaces

Unless another finish is specified, surfaces shall be left with the texture imparted by the forms except that defective surfaces shall be repaired as described in paragraph FORMED SURFACE REPAIR. Unless painting of surfaces is required, uniform color of the concrete shall be maintained by use of only one mixture without changes in materials or proportions for any structure or portion of structure that is exposed to view or on which a special finish is required. The form panels used to produce the finish shall be orderly in arrangement, with joints between panels planned in approved relation to openings, building corners, and other architectural features. The finished surface of textured, tooled, and other architectural finishes shall duplicate the pre-approved sample panel. The sample panel shall be prepared in accordance with Section 03101 FORMWORK FOR CONCRETE. Forms shall not be reused if there is any evidence of surface wear or defects that would impair the quality of the surface.

3.4.2.1 Textured Finish

Textured finish shall be applied where specified or indicated, unless otherwise directed. This type of finish shall be applied where specified to conform to details shown in the drawings by use of approved textured form liners. Liner panels shall be secured in the forms by methods recommended by the manufacturer but not by methods that will permit impressions of nail heads, screw heads, washers, or the like to be imparted to the surface of the concrete. Edges of textured panels shall be sealed to each other to prevent grout leakage. The sealant used shall be nonstaining to the surface. The finish shall be similar to and shall closely match the finish on the sample panel.

3.4.2.2 Tooled Finish

Tooled finish shall be applied where specified or indicated, unless otherwise directed. The thoroughly cured concrete shall be dressed with electric, air, or hand tools to a uniform texture and shall be given a hand-tooled surface texture. The finish shall be similar to and shall closely match the finish on the sample panel.

3.4.3 Formed Surface Repair

After removal of forms, all ridges, lips, and bulges on surfaces permanently exposed shall be removed. All repairs shall be completed within 48 hours after form removal.

3.4.3.1 Class A Finish

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE and as shown to have a class A finish shall have surface defects repaired as follows: defective areas, voids, and honeycombs smaller than 16 square inches in area and less than 1/2 inch deep and bug holes exceeding 1/2 inch in diameter shall be chipped and filled with dry-packed mortar. Holes left by removal of tie rods shall be reamed and filled with dry-packed mortar as specified in paragraph MATERIAL AND PROCEDURE FOR REPAIRS. Defective and unsound concrete areas larger than described shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern with lines parallel to the formwork, the defective concrete removed by chipping, and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin meeting the requirements of paragraph EPOXY RESIN, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.3.2 Class C and Class D Finishes

Surfaces listed in Section 03101 FORMWORK FOR CONCRETE and as shown shall have defects repaired as follows: defective areas, voids, and honeycombs smaller than 24 square inches and less than 2 inches deep; bug holes exceeding 1-1/2 inches in diameter shall be chipped and filled with dry-packed mortar; and holes left by removal of the tie rods shall be chipped and filled with dry-packed mortar. Defective and unsound concrete areas larger than 24 square inches and deeper than 1-1/2 inches shall be defined by 1/2 inch deep dovetailed saw cuts in a rectangular pattern, the defective concrete removed by chipping, and the void repaired with replacement concrete. The prepared area shall be brush-coated with an epoxy resin meeting the requirements of paragraph EPOXY RESIN, or a neat cement grout after dampening the area with water. The void shall be filled with replacement concrete in accordance with paragraph MATERIAL AND PROCEDURE FOR REPAIRS.

3.4.3.3 Material and Procedure for Repairs

The cement used in the dry-packed mortar or replacement concrete shall be a blend of the cement used for production of project concrete and white portland cement properly proportioned so that the final color of the mortar or concrete will match adjacent concrete. Trial batches shall be used to determine the proportions required to match colors. Dry-packed mortar shall consist of one part cement to two and one-half parts fine aggregate. The fine aggregate shall be that used for production of project concrete. The mortar shall be remixed over a period of at least 30 minutes without addition of water until it obtains the stiffest consistency that will permit placing. Mortar shall be thoroughly compacted into the prepared void by tamping, rodding, ramming, etc. and struck off to match adjacent concrete.

Replacement concrete shall be produced using project materials and shall be proportioned by the Contracting Officer. It shall be thoroughly compacted into the prepared void by internal vibration, tamping, rodding, ramming, etc. and shall be struck off and finished to match adjacent concrete. Forms shall be used to confine the concrete. If an expanding agent is used in the repair concrete, the repair shall be thoroughly confined on all sides including the top surface. Metal tools shall not be used to finish permanently exposed surfaces. The repaired areas shall be cured for 7 days. The temperature of the in situ concrete, adjacent air, and replacement mortar or concrete shall be above 40 degrees F during placement, finishing, and curing. Other methods and materials for repair may be used only when approved in writing by the Contracting Officer. Repairs of the so called "plaster-type" will not be permitted.

3.5 CURING AND PROTECTION

3.5.1 Duration

All concrete shall be cured by an approved method. Curing effectiveness and methods shall be continuously maintained to ensure that concrete curing is uninterrupted for the entire curing period.

Concrete produced with Type I or III Portland cement shall be cured for at least 7 days.

Concrete containing Type II Portland cement, or fly ash shall be cured for at least 14 days.

Concrete containing GGBF slag shall be cured for at least 21 days.

Curing of the special aggregate concrete shall be a continuously applied wet cure for a minimum to 120 hours. The special aggregate concrete shall be covered with a wet burlap or wet cotton mat covering and water applied to the mats to maintain a wet condition.

Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, and mechanical damage. All materials and equipment needed for adequate curing and protection shall be available and at the placement site prior to the start of concrete placement. Concrete shall be protected from the damaging effects of rain for 12 hours and from flowing water for 14 days. No fire or excessive heat including welding shall be permitted near or in direct contact with concrete or concrete embedments at any time. Concrete placements with a least dimension of 2.5 feet shall be protected from damaging thermal gradients and temperature conditions as recommended in ACI 207 , except as otherwise specified or directed. The contractor shall provide, install, and monitor approved concrete temperature sensors in the middle of each placement lift, near the free surface of each lift. The air temperature near the placement shall be monitored by approved methods. The Contractor shall accomplish temperature monitoring at least twice per shift, and more frequently if required due to changing

temperature conditions. The temperature data shall be collected and stored in an approved data logger, which can be downloaded to paper printout (and electronic data storage and processing software if required for evaluation). A record of all readings shall be maintained and evaluated for adequacy of protection by the Contractor. Certified report of temperature data, times of temperature monitoring and results of data evaluation shall be reported daily in writing to the Contracting Officer. Temperature monitoring and concrete protection shall be continuously maintained until concrete thermal conditions as determined in accordance with ACI 207 indicate that the concrete will not be subject to damaging thermal conditions, but not less than the specified curing period.

3.5.2 Moist Curing

Moist-cured concrete shall be maintained continuously, not periodically, wet for the entire curing period. If water or curing materials stain or discolor concrete surfaces that are to be permanently exposed, they shall be cleaned as required in paragraph APPEARANCE. Where wooden form sheathing is left in place during curing, the sheathing shall be kept wet at all times. Where steel forms are left in place during curing, the forms shall be carefully broken loose from the hardened concrete and curing water continuously applied into the void so as to continuously saturate the entire concrete surface. Horizontal surfaces may be moist cured by ponding, by covering with a minimum uniform thickness of 2 inches of continuously saturated sand, or by covering with saturated nonstaining burlap or cotton mats. Horizontal construction joints may be allowed to dry for 12 hours immediately prior to the placing of the following lift.

3.5.3 Membrane-Forming Curing Compound

Concrete may be cured with an approved membrane-forming curing compound in lieu of moist curing except that membrane curing will not be permitted on any surface to which a grout-cleaned finish is to be applied or other concrete is to be bonded, on any surface containing protruding steel reinforcement, on an abrasive aggregate finish, or any surface maintained at curing temperature by use of free steam. A styrene acrylate or chlorinated rubber compound may be used for surfaces that are to be painted or are to receive bituminous roofing or waterproofing, or for floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified.

3.5.3.1 Pigmented Curing Compound

A pigmented curing compound meeting the requirements of the above paragraph MEMBRANE-FORMING CURING COMPOUND may be used on surfaces that will not be exposed to view when the project is completed.

3.5.3.2 Nonpigmented Curing Compound

A nonpigmented curing compound containing a fugitive dye may be used on surfaces that will be exposed to view when the project is completed. Concrete cured with nonpigmented curing compound must be shaded from the sun for the first 3 days when the ambient temperature is 90 degrees F or higher.

3.5.3.3 Application

The curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. The surfaces shall be thoroughly moistened with water, and the curing compound applied as soon as free water disappears. The curing compound shall be applied to unformed surfaces as soon as free water has disappeared and bleeding has stopped. The curing compound shall be applied in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 75 psi, at a uniform coverage of not more than 400 square feet per gallon for each coat, and the second coat shall be applied perpendicular to the first coat. Concrete surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. All concrete surfaces on which the curing compound has been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause that will disrupt the continuity of the curing membrane.

3.5.4 Evaporation Retardant

Sheet curing shall not be used on vertical or near-vertical surfaces. All surfaces shall be thoroughly wetted and be completely covered with waterproof paper or polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Covering shall be laid with light-colored side up. Covering shall be lapped not less than 12 inches and securely weighted down or shall be lapped not less than 4 inches and taped to form a continuous cover with completely closed joints. The sheet shall be weighted to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Coverings shall be folded down over exposed edges of slabs and secured by approved means. Sheets shall be immediately repaired or replaced if tears or holes appear during the curing period.

3.5.5 Cold-Weather Curing and Protection

When the daily outdoor low temperature is less than 32 degrees F, the temperature of the concrete shall be maintained above 40 degrees F for the first 7 days after placing. In addition, during the period of protection removal, the air temperature adjacent to the concrete surfaces shall be controlled so that concrete near the surface will not be subjected to a temperature differential of more than 25 degrees F as determined by observation of ambient and concrete temperatures indicated by suitable temperatures measuring devices furnished by the Contractor as required and installed adjacent to the concrete surface

and 2 inches inside the surface of the concrete. The installation of the thermometers shall be made by the Contractor at such locations as may be directed.

3.5.6 Hot Weather Curing and Protection

WHEN THE RATE OF EVAPORATION OF SURFACE MOISTURE, AS DETERMINED BY USE OF FIG. 2.1.5 OF ACI 305, MAY REASONABLY BE EXPECTED TO EXCEED 0.2 POUNDS PER SQUARE FOOT PER HOUR, PROVISIONS FOR WINDBREAKS, SHADING, FOG SPRAYING, OR WET COVERING WITH A LIGHT COLORED MATERIAL SHALL BE MADE IN ADVANCE OF PLACEMENT, AND SUCH PROTECTIVE MEASURES SHALL BE TAKEN AS QUICKLY AS FINISHING OPERATIONS WILL ALLOW.3.6 SETTING OF BASE PLATES AND BEARING PLATES

3.6.1 Setting of Plates

After being plumbed and properly positioned, column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates shall be provided with full bearing with nonshrink grout. The space between the top of concrete or masonry-bearing surface and the bottom of the plate shall be approximately 1/24 of the width of the plate, but not less than 1/2 inch for plates less than 12 inches wide. Concrete surfaces shall be rough, clean, and free of oil, grease, and laitance, and they shall be damp. Metal surfaces shall be clean and free of oil, grease, and rust.

3.6.2 Nonshrink Grout Application

Nonshrink grout shall conform to the requirements of paragraph NONSHRINK GROUT. Water content shall be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.6.2.1 Mixing and Placing of Nonshrink Grout

Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified. Ingredients shall be thoroughly dry-mixed before adding water. After adding water, the batch shall be mixed for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. The space between the top of the concrete or masonry-bearing surface and the plate shall be filled solid with the grout. Forms shall be of wood or other equally suitable material for retaining the grout and shall be removed after the grout has set. If grade "A" grout as specified in ASTM C 1107 is used, all surfaces shall be formed to provide restraint. The placed grout shall be worked to eliminate voids; however, overworking and breakdown of the initial set shall be avoided. Grout shall not be retempered or subjected to vibration from any source. Where clearances are unusually small, placement shall be under pressure with a grout pump. Temperature of the grout, and of surfaces receiving the grout, shall be maintained at 65 to 85 degrees F until after setting.

3.6.2.2 Treatment of Exposed Surfaces

After the grout has set, those types containing metallic aggregate shall have the exposed surfaces cut back 1 inch and immediately covered with a parge coat of mortar proportioned by mass of one part portland cement, two parts sand, and sufficient water to make the mixture placeable. The parge coat shall have a smooth, dense finish. The exposed surface of other types of nonshrink grout shall have a smooth, dense finish.

3.6.2.3 Curing

Grout and parge coats shall be cured in conformance with paragraph CURING AND PROTECTION.

3.7 TESTS AND INSPECTIONS

Tests and inspections shall conform to the following requirements.

3.7.1 General

The Contractor shall perform the inspections and tests described below, and, based upon the results of these inspections and tests, he shall take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, concrete placement shall cease. The laboratory performing the tests shall conform with ASTM C 1077. The laboratory shall be located onsite. (An offsite laboratory may be used, subject to the approval of the Contracting Officer.) The individuals who sample and test concrete or the constituents of concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete construction shall have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Transportation Construction Inspector (CTCI). The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C 1077.

3.7.2 Testing and Inspection Requirements

3.7.2.1 Fine Aggregate

a. Grading - At least once during each shift when the concrete plant is operating, there shall be one sieve analysis and fineness modulus determination in accordance with ASTM C 136 and COE CRD-C 104 for the fine aggregate or for each size range of fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

b. Corrective Action for Fine Aggregate Grading - When the amount passing on any sieve is outside the specification limits,

the fine aggregate shall be immediately resampled and retested. If there is another failure on any sieve, the fact shall immediately be reported to the Contracting Officer.

c. Moisture Content Testing - When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, there shall be at least four tests for moisture content in accordance with ASTM C 566 during each 8-hour period of mixing plant operation. The times for the tests shall be selected randomly within the 8-hour period. An additional test shall be made whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, at least two direct measurements of moisture content shall be made per week to check the calibration of the meter. The results of tests for moisture content shall be used to adjust the added water in the control of the batch plant.

d. Moisture Content Corrective Action - Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, the scale settings for the fine-aggregate batcher and water batcher shall be adjusted (directly or by means of a moisture compensation device) if necessary to maintain the specified slump.

3.7.2.2 Coarse Aggregate

a. Grading - At least once during each consecutive 8 hours of operations in which the concrete plant is operating, there shall be a sieve analysis in accordance with ASTM C 136 for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. However, the Contractor shall be responsible for delivering the aggregate to the mixer within specification limits. A test record of samples of aggregate taken at the same locations shall show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for graduation control which are coarser than the specification limits for samples taken at locations other than as delivered to the mixer to allow for degradation during handling.

b. Corrective Action for Grading - When the amount passing any sieve is outside the specification limits, the coarse aggregate shall be immediately resampled and retested. If the second sample fails on any sieve, that fact shall be reported to the Contracting Officer. Where two consecutive averages of five tests are outside specification limits, the operation shall be considered out of control and shall be reported to the Contracting Officer. Concreting shall be stopped and immediate steps shall be taken to correct the grading.

c. Coarse Aggregate Moisture Content - A test for moisture content of each size group of coarse aggregate shall be made at least twice per week. When two consecutive readings for smallest

size coarse aggregate differ by more than 1.0 percent, frequency of testing shall be increased to that specified above for fine aggregate, until the difference falls below 1.0 percent.

d. Coarse Aggregate Moisture Corrective Action - Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more, the scale setting for the coarse aggregate batcher and the water batcher shall be adjusted if necessary to maintain the specified slump.

3.7.2.3 Quality of Aggregates

a. Frequency of Quality Tests - Thirty days prior to the start of concrete placement the Contractor shall perform all tests for aggregate quality listed below. In addition, after the start of concrete placement, the Contractor shall perform tests for aggregate quality in accordance with the frequency schedule shown below. Samples tested after the start of concrete placement shall be taken immediately prior to entering the concrete mixer.

PROPERTY	FREQUENCY FINE AGGREGATE	FREQUENCY COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C 127 ASTM C 128
Absorption	Every 3 months	Every 3 months	ASTM C 127 ASTM C 128
Durability Factor Using, (Procedure A)	Every 12 months	Every 12 months	COE CRD-C 114 ASTM C 666
Alkali Reactivity	Every 3 months	Every 3 months	ASTM C 1260
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C 142
Material Finer than the 75-m (No. 200) Sieve	Not applicable	Every 3 months	ASTM C 117
Impurities	Every 3 months	Not applicable	ASTM C 40 ASTM C 87

L.A. Abrasion	Not applicable	Every 6 months	ASTM C 131 ASTM C 535
Petrographic Examination	Every 6 months	Every 6 months	ASTM C 295
Total Chert, than less 2.40 specific gravity	Every 6 months	Every 4 hours	ASTM C 123
Coal and Lignite, less than 2.00 gravity	Every 6 months	Every 6 months	ASTM C 123

b. Corrective Action for Aggregate Quality - If the result of a quality test fails to meet the requirements for quality immediately prior to start of concrete placement, production procedures or materials shall be changed and additional tests shall be performed until the material meets the quality requirements prior to proceeding with either mixture proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, the test shall be rerun immediately. If the second test fails the quality requirement, the fact shall be reported to the Contracting Officer and immediate steps taken to rectify the situation.

3.7.2.4 Scales

a. Weighing Accuracy - The accuracy of the scales shall be checked by test weights prior to start of concrete operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT. Such tests shall also be made as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

b. Batching and Recording Accuracy - Once a week the accuracy of each batching and recording device shall be checked during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. The Contractor shall confirm that the calibration devices described in paragraph BATCH PLANT for checking the accuracy of dispensed admixtures are operating properly.

c. Scales Corrective Action - When either the weighing accuracy or batching accuracy does not comply with specification requirements, the plant shall not be operated until necessary

adjustments or repairs have been made. Discrepancies in recording accuracies shall be corrected immediately.

3.7.2.5 Batch-Plant Control

The measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures shall be continuously controlled. The aggregate weights and amount of added water shall be adjusted as necessary to compensate for free moisture in the aggregates. The amount of air-entraining agent shall be adjusted to control air content within specified limits. A report shall be prepared indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic yard for each class of concrete batched during plant operation.

3.7.2.6 Concrete Mixture

a. Air Content Testing - Air content tests shall be made when test specimens are fabricated. In addition, at least two tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government quality assurance representative. Tests shall be made in accordance with ASTM C 231. Test results shall be plotted on control charts which shall at all times be readily available to the Government. Copies of the current control charts shall be kept in the field by the Contractor's quality control representatives and results plotted as tests are made. When a single test result reaches either the upper or lower action limit a second test shall immediately be made. The results of the two tests shall be averaged and this average used as the air content of the batch to plot on both the control chart for air content and the control chart for range, and for determining the need for any remedial action. The result of each test, or average as noted in the previous sentence, shall be plotted on a separate chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph AIR CONTENT. An upper warning limit and a lower warning limit line shall be set 1.0 percentage point above and below the average line. An upper action limit and a lower action limit line shall be set 1.5 percentage points above and below the average line, respectively. The range between each two consecutive tests shall be plotted on a control chart for range where an upper warning limit is set at 2.0 percentage points and up upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the Contractor's materials or transportation methods cause air content loss between the mixer and the placement, correlation samples shall be taken at the placement site as required by the

Contracting Officer and the air content at the mixer controlled as directed.

b. Air Content Corrective Action - Whenever points on the control chart for percent air reach either warning limit, an adjustment shall immediately be made in the amount of air-entraining admixture batched. As soon as is practical after each adjustment, another test shall be made to verify the result of the adjustment. Whenever a point on the control chart range reaches the warning limit, the admixture dispenser shall be recalibrated to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content shall be considered out of control and the concreting operation shall immediately be halted until the air content is under control. Additional air content tests shall be made when concreting is restarted. All this shall be at no extra cost to the Government.

c. Slump Testing - In addition to slump tests which shall be made when test specimens are fabricated, at least four slump tests shall be made on randomly selected batches in accordance with ASTM C 143/C 143M for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government's quality assurance representative. Test results shall be plotted on control charts which shall at all times be readily available to the Government. Copies of the current control charts shall be kept in the field by the Contractor's quality control representatives and results plotted as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, a second test shall immediately be made on the same batch of concrete. The results of the two tests shall be averaged and this average used as the slump of the batch to plot on both the control chart for percent air and the chart for range, and for determining the need for any remedial action. An upper warning limit shall be set at 1/2 inch below the maximum allowable slump on separate control charts for percent air used for each type of mixture as specified in paragraph SLUMP, and an upper action limit line and lower action limit line shall be set at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. The range between each consecutive slump test for each type of mixture shall be plotted on a single control chart for range on which an upper action limit is set at 2 inches. Samples for slump shall be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the Contractor's materials or transportation methods cause slump loss between mixer and the placement, correlation samples shall be taken at the placement site as required by the Contracting Officer and the slump at the mixer controlled as directed.

d. Slump Corrective Action - Whenever points on the control chart for slump reach the upper warning limit, an adjustment shall be immediately made in the batch weights of water and fine aggregate. The adjustments are to be made so that the total

water content does not exceed that amount allowed by the maximum W/C specified, based upon aggregates which are in a saturated surface-dry condition. When a single slump reaches the upper or lower action limit, no further concrete shall be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, another test shall be made to verify the correctness of the adjustment. Whenever two consecutive slump tests, made during a period when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, the concreting operation shall immediately be halted and the Contractor shall take appropriate steps to bring the slump under control. Also, additional slump tests shall be made as directed. All this shall be at no additional cost to the Government.

e. Temperature - The temperature of the concrete shall be measured when compressive strength specimens are fabricated. Measurement shall be in accordance with ASTM C 1064/C 1064M. The temperature shall be reported along with the compressive strength data. During hot weather conditions, mass or large placements with a least dimension of 2.5 feet shall have a temperature meassurement made for each batch or delivery at the placement location, prior to placement.

f. Compressive-Strength Specimens - At least one set of test specimens shall be made each day on each different concrete mixture placed during the day, except special aggregate concrete. At least one set of test specimens shall be made for special aggregate concrete for every 50 cubic yards, or fraction thereof, placed in one continuous operation. Additional sets of test cylinders shall be made, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. A random sampling plan shall be developed by the Contractor and approved by the Contracting Officer prior to the start of construction. The plan shall assure that sampling is done in a completely random and unbiased manner. A set of test specimens for concrete with a 28-day specified strength per paragraph DESIGN REQUIREMENTS shall consist of four cylinders, two to be tested at 7 days and two at 28 days. A set of test specimens for concrete with a 7-day strength per specified paragraph DESIGN REQUIREMENTS shall consist of six cylinders, two tested at 3 days, two at 7 days, and two at 28 days. Test specimens shall be molded and cured in accordance with ASTM C 31/C 31M and tested in accordance with ASTM C 39/C 39M. All compressive-strength tests shall be reported immediately to the Contracting Officer. Quality control charts shall be kept for individual strength tests, moving average for strength, and moving average for range for each mixture. The charts shall be similar to those found in ACI 214.

3.7.2.7 Inspection Before Placing

Foundation or construction joints, forms, and embedded items shall be inspected for quality by the Contractor in sufficient time prior to each concrete placement to certify to the Contracting Officer that

they are ready to receive concrete. The results of each inspection shall be reported in writing.

3.7.2.8 Placing

a. Placing Inspection - The placing foreman shall supervise all placing operations, shall determine that the correct quality of concrete or grout is placed in each location as directed and shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, yardage placed, and method of placement.

b. Placing Corrective Action - The placing foreman shall not permit batching and placing to begin until he has verified that an adequate number of vibrators in working order and with competent operators are available. Placing shall not be continued if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, immediate steps shall be taken to improve temperature controls.

3.7.2.9 Vibrators

a. Vibrator Testing and Use - The frequency and amplitude of each vibrator shall be determined in accordance with COE CRD-C 521prior to initial use and at least once a month when concrete is being placed. Additional tests shall be made as directed when a vibrator does not appear to be adequately consolidating the concrete. The frequency shall be determined at the same time the vibrator is operating in concrete with the tachometer held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete. The amplitude shall be determined with the head vibrating in air. Two measurements shall be taken, one near the tip and another near the upper end of the vibrator head and these results averaged. The make, model, type, and size of the vibrator and frequency and amplitude results shall be reported in writing.

b. Vibrator Corrective Action - Any vibrator not meeting the requirements of paragraph VIBRATORS shall be immediately removed from service and repaired or replaced.

3.7.2.10 Curing

a. Moist-Curing Inspections - At least once each shift, and once per day on nonwork days an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded.

b. Moist-Curing Corrective Action - When a daily inspection report lists an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for such areas shall be extended by one (1) day.

c. Membrane-Curing Inspection - No curing compound shall be applied until the Contractor's authorized representative has verified that the compound is properly mixed and ready for spraying. At the end of each operation, he shall estimate the quantity of compound used by measurement of the container and the area of concrete surface covered and compute the rate of coverage in square feet per gallon. He shall note whether or not coverage is uniform.

d. Membrane-Curing Corrective Action - When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

e. Sheet-Curing Inspection - At least once each shift and once per day on nonwork days, an inspection shall be made of all areas being cured using material sheets. The condition of the covering and the tightness of the laps and tapes shall be noted and recorded.

f. Sheet-Curing Corrective Action - When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, the tears and holes shall promptly be repaired or the sheets replaced, the joints closed, and the required curing period for those areas shall be extended by one (1) day.

3.7.2.11 Cold-Weather Protection and Sealed Insulation Curing

At least once each shift and once per day on nonwork days, an inspection shall be made of all areas subject to cold-weather protection. The protection system shall be inspected for holes, tears, unsealed joints, or other deficiencies that could result in damage to the concrete. Special attention shall be taken at edges, corners, and thin sections. Any deficiencies shall be noted, corrected, and reported.

3.7.2.12 Cold-Weather Protection Corrective Action

When a daily inspection report lists any holes, tears, unsealed joints, or other deficiencies, the deficiency shall be corrected immediately and the period of protection extended 1 day.

3.7.2.13 Mixer Uniformity

a. Stationary Mixers - Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 75,000 cubic yards of concrete placed, whichever results in the longest time interval, uniformity of concrete mixing shall be determined in accordance with ASTM C 94/C 94M.

b. Truck Mixers - Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, uniformity of concrete shall be determined in accordance with ASTM C 94/C 94M. The truck mixers shall be selected randomly for testing. When satisfactory performance is found in one truck

mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

3.7.2.14 Mixer Uniformity Corrective Action

When a mixer fails to meet mixer uniformity requirements, either the mixer shall be removed from service on the work, the mixing time shall be increased, batching sequence changed, batch size reduced, or adjustments shall be made to the mixer until compliance is achieved.

3.7.3 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report shall be prepared for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all test and inspection records.

LIST OF COARSE AGGREGATE SOURCES

QUARRIES	COUNTY	STATE	GEOLOGICAL UNIT
LaFarge (Menefee) - Dresden Quarry Sec. 23, T.46N, R22W Sedalia, MO 816-826-0328	Pettis	MO	Burlington LS
Fischer Quarries Sec 17, T46, R21 Hughesville, MO 660-829-5555, 800-352-1517	Pettis	MO	Burlington LS
Hilty Quarries - Snyder QuarrY Sec. 16, T39N, R25W Clinton, MO 816-855-8135	St. Clair	MO	Burlington LS
Hilty Quarries			

- Tightwad Quarry Benton MO
Burlington LS
Sec. 3 & 34, T41N, R24W
Clinton, MO
816-855-8135

Hilty Quarries
- Warsaw North Quarry Benton MO
Burlington LS
Sec. 15, T41N, R23W
Clinton, MO
816-855-8135

Hilty Quarries
- Warsaw South Quarry Benton MO
Burlington LS
Sec. 4 T39N, R22W
Clinton, MO
816-855-8135

Ash Grove Aggregates
- Wheatland QRY Hickory MO
Burlington LS
Sec. 2, T37N, R23W
Butler, MO
816-679-4128

LIST OF FINE AGGREGATE SOURCES

SOURCE	LOCATIONS	GEOLOGICAL UNIT
Commercial Producers Alluvial Sand	Kansas & Missouri Rivers	Natural

LIST OF COARSE SPECIAL AGGREGATE SOURCES (ABRASIVE)

SOURCE	LOCATIONS	GEOLOGICAL UNIT
Iron Mountain Trap Rock Co.,	Sec. 29, 30 & 31, T 35 N, R 4 E, St. Francois County, Iron Mountain, Missouri 63649	Felsite Porphyry
Concrete Materials Quarry	Sec. 18, T. 101 N., R. 49 W. Minnehaha County Sioux Falls, South Dakota	Sioux Quartzite
Dell Rapids Quarry L. G. Everist	Sec. 10, T 104 N, R 49 W, Minnehaha County Sioux Falls, South Dakota	Sioux Quartzite

LIST OF FINE SPECIAL AGGREGATE SOURCES (ABRASIVE)

SOURCE	LOCATIONS	GEOLOGICAL UNIT
Commercial Producers	Kansas & Missouri Rivers	Natural Alluvial Sand

Sec 5, T52N, R21W

Listing of a source is not to be construed as approval of all material from the source. The right is reserved to reject materials from certain localized areas, zones, strata, or channels when such materials are unsuitable as determined by the Contracting Officer. A winter quarrying prohibition is in effect for this Contract.

Materials may be furnished from any of the above listed sources or, at the option of the Contractor, may be furnished from any other source designated by the Contractor and approved by the Contracting Officer.

-- End Of Section --